

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

110.899 Thesis

Presented in partial fulfilment of the requirements for MBS degree

**Mandatory Recognition of Externalities, Price Elasticity and the Market
Value of Firms**

Name: John Mead

Student ID: 03400816

School of Accountancy

Massey University

2009

Mandatory Recognition of Externalities, Price Elasticity and the Market Value of Firms

ABSTRACT

The scene for environmental performance and disclosures is changing rapidly from that of a voluntary state to one where both are being mandated. One such regulatory initiative is that of the European Union Emissions Trading Scheme (EU ETS), under which all firms within certain industries have to comply with similar environmental performance and disclosure requirements. The imposition of such requirements can have both adverse and beneficial effects on firm value. The purpose of this study is to examine how EU ETS membership affects the market value of European firms. Using a sample of 1,985 firm-year observations from Great Britain, France, Germany, Spain and Italy, I find that joining the EU ETS has a positive impact on firm value, and this impact is larger for firms with high price elasticity of demand (PED). These findings suggest that a regulated environmental performance and environmental disclosure setting is likely to reduce uncertainties pertaining to externalities, in particular, for firms which are unable to shift their externality costs to their consumers.

ACKNOWLEDGEMENTS

This paper has benefited from presentations at Massey University. I appreciate helpful comments and suggestions from Asheq Rahman and Steve Courtenay, (supervisors), and Paul Dunmore, Jill Hooks, Michael Bradbury, Natasja Steenkamp, Nicholas Smith, Helen Bishop, and Warwick Stent. I also wish to thank Andrew Brown for technical support.

TABLE OF CONTENTS

	Page
Abstract	1
Acknowledgements	2
Table of contents	3
List of tables	4
Introduction	5
Background	8
Literature review	16
Hypotheses	24
Sample selection and variable measurement	30
Results	34
Discussion	45
Conclusions, limitations & future research	49
References	53
Appendix 1	71
Appendix 2	75

LIST OF TABLES

	Page
Table 1: Sample details	59
Table 2: Carbon allowances	60
Table 3: Descriptive statistics for all countries	61
Table 4: Descriptive statistics all industries	63
Table 5: T Tests	64
Table 6: Correlations merged	65
Table 7: Regressions H1	66
Table 8: Regressions H2	67
Table 9: Regressions H3a	68
Table 10: Regressions H3b	69
Table 11: Regressions industry sectors	70

INTRODUCTION

Studies examining the value relevance of corporate environmental performance information find that such information is beneficial to investors in assessing environmental liabilities in different settings (Dhaliwal, 2008), and the likely impact of this is the decrease in market returns (Chapple, Clarkson & Gold, 2009), lowering of the cost of capital (Clarkson, et al, 2008) or better forecast accuracy (Aerts, Cormier & Magnan, 2007). These studies primarily attempt to evaluate whether or not voluntary environmental disclosures reduce information asymmetry pertaining to externalities, and their findings indicate such disclosures can be useful in reducing adverse selection risk.

Most of the environmental disclosure studies have been conducted in voluntary disclosure settings, where firms choose to disclose information about externalities only when it is beneficial to them. This is consistent with Dye's (2001, p. 184) disclosure theory that "any entity contemplating making a disclosure will disclose information that is favourable to the entity, and will not disclose information unfavourable to the entity." In this light, a firm disclosing information on externalities faces the risk of revealing the negative financial consequences of externalities, but at the same time could be avoiding penalties for not disclosing such information. Non-disclosure creates uncertainties, which leads investors to discount the value of the firm for the presumed effects of potential liabilities (externalities) on a firm's financial performance. This is known as the disclosure principle (Verrecchia, 1983).

The scene for environmental disclosures is changing rapidly from that of a voluntary state to one where both environmental performance and environmental disclosures are being mandated. I examine the effects of one such regulatory initiative, that of the European Union Emissions Trading Scheme (EU ETS), under which all firms within certain industries must comply with certain environmental performance and disclosure requirements.

The EU ETS was enacted in 2005 in response to EU's obligations under the 1992 Kyoto Treaty. Its purpose is to create a regulatory environment to control carbon dioxide (CO₂) emissions within the EU. It uses a tradable permits market-based system enforced by statutory penalties. The EU ETS with its regulatory internalisation of the cost of CO₂ emissions provides the opportunity to investigate the value relevance of externalities and

externalities disclosure in a mandatory environment. Because of the mandatory nature of the scheme, firms that were previously reluctant to disclose due to the adverse financial consequences of the revelation of externalities must make externalities disclosures. The question, therefore, is what valuation effects the firms face under the mandatory imposition of the EU ETS regulatory regime.

All the EU ETS firms are required to follow the same set of rules for environmental performance and disclosures. The imposition of externalities regulation is likely to have both adverse and beneficial effects. The adverse effect is the internalisation or recognition of the environmental externalities in the form of additional operating costs. The beneficial effect is an information effect. Investors, who previously were discounting the value of the firm due to lack of information, are better able to value the firm with more specific environmental information. With reduced discounting for uncertainties, they are likely to value the firm upwards.

The purpose of this study is to examine how EU ETS membership affects the market value of EU ETS firms' equities. I consider both the adverse effects and the beneficial effects arguments to formulate the hypotheses. However, I also carefully consider one other important feature of firms which, I argue, mediates the relation between firm value and the recognition and disclosure of externalities. This feature is the price elasticity of demand (PED) of a firm's products.

A shortcoming of prior research is that the studies were done without the inclusion of pertinent microeconomic variables. One critical assumption that underpins most prior studies is that all firms are affected by externalities in a similar manner. From an economic standpoint, this premise is flawed. The PED literature states that firms dealing with products with inelastic demand are able to shift their costs to the consumers (Bernstein & Griffin, 2006; Weisman, 2007). This behaviour is also likely to occur when costs relating to externalities are imposed on firms.

From the adverse effect perspective, I argue that firms in industries with products that have inelastic PED shift the costs of externalities to the consumers when they are mandated to internalize externalities. Consequently, they will not suffer any significant adverse consequences from EU ETS membership. However, firms with products that have high PED

will have to absorb the costs of externalities. Consequently, they may suffer significant adverse valuation consequences.

From the information effects perspective, the consequences are likely to be different. Firms that have low PED will continue to enjoy the same benefit of no adverse effects on firm value as they will continue to shift the costs of externalities to consumers. Perhaps, they may benefit to some extent because the EU ETS lowers information asymmetry on externalities for all firms. However, firms with high PED will benefit from joining the regulatory regime of recognition and disclosure of externalities. I argue that prior to the joining of EU ETS, investors had no clear method of estimating and evaluating the effects of externalities, but in a regulated regime where the rules of recognition and disclosure are clearly defined, investors will be better able to value the externalities. A better information set leads to investors reducing the discounting of firm values. Therefore, instead of the high PED firms encountering adverse effects on their valuation, they would enjoy higher values. This argument is consistent with the Ohlson (1995) linear information dynamics argument of better disclosure improving the market value of firms.

Using a sample of 1,985 firm-year observations of the firms regulated by EU ETS in Great Britain, France, Germany, Spain and Italy, I find that joining the EU ETS has (1) a positive impact on firm value; (2) price elasticity has a negative impact on firm value confirming that high elasticity adversely affects firm values; and (3) high elasticity firms are positively impacted by the mandated membership of EU ETS. I also find that there are some variations in results between countries. Further analysis reveals that the differences in the features of firms within industries between countries are the likely causes of these variations.

The remainder of the paper is organized as follows: In Section 2, I discuss what externalities are, how various methods have been proposed and introduced to make firms internalise certain environmental externalities, how they are now being imposed on European firms through the EU ETS, and what costs and benefits arise from it for the firms. In Section 3, I review the existing accounting literature on environmental externalities reporting. In Section 4, I propose the relevant hypotheses. In Section 5, I describe the sample selection and variable measurement processes. In Section 6, I analyze the results and in Section 7, I discuss these results. Finally, in Section 8, I draw conclusions and identify the limitations and possible extensions of this study.

BACKGROUND

In this section I discuss the nature of externalities and the essence of carbon financial instruments, carbon trading markets and the functioning of climate exchanges, in particular the EU ETS. I also explain PED for firms' products and how it affects the value of the firm when externalities are mandatorily internalised.

Externalities

An externality is an impact on any party not directly involved in an economic decision. It occurs when an economic activity inflicts costs or benefits to third party stakeholders who are not directly partaking in the original economic transaction. An externality can have either positive or negative economic and utility consequences for the affected third party stakeholders (Weitzman, 1974). Pollutants such as acid rain, smog and green house gases (GHGs) are all examples of negative externalities.

Control of Externalities

Over the last few decades there has been a realisation by the global community that entities cannot disregard their environmental actions. The phenomenon called Global Warming created a political environment which has resulted in action being taken at every level to address the GHG externality issue. GHGs are by no means the first externalities to be tackled by regulation; they are however the first to be uniformly dealt with by market based mechanisms across several countries and industrial sectors.

Early Externalities Control

Prior to market based initiatives, environmental issues were dealt through regulation and taxation. An example of the use of regulation is the control of chlorofluorocarbons (CFCs). In the early 1980's it was determined that CFCs had been accumulating in the atmosphere and were responsible for the creation of a hole in the ozone layer in the stratosphere. The ozone layer protects the earth by shielding it from the sun's ultraviolet light. The destruction of the ozone layer was determined to have been caused by CFCs and as a result the decision was

made to ban CFCs. An international agreement, the Montreal Treaty, was put in place in 1986 to gradually phase out CFCs in a controlled manner over a number of years, and then ban them.

Taxation is the second common method used to address externalities. A tax can often be framed as an excise duty or customs charge and applied on cross-border transactions or through a variety of different governmental agencies. The revenues gained from taxation are then applied to remedy the impacts caused by the externality. The advantages of taxation are that it can be specific and can be targeted towards an industry or sector which means it can be quite efficient and transaction costs can be lowered. Tax can also be set at a point where it captures larger emitters and avoids impacting on smaller ones. This can limit the impact on marginal producers of externalities.

The negative aspects of a tax are that it alters the transaction costs creating a tax wedge that can result in market inefficiencies. The other problem with tax is that its effectiveness as a behaviour change agent is limited by the PED of the item being taxed. For example, in most countries petrol has some form of tax associated with it. The tax serves several purposes: raising revenues, limiting consumption, etc. However, petrol is relatively inelastic in its demand pricing and the tax is easily passed on to the consumer. The amount of fuel consumed can be limited by the consumer choosing not to use their vehicle, given the inelasticity of petrol. If the objective is to limit consumer use of vehicles through the petrol tax then the price increase has to be relatively significant to achieve its purpose.

Early Market-Based Initiatives

One of the first significant market mechanisms to control externalities was the US Acid Rain trading scheme that began in the 1980's (Bayon, Hawn, & Hamilton, 2007). Under the Clean Air Amendment Act 1990 this developed in to a cap-and-trade market for sulphur dioxide (SO₂). The federal government elected to cap emissions of SO₂ and allowed trading of allowances to emit SO₂. The number of allowances allocated was based on the SO₂ intensity of the fuel's inputs (Bayon et al., 2007). The United States Environmental Protection Agency (US EPA) subsequently introduced the Clean Air Interstate Rule (CAIR) which created the federal nitrogen oxides (NO_x) budget-trading trade program, output based allocation program designed to increase investment in cleaner energy production. It resulted in the development

of a secondary market for NO_x allowances similar to the SO₂ market (Bird, Holt, & Carroll, 2008).

The Renewable Energy Certificate market (RECs) in the US is a similar market-based mechanism to the current GHG markets being established internationally. This cap-and-trade system effectively created a sellable certificate for each megawatt of “green renewable” electricity. It has many of the same market features and issues of carbon markets, including the creation of value through the use of the economic mechanism of scarcity. It was created to encourage investment in alternative energy generation (Wright, 2006) and it uses both voluntary and regulatory frameworks. In voluntary markets, companies either invest in renewable projects or buy RECs so that they can sell “green” electricity. This is electricity that customers can be assured through a verification system that has been originally produced by a “renewable” electricity generation process.

The actual physical electricity that the consumer is using may not be from a renewable source given the nature of the electricity grid infrastructure. The conceptual point is that someone else, another consumer, pays non-renewable electricity rates yet consumes renewably produced electricity and, as such, the market balances out. The reason why a consumer buys “green electricity” is a matter of exercising social and political beliefs through their purchasing choices.

In some regulatory jurisdictions electricity companies must either invest in renewable energy sources or buy an appropriate number of REC certificates to meet regulatory demands that a certain percentage of electricity generated comes from renewable sources. This framework forces companies to invest in alternative electricity production methods to conserve electricity through delivery so that resources can be utilised more efficiently and to promote investment in alternative technologies and their development. In the US, where the REC market is mandatory in many states, there has been a convergence of the CO₂ and REC markets where excess RECs are being converted into voluntary CO₂ certificates. This is possible due to the physical and structural similarities between the CO₂ and REC markets. The production of a megawatt of electricity can be equated to a certain number of tonnes of CO₂ produced once the efficiency of the combustion process is known. Alternatively, input values of the fossil fuels can be utilised for the CO₂ calculations.

These markets suffer from failures with respect to dependence on regulatory forces to ensure scarcity. The quality of the credits is linked to the verification of the credit source.

Information asymmetries about credit sources have considerable pricing impacts. Also, the credits are dependent on external sources for liquidity, which limits the price cap.

Carbon Trading

The objective of establishing global CO₂ markets (often referred to as carbon markets) is to provide a cost-effective market-based mechanism of attributing a value to the CO₂ externality. These mechanisms put a price on GHGs and provide a market-based stimulus to develop clean technology as part of a cost-cutting programme or as a source of revenue generation. A market incentive takes the place of regulatory incentives and provides a monetary reward for those companies that cut emissions and a monetary penalty for those companies who do not (Bayon et al., 2007; Wright, 2006) .

Carbon markets function by allowing firms to emit GHGs to a pre-specified level and then the firm is penalized for the production of amounts over this level. This is done through the establishment of a cap on the emission of GHGs. Where a firm needs to emit more than the cap, it can buy additional entitlements from the market, or it may sell its entitlements to the market if it does not need them. This is referred to as a cap-and-trade market. The cap limits supply and creates scarcity, which creates the value aspect of the credit. See Appendix 1 for the workings of the carbon market and an EU ETS cap and trade example.

Offsetting of carbon production through the purchase of credits is an alternative to producing less carbon through the use of technologies or lowering production outputs. Offsetting is the purchasing of carbon credits, effectively the right to pollute, and the balancing of these with the amount of carbon produced by the firm that it is accountable for under either a regulatory regime or a voluntary arrangement. This process is not without its critics. Some argue that a carbon trading mechanism has diverted attention away from the root causes of climate change and is acting as an obstacle to deal with them (Bayon et al., 2007).

In response to GHGs and their regulatory implications, companies are developing a number of measures to meet regulatory compliance, mitigate these new costs and achieve competitive advantages in the market place. The impact of the new technologies in terms of bottom line

implications and affects of externalities are slowly being recognised in the firm's accounts. The savings and costs are becoming evident in company reports, often as indirect benefits that are captured as part of technology changes (Scott-Thomas, 2008). This, in turn, is leading to the creation of new industries and new business opportunities for entrepreneurial firms.

Kyoto Protocol and GHGs

The United Nations Framework Convention on Climate Change (UNFCCC) has taken the lead on the global warming issue, and its key mechanism for correcting environmental imbalance is the 1992 Kyoto Protocol. The Kyoto Protocol is based on the idea that those responsible for GHG externalities should be the principle parties involved in developing solutions to remedy the problem. It is founded with the notion that numerous countries around the world are now entering a development stage and the need to mitigate additional GHG growth from developing countries as they enhance their economic welfare. Standards and appropriate actions need to be incorporated to ensure that developments occur in a sound and acceptable way.

The Kyoto Protocol is targeted at the country level. It is divided into a number of phases in order to allow countries time to adapt their economies to operate in a carbon constrained world and to minimise the amount of financial discomfort. Under Kyoto, country GHG allocations are derived from a baseline year methodology, with 1990 as the baseline. The intention of the first commitment period 2005-2007 is for countries taking part under Kyoto to reduce their production of GHGs under the 1990 levels by 5.2%.

Under Kyoto, countries are not treated equally. Only the 37 industrialised countries are committed under the first commitment period to reducing GHGs. The Kyoto protocol does not demand the use of a cap-and-trade system at the country level. However, the UNFCCC suggests that market-based mechanisms have the potential to be more effective than pure regulatory control. Most of these countries have opted for some form of cap-and-trade system, allowing market forces to aid them in their reduction process.

Current State of the Markets

Carbon has entered the market in several ways. Firms directly buy and sell carbon credits to meet regulatory requirements and /or abide by contractual obligations or promises to produce

carbon only to a certain level or not at all (Leake, 2008; Gunther, 2008). Companies base their strategic plans, market and product development activities as well as funding projections on their commitment to enter carbon markets (O'Brien, 2008; Gunther, 2008). Market participants have also created indirect entities that have exposure to the carbon environment allowing investors alternative options to participate in carbon financial transactions. There are numerous hedge and trading funds that actively invest in carbon credit generating funds directly (Gunther, 2008).

The growth of the world's carbon markets has been phenomenal, particularly in light of the fact that the first regulatory trading system, the EU ETS, began in 2005. The initial fund that established this market is the Prototype Carbon Fund, it was started by the World Bank in 2000 with the backing of six countries¹ (Gunther, 2008). In the last three years, worldwide carbon markets have exceeded all expectations. Analysts predict that by 2010 the EU ETS alone will trade in excess of sixty billion Euros in CO₂ credits (World Bank, 2008).

Carbon Trading in the European Union

The European Union developed the EU ETS in response to the 1992 UNFCCC. It addresses its member states' CO₂ emissions obligations. The EU has been developing market-based policies to deal with the threat of global warming. In 2000, the European Commission started a premarket establishment strategy to encourage firms to undertake Clean Development Mechanism (CDM) and Joint Investment (JI) projects² so as to establish a supply of carbon credits to increase liquidity in the upcoming carbon market. It also provided the time necessary to educate the local governments of the member states and the affected industries about their commitments under the EU ETS trading regime.

The initial trading period of the EU ETS (2005-07) covers only CO₂ emissions from large emitters in the power and heat generation industry and in selected energy-intensive sectors: combustion plants, oil refineries, coke ovens, iron and steel plants and factories making cement, glass, lime, bricks, ceramics, pulp and paper (European Union, 2008, p. 7).

¹ They are Canada, Finland, Japan, The Netherlands, Norway and Sweden as well as 17 companies which included BP Deutsche Bank and Mitsubishi. The fund invests in forests in Romania, hydropower in Costa Rica, and wind farms in China. (Gunther, 2008)

² UNFCCC mechanisms to create a supply of tradable credits sourced from sanctioned developing country "clean" technology projects.

Implementation is taking place in phases, with periodic reviews and opportunities for expansion to other GHGs and sectors. Allocation plans for emission allowances are decided periodically, and the market is regulated by a strong compliance framework. The market is EU-wide but taps emission reduction opportunities in the rest of the world through the use of CDM and JI and provides for links with compatible systems in third world countries (European Union, 2008).

In the second trading period (2008-2012) it is expected that Nitrous oxide (NO_x) emissions will be added and the newly joined EU members will fall under the full regulatory authority of the EU ETS (European Union, 2008). The EU demands that the member states create national allocation plans (NAPs) based upon a set of rules under the EU ETS directive. The most important of these rules are that an allocation plan has to reflect a member states' Kyoto target as well as its actual and projected progress towards meeting the target. Where member states intend to use CDM and JI credits to help them reach their national emission targets – thereby giving their companies more scope to emit – these plans must be substantiated, for example, through budgetary provisions (European Union, 2005).

At the member state level, most allowances are allocated to firms free of charge. The allowances are determined at a facility level basis. These allowances are set at ninety-five percent of the 1990 baseline year in the initial trading phase and ninety percent in the second phase from 2008-2012 (European Union, 2008). The difference is made up by the participant firms by either cutting their production of CO₂ or purchasing credits to mitigate the excess CO₂ produced. The EU established a number of monitoring and compliance procedures to ensure that the EU ETS is adequately policed and enforced.

These require each installation to have a permit from its complaint authority for its emissions of GHGs. A condition of granting the permit is that the operator must prove that it is capable of monitoring and reporting the plants' emissions. In the initial trading period, installations in the twenty-seven member states are covered. They account for around fifty percent of the EU's total CO₂ emissions and about forty percent of its overall GHG emissions. The CO₂ allowances of the top five EU countries are shown in table 1.

[Insert Table 1 here]

A permit is fundamentally different from an allowance. A permit sets out the emissions monitoring and reporting requirements for a firm, whereas allowances are the systems tradable units. Installations must report their CO₂ emissions at the end of each calendar year measured in terms of European Union Allowances (EUAs)³. Firms must adhere to the EU ETS commission's monitoring and reporting guidelines, which must be checked by independent verifiers on the basis of set criteria and then made public. Firms whose emissions reports for the previous year are not verified as satisfactory are not allowed to sell allowances until a revised report is approved by a verifier. At the end of each calendar year, firms must surrender a number of allowances equivalents to their verified CO₂ emissions for the year.

Member states are required to account for the credits. They maintain a registry of credits purchased and then subsequently surrendered (offset) by individual companies. These allowances are then cancelled so they cannot be used again. Firms that do not surrender enough allowances to cover their emissions have to pay a fine for each excess tonne of CO₂ emitted. The penalty is €40 per tonne between 2005 and 2007 and €100 from 2008. In addition to penalties, firms also have to obtain allowances to make up the shortfall in the following year, and they are "named and shamed" by having their names published. In addition to these penalties, some member states have added additional dissuasive sanctions for any infringements of the EU ETS rules at the national level (European Union, 2004).

EU ETS has nine exchanges that offer over the counter (OTC) trading facilities for carbon credits and their associated derivatives. When it was launched in 2005 the EU ETS became the world's largest cap-and-trade system for trading emissions of carbon credits. It is also the world's largest regulatory enforcement cap-and-trade market where membership is required by legislation. Its largest exchange is the European Climate Exchange (ECX) based in London, that accounts for over eighty-five percent of OTC carbon credit transactions that take place in the EU (Climate Exchange PLC, 2007). It is a wholly-owned subsidiary of Climate Exchange PLC, a publicly traded company listed on the London Stock exchange. Climate Exchange PLC also owns the Chicago Climate Exchange (CCX), the Montreal

³ 1 x EUA = 1 x tonne of CO₂ = 1 x CDM = 1 x JI

Climate Exchange (MCX), The North-eastern Climate Exchange (NCEX), and the New York Climate Exchange (NYCX), all of which were created in 2006 (Bayon et al., 2007)

European trading constitutes eighty percent of the global turnover of CO₂ allowances and credits, which was valued at €14.6 billion in 2006 (European Union, 2008). In the first year of trading, 2005, 27 million allowances (tonnes of CO₂) were traded with a value of €5 billion. In 2006, trading volume rose to more than 800 million allowances, and in 2007 this level was reached after only seven months of the year.

In summary, under the EU ETS there is now a mandatory system that forces firms to internalize the cost of the externality, CO₂. Using a structured reporting system, firms have to define the amount of CO₂ they produce, and they undertake to purchase credits to mitigate any level of production above their pre-assigned allowance. The EU ETS has achieved two things that the previous voluntary schemes have not. It has created a uniform cost effect that affects EU ETS firms and an informational effect that allows the market to better estimate a firm's externality liability.

LITERATURE REVIEW

According to Clarkson et al (2006), the existing literature in environmental accounting research can be categorized into three broad groups. The first group examines the value relevance of corporate environmental performance information and shows that such information is valuable to investors seeking to assess environmental liabilities in different settings. The second group examines factors affecting managerial decisions to disclose potential environmental liabilities. This group of studies finds that there are strategic factors affecting firms' decisions to disclose environmental liability information, especially when disclosure is discretionary. A third line of studies explores the relation between environmental disclosure and environmental performance. This study is aligned with the first line of research. It examines the effect of EU ETS membership on the value of a firm's equity.

The value of environmental disclosure is relevant only to the extent of the nature of the events disclosed. Improved environmental disclosure does not necessarily mean improved economic performance as firms also increase disclosure in response to negative situations or

to provide a sense of greenwash⁴ to their accounts (Clarkson et al., 2006b; Patten, 2002). Environmental disclosure relative to economic performance is found to be positive / neutral to the point where regulatory risk is mitigated and then further expenditure is negative to economic performance (Al-Tuwaijri, Christensen, & Hughes, 2004; Hughes, 2000). When a firm exceeds regulatory disclosure limits, the markets penalise it for the managers' voluntary actions. Research to date supports the hypothesis that markets penalise firms for not meeting regulatory standards or placing themselves at undue financial risk (Bebbington & Larrinaga-González, 2008; Fisher-Vanden & Thorburn, 2008).

Most of the research to date into the value relevance of environmental disclosures, environmental accounting and carbon accounting has been on voluntary disclosure made at the discretion of the firm in question. Nearly all research on voluntary environmental activities has found that there is no link between disclosure and improved market value (Al-Tuwaijri et al., 2004). Research into regulatory market environments such as the Renewable Energy Certificates (RECs) and SO₂ tradable pollution permits in the US has found that the market perception of these activities has been positive although somewhat obscured by the lack of relevant disclosure (Hoffman, 1998, 2001; Bebbington & Larrinaga-González, 2008; Kolk, Levy, & Pinkse, 2008).

From a value relevance perspective, the predictability of a firm's return is derived largely from data external to the firm and the firm's historical stock pricing and returns are largely irrelevant (Fama & Miller, 1972; Keim & Stambaugh, 1986). Observable macroeconomic and financial variables are the significant underlying influences. The impact of regulating an externality through the use of a cap-and-trade market mechanism should have a noticeable effect on firms' stock prices. Market betas of firms within the same industry sector should remain unchanged if the regulation is evenly applied across an industry and no firm has acquired a change in competitive advantage from the regulation.

A firm's elective decision to partake in a voluntary CO₂ cap-and-trade market will contain additional and / or different signalling information than a firm partaking in a compulsory CO₂ cap-and-trade market. A compulsory scheme removes the firm's individual choice. The market is not valuing a firm's decision but the impact of an exogenous event. Numerous

⁴ Greenwash is the controlled disclosure of information to create an impression of good environmental practice (Hoffman, 2001).

studies have documented that specific environmental events such as disasters or law changes have a significant and rapid effect on stock prices. It is difficult to determine the long-term effects of these events given the existence of noise and the macroeconomic effects of related events (Hoffman, 2001). The regulation of CO₂ by the EU ETS provides the opportunity to study the impact of a uniform event across several markets and across several countries effectively limiting noise and allowing the capture of a known event on the stock prices of firms in several pre-selected industries.

This is possible because CO₂ emissions data are available through various government and OECD facilities and web sites (European Union, 2004, 2005). Johnston et al (2008) note that in the case of the SO₂ market the information regarding the allocation of SO₂ credits, emissions and credit purchases was difficult to ascertain due to the underdeveloped reporting regime. Even with these limitations, they find evidence that the market assigned positive value to emission allowances that a firm was granted, and they conclude that investors viewed these allowances as assets. They find there is less evidence of this when a firm purchases emission rights.

Traditionally, voluntary recognition of externalities is characterised by “good news” information being released to the market. As with all voluntary actions, the firm concerned can control the content of the information release. Chapple et al (2009) find significant effects for the voluntary disclosure of carbon obligations, but the negative effects could be attributed to the lack of credibility of this disclosure as there is no external verification of the disclosed amounts. These results could also arise due to the disclosure principle (Verrecchia, 1983). With mandated recognition of externalities as in the EU ETS, the contents and often the format of information released are specified. Mandated releases generally contain “bad news” characteristics and the effect on the firm are determined by firm and industry specific aspects such as PED, industry norms and the underlying market expectations (Berthelot, Cormier & Magnan, 2003).

The CO₂ market in Europe, through its clear and readily available emissions reporting regimes, allows investors the opportunity to have direct access to what previously would be private information. Under the semi-strong efficient market hypothesis (EMH), one would expect the market to have absorbed such data into the valuation of the firm, and this

information should have been captured by market participants who have combined it with their own privately generated data to create additional beneficial private information.

The EU ETS challenges the status quo of current research because it has created a mandated environment where environmental action is not a choice but a compulsory action required of all firms across specified industry sectors. Failure to meet the ongoing requirements, including the continued reduction in CO₂ emissions is met with stiff and significant penalties (European Union, 2004, 2005). Under the EU ETS, the carbon status of firms is clearly transparent and this information is highly accessible. The market for trading of permits is well established and the penalties well known. The financial implications can be calculated for performance as well as non-performance. The unknown determinant in the EU ETS is whether firms will be able to pass the costs on or will they have to absorb them. The ability of the firm to pass the new carbon costs on will determine the effect on firms' earnings (Carbon Trust, 2008).

The Value Relevance of Externalities

The importance of externalities is based on the materiality of the financial consequences they have on a firm's earnings (Hoffman, 2007). The economic effect of GHGs impact a firm's earnings, cost structures and balance sheet (Bebbington & Larrinaga-González, 2008; IASB, 2008; IETA, 2007). The perceived current view taken by markets is that environmental expenditure above what is required to meet regulatory control is an expense for the firms (Porter & Linde, 1995). Yet in non-regulatory environments, numerous firms choose to partake in a voluntary carbon trading programme. Firms may value the experience gained from being a member of a voluntary market and use it as a way to influence future regulatory requirements and policy settings.

Likewise, the experience may provide preparation for potential regulatory requirements, or provide a competitive differentiation as consumers become increasingly concerned about climate change, including being able to offer products that are "carbon neutral". The firms may find membership of voluntary markets beneficial for developing company-wide corporate social responsibility or sustainability strategies. This may provide better access to capital by helping attract new sources of investment and project financing, and may even

assist in the recruitment, retention and reward of staff because of “good actor” perception (Bayon et al., 2007).

Regardless of how the financial consequences of externalities are reported, investors form an opinion on the net wealth effects created by the statutory responsibilities of externality regulation. The value relevance of the externality should then be captured within the market value of the stock price. With regard to carbon, Bebbington & Larrinaga-González (2008, p. 707) note that “investors and policy makers and the public in general could be expected to need information from which they can assess the carbon intensity of corporate products and services and estimate the regulatory and competitive risks that a corporation is likely to face.” The publication of this information need not rely on inclusion in the firm’s annual accounts nor need it be of a financial nature.

Accounting and reporting on CO₂ emissions provides a source of new information to the market that significantly lowers the estimation error in assessing further environmental obligations. It serves as a source of verification for data found in other parts of the financial statements and provides an insight and understanding of the company (Hoffman, 2001). It captures items such as the energy use of electricity or coal and the efficiency of equipment, the competitiveness of the firm against other organisations, and the ongoing efficiency of fixed assets. It can provide a whole new set of opportunities for benchmarking and scorecard type activities.

The information has an external verification component and acts as an external audit source. The European Union has established a compliance unit to audit CO₂ emitting sites (European Union, 2004) ensuring that information from these sites is true and accurate. The audit results are available from The European Union Compliance Unit via their website (European Union, 2004) and the audit function extends to cover both emissions and emission measurement and management processes. In some ways, this additional audit is perhaps more stringent than the current accounting audit (Hoffman, 2007). It also allows better bench-marking between industries and geographies as it circumvents many of the comparison issues such as currency translation and timeliness of the financial periods and their reconciliation.

Price Elasticity

The price elasticity of a market determines the sensitivity of consumers to price changes. The EU ETS imposes a series of compliance costs on firms in certain industries. The affected firms face the choice of passing these costs on or absorbing them which, in turn, can affect earnings and eventually flow through to a valuation effect. Price elasticity, by definition, is the amount of a price change that a market participant is willing to accept before the demand / supply of a good or service changes in response to that price (Case & Fair, 1999).

Economists define price elasticity (η) as the percentage change of demand (numerator) over the percentage change in price (denominator). Since both are percentages, the ratio is not expressed as a specific unit of measurement and can be compared across different industry sectors (Bernstein & Griffin, 2006).

In this study, I focus on demand elasticity for several reasons; first, the supply elasticity of a market is relatively immaterial if the cost changes are able to be carried through to the customer while at the same time the firm retains its profit margins. Second, the market sensitivity to PED is the determinate factor that a firm considers when contemplating increasing its prices to compensate for the additional costs of meeting its regulatory obligations. Firms have limited opportunities to increase prices in highly elastic markets. Any increase in market elasticity will cause firms to incur reduced demand and decreased earnings (Case & Fair, 1999). Third, demand elasticity is impacted by consumer choice. The ability of the consumer to substitute an alternative product or to easily swap suppliers governs the elasticity of demand. The nature of the market or goods in question is critical in determining the consumer's ability to exercise choice. In the electricity market there are limited substitutes; regulations prevent new market entrants and limit means of distribution. In markets such as chemicals or pulp and paper, consumers have greater choice and logistically, substitutes are more freely available, meaning these markets, in general, enjoy, greater PED (Bernstein & Griffin, 2006).

From an econometric perspective, if consumer preferences and the distribution of preferences remain stable or controlled then exogenous price changes illustrate the structural parameters of demand (Brown & Rosen, 1982; Cazals et al., 2005; Kahn & Lang, 1988). Thus, demand elasticity has two components, change in price and change in preferences (Cazals et al., 2005). Demand elasticity is the key determinant of whether a firm can pass on some or all of its

carbon regulation costs. The majority of the industries targeted by the EU ETS have few viable substitutes because there are significant limitations on new market entrants and market substitution by non EU ETS regulated firms. These limitations mean that for several industries the opportunity to pass through⁵ the total cost increase resulting from EU ETS membership is available. Chapple, Clarkson & Gold (2009) note Australian firms that voluntarily disclose their carbon costs on the Carbon Disclosure Project (CDP) have limited ability to pass through these costs unlike EU ETS member firms that face mandatory disclosure. Market valuations are determined by earnings and these, in turn, are determined by changes in the firm's revenues and cost structures (Bernard, 1995).

The supply elasticity of a firm is important over the long term in determining the firm's market price. In the EU ETS, the firms facing CO₂ regulation are involved in industries such as electricity generation, steel production, concrete production and pulp and paper. It is difficult for these firms to build plants and develop new technologies at short notice. With the exception of carbon flight⁶, short term changes in supply elasticity are not easily possible and unlikely to significantly influence the industry sector supply curve. The supply price elasticity has little relevance to this research because the time frame under investigation is for phase I of the EU ETS (2005-2007) that makes many of the options available for firms to adjust their supply unavailable.

These same market characteristics also limit available product substitution which means firms have limited opportunities to source alternatives for their supply chain. The EU and local governments are aware of the potential for this event and have taken steps to grandfather⁷ such industries with additional credits. It is clear that in the advent of this situation becoming a reality the EU would reinstate equilibrium through the use of tariffs (European Union, 2008). The nature of many of the goods in question, such as concrete and electricity, means that there is a geographical limitation on how far these goods can be economically sourced.

⁵ Pass through rate is the term used to explain the percentage of a cost increase that a firm can pass onto a customer before demand is effected (Carbon Trust, 2008).

⁶ Carbon flight is the expression given to companies moving their manufacturing into other geographies to avoid CO₂ regulation (Global Reporting Initiative, 2002) .

⁷ When a government or state gives a company or industry preferential treatment that declines over a specified time period so that the firm has time to adjust to changes in its operating environment.

Price elasticity is closely aligned with the concept of market power, which is the ability of a firm to maintain prices above competitive levels for a significant period of time (Weisman, 2007). A firm's market power increases when their market share increases, and they take a dominant position in the market effectively becoming a market price setter. Market power decreases with increasing market PED, an indication that consumers' alternatives for substitution are increasing. The markets that EU ETS have regulated with respect to carbon are, by their very nature, dominated by large firms that have historically held significant market power. From a demand perspective, the PED of these markets are weighted towards being inelastic, meaning consumers have limited opportunity for substitution and are effectively price takers across the demand curve.

Many industry PEDs are well documented. The electricity, fuel and gas markets have inelastic short-term demand structures that have been consistent over time. In the US, the electricity market has been inelastic in nature for the last 30 years and the variance in this inelasticity has been negligible regardless of energy demands, oil shocks, technology changes and numerous other macro and microeconomic factors (Bird et al., 2008; Bohi & Zimmerman, 1984; Garcia-Cerutti, 2000; Houthakker, Verleger, & Sheehan, 1974; Lijesen, 2007; Maddala et al., 1997; Taylor, 1975).

The US gasoline market has also illustrated strong short-term demand inelasticity that was only briefly affected by the 1970's oil shocks and quickly reverted back to the status quo (Houthakker et al., 1974). The inelasticity of an industry sector is important because it defines the options available to firms within that industry sector facing increased costs. Markets such as electricity generation, gas and fuel have documented inelastic PED which means consumers are prepared to maintain demand in the face of price increase.

HYPOTHESIS DEVELOPMENT

A change from a voluntary cap-and-trade market-based mechanism to a mandatory environment restricts companies choice's in how they recognise externalities (Orlitzky, Schmidt, & Rynes, 2003). The decision to have an environmental policy with specific regard to GHGs is no longer left to the company. Ultimately, the impact of mandatory regulation and the firm's decisions on how to fulfil its obligations affects its stock price, and will have significant value relevance. The imposition of externalities regulation is likely to have both adverse effects and beneficial effects on the EU ETS firms. I consider both of these effects to formulate the hypotheses.

The adverse effect is the internalisation or recognition of the environmental externalities in the form of additional operating costs. Investors consider a firm's exposure to future environmental costs, then condition their estimates of future cash flows based upon this exposure assessment. Investors would weigh these environmental costs and would factor a discount into the market value of the firm for the costs of compliance including reporting and mitigation through mandatory technology investments.

The beneficial effect is an information effect. Investors who previously were discounting the value of the firm due to lack of information, with more specific environmental externality information, are better able to value the firm. They are likely to reduce the discount for uncertainties, and are likely to value the firms upwards. Specifically, when a firm joins the EU ETS the market value of a firm will increase because of the reduced uncertainty about externalities in the market place. Richardson and Welker (1999), Clarkson et al (2007) argue that information about social activities is relevant to assess the firm's prospects and, that enhanced disclosure of social and environmental activities has the same effect as enhanced disclosure of other financial activities. This suggestion is consistent with the emerging theory of "Ethical Investing" (Reyes & Grieb, 1998).

Effective reduction of environmental externalities can help legitimise the firm in the eyes of consumers and contribute to a firms' product/service market success (Garrett, 1987; Menon

& Menon, 1997). Consumers may rationally choose to pay more to acquire a product or service from firms with positive environmental commitments to reduce externalities. The extension of this literature to the capital market is uncomplicated if investment decisions are recognized as decisions to forego current consumption in favour of future consumption.

Ultimately the market places a value on EU ETS membership. The market is likely to impound both the adverse financial impact and the beneficial informational impact in the firm's adjusted stock price. Investors would weigh the certainty of the environmental performance and cost precursors after the firm has joined the EU ETS (Hughes & Reynolds, 2001). However, given the presence of both the adverse and beneficial considerations, the overall effect on market value of mandatory inclusion into the EU ETS is unknown. Therefore, I state the first hypothesis in the null form as follows:

H1: The market value of firms is not associated with EU ETS membership.

A shortcoming of prior studies is that they were done without the inclusion of pertinent microeconomic variables. One critical assumption that underpins most prior studies is that all firms are affected by externalities in a similar manner. From an economic standpoint, this premise is flawed. The value relevance of the exogenous effects of joining the EU ETS is dependent upon at least two considerations: the ability of the company to pass on cost effects of the environmental externality compliance, and an informational effect that is attributed to the ability of the market to make more accurate assessments of company's environmental obligations. The PED literature states that firms dealing with products with a low price elasticity of demand are able to shift their costs to the consumers (Bernstein & Griffin, 2006; Weisman, 2007). This behaviour is likely to occur when costs relating to externalities are imposed on firms.

By analysing firms within the EU ETS with reference to their industrial sector and geography there is an opportunity to determine if the market differentiates firm value judgements with respect to industry PED. Financially, PED is likely to have a negative effect on firm value because high PED firms are not able to pass through their externality costs, and for that matter other costs imposed by suppliers, to the consumer of their products. The PED of different market sectors has been well documented in economic studies and is found to be

included in the security prices of firms (Weisman, 2007). Thus I state the following hypothesis in the alternative form:

H2: The market value of firms is negatively associated with PED.

The effects of the mandatory EU ETS membership are likely to vary between high and low PED firms. From the adverse financial effects perspective, I argue that firms in industries with products that have low PED (inelastic demand) shift the costs of externalities to the consumers when they are mandated to internalize the externalities. Consequently, they will not suffer any significant adverse consequences from EU ETS membership. However, firms with products that have high PED have to absorb the costs of externalities. Consequently, they are likely to suffer significant adverse valuation consequences.

From the beneficial information effects perspective, the consequences are unlikely to be different between low and high PED firms. Firms with low PED will enjoy the benefit of no adverse effects on firm value as they will continue to shift the costs of externalities to consumers. Firms that undertake environmental activities involving the absorption of externalities may be able to transfer the costs incurred to their customers providing the industry sector they operate in has an inelastic PED. Firms whose industry sector has an elastic PED will not be able to pass them on. This cost absorption will lower their performance, and their market place values will decline.

The low PED firms may benefit to some extent from being in the EU ETS because of the lower information asymmetry on externalities for all firms. Firms with high PED will benefit more from joining the regulatory regime of recognition and disclosure of externalities of the EU ETS. I argue that in their case, prior to the joining of EU ETS, investors had no clearly delineated method of estimating and evaluating the effects of externalities, but in a regulated regime where the rules of recognition and disclosure are clearly defined, investors will be better able to value the externalities. A better information set leads to investors reducing their discounting of firm values due to the presence of externalities. Therefore, instead of encountering excessive adverse effects on their valuation, the high PED firms will enjoy more measured effects, and in turn are likely to experience higher firm values. This argument is consistent with the Ohlson (1995) linear information dynamics argument of better disclosure improving the market value of firms. Likewise, I hypothesise that:

H3_a: For low PED firms, the market value of firms is not associated with EU ETS.

H3_b: For high PED firms, the market value of firms is positively associated with EU ETS.

Empirical Model

I study the broader effects of the setting of the firms with regards to monitoring of environmental externalities. My intention is to evaluate the broader effects of a move from a setting where externalities were internalised or ascertained on a voluntary basis to the current setting where they are being recognized and disclosed through a mandatory regime. The value relevance test has been used in accounting disclosure choice and the impact of environmental actions studies (Al-Tuwaijri et al., 2004; Botosan & Plumlee, 2002; Campbell, Sefcik, & Soderstrom, 2001; Hughes & Reynolds, 2001; Johnston, Sefcik, & Soderstrom, 2008; Plumlee, Brown, & Marshall, 2007). A value relevance model investigates the market effects on a firm's value of environmental disclosure and actions. I use this method to evaluate the effect of EU ETS membership on the market's perception of the value of the firms.

I adopt the Ohlson (1995) linear information dynamics model to evaluate the effect on firm value of the EU ETS. The model explicitly states that market value is a summary measure of the information set relevant to investors. It links the current financial statement data directly to firm value without any explicit reference to dividends (Barth & McNichols, 1994; Bernard, 1995). This model captures the immediate recognition and incorporation into stock price of the net present value of all future cash flows associated with the arrival of new information coming to the market's attention (Fisher-Vanden & Thorburn, 2008). Feltham & Ohlson (1996) extend the notion to that of economic rents, i.e., returns in excess of the cost of capital for a finite number of periods, are captured in the persistence parameter on abnormal earnings. The significance of this relative to my study is the all-encompassing market perception of the broader and long term effects of the regulatory regime of the EU ETS on the firm's earnings potential.

The value relevance study uses price levels to determine what is reflected in firm value in a specific time period (Barth, Beaver, & Landsman, 2001). In a level of valuation investigation, the variables of interest summarise returns information (discounted value of future returns)

for all prior periods that is relevant for forecasting performance. In a returns specifications the variables of interest include items of new information to explain firms prices within the return period (Barth & Clinch, 2009). My investigation analyses the effect membership of the EU ETS has on firms' long term future foreseeable returns, and the effect PED has on this relation.

I employ two multivariate models to examine the hypotheses delineated earlier. For hypotheses *H1*, I use Model 1. The experimental variable is *EU ETS*_{*t*}. This model is first estimated for all countries together and then by each country. Following Ohlson (1995), I control for other variables that affect the market value of firms. Therefore, Model 1 is as follows:

$$MV_{t+1} = \alpha_0 + \beta_1 BV_t + \beta_2 OPI_{t+1} + \beta_3 \Delta OPI_{t+1} + \beta_4 LEV_t + \beta_5 EU ETS_t + \varepsilon_t$$

(Model 1)

Where:

- MV* = Log of the market value divided by total assets at time t
- BV* = Shareholders equity at time t divided by total assets at time t
- OPI* = Operating income at time t + 1 divided by total assets at time t
- ΔOPI* = Change in time t + 1 operating income divided by total assets at time t
- LEV*_{*t*} = Long term debt at time t divided by total assets at time t
- EU ETS* = Dichotomous variable denoting membership of the EU ETS, 1 a member (after 2005), 0 not a member (before 2005)
- ε*_{*t*} = Residual

To test *H2*, I introduce *PED* to Model 1, resulting in Model 2. This model is also first estimated for all countries together and then by each country separately. Therefore, Model 2 is as follows:

$$MV_{t+1} = \alpha_0 + \beta_1 BV_t + \beta_2 OPI_{t+1} + \beta_3 \Delta OPI_{t+1} + \beta_4 LEV_t + \beta_5 EU ETS_t + \beta_6 PED_t + \varepsilon \quad (\text{Model 2})$$

Where:

PED_t = Elasticity of industry; a dichotomous variable with (0) denoting low elastic and (1) denoting high elastic industry.

$$\eta < 1 = \text{inelastic} = 0$$

$$\eta > 1 = \text{elastic} = 1$$

For hypotheses $H3_a$ and $H3_b$ I use Model 1, but separately for the low PED and high PED firms. Therefore, the model is estimated twice. The model is first estimated for all countries together, I then repeat the model for each hypothesis on a country by country basis

The link between market value and book value, earnings, earnings change and long term debt, on the other, has been a focus of accounting researchers in value relevance studies (Barth & McNichols, 1994; Hughes, 2000). Therefore, I use book value (BV), earnings (OPI), earnings change (ΔOPI) and long term debt (LEV) as control variables. The variables have been assigned time constants to ensure that the calculations are consistent on a year on year basis.

Earnings are included as a measure of firm performance. Earnings or forecasted dividends are used to capture the expected value of the firm's future operations (Barth & Clinch, 2009; Bernard, 1995; Botosan & Plumlee, 2002). In this model, operating income is used as the earnings variable and the change in operating income on a yearly basis is used to capture earnings surprise effects. Book value and leverage are included to account for capital structure differences. Book value, operating income, change in operating income and leverage are all deflated by total assets. Richardson & Welker (1999) and Berthelot et al (2003) document inconsistent results in their research on the relation between firm performance and environmental disclosure.

They note that some studies find a positive association between firm performance and environmental disclosure, while others note a negative association. There is a view that firms benefit from climate change differently. Some benefit through the development of new

technologies and the gaining of a competitive advantage over their rivals (Cogan, 2006; Hoffman, 1998, 2001, 2007; Stern, 2006; WBCSD, 2004), while others with high PED firms may not be able to transfer costs. Al-Tuwaijri et al (2004) describes this as focussing on the firm specific *ex ante* opportunity costs represented by environmental change instead of fixating on the deadweight costs of *ex post* regulatory compliance. While these firm specific changes constitute important effects, my study does not deal with each specific effect. I only take into consideration PED.

SAMPLE SELECTION AND VARIABLE MEASUREMENT

Sample selection

Firms are selected from industries that are covered by the EU ETS (European Union, 2008). The six digit SIC Industry code is used and eight industry sectors are chosen to give an appropriate representation of the industries included in the EU ETS. Data are obtained from Global Vantage and the selection of company information is limited to firms that are active during the period 2002 to 2007. The January to December calendar format is used to reflect the calendar format used by the EU ETS. Firms with multiple issues during this period are limited to their first issue.

[Insert Table 1 here]

The countries selected for this research are Great Britain (GBR), Germany (DEU), France (FRA), Italy (ITA), and Spain (ESP). The selection of these countries is based on the fact that they contain the largest number of emitters within the EU ETS and account for sixty percent of the EU CO₂ allowances. These markets contain the largest firms and have the greatest development, depth and liquidity of all the capital markets within the European Union.

[Insert Table 2 here]

In this investigation, 540 firms were selected from eight industry sectors over five countries. Great Britain contributed 320 firms (59%) providing a significant country weighting. Germany contributed 87 firms (16%), France 53 firms (10%), Spain 37 firms (7%) and Italy 43 (8%). On an industry basis, Metals and Mining was the most significant contributor to the

sample with 147 firms (35%), Oil, Gas and Consumable Fuels 126 firms (23%), Chemicals 100 firms (19%), Electric Utilities 40 firms (7%), Construction Materials 32 firms (6%), Multi-Utilities 18 firms (3%) and Gas Utilities 12 (2%).

When the sample is split into elastic and inelastic industries, the sample size of the inelastic industries is found to be 196 firms contributing 631 firm-year observations composed of; Oil, Gas and Consumable Fuels 418 (66%), Electric Utilities 103 (16%), Multi-Utilities 72 (11%) and Gas Utilities 38 (6%). The elastic industry sample consists of 344 firms contributing 1186 firm-year observations; Metals and Mining 593 (50%), Chemicals 384 (32%), Construction Materials 113 (10%) and Paper and Forest Products 96 (8%).

[Insert Tables 3&4 here]

The total number of firm-year observations in the sample is 1,985. Great Britain accounted for 1,164 (59%), Germany 284 (14%), France 218 (11%), Spain 164 (8%) and Italy 155 (8%). The descriptive statistics reflect the effect of having two countries with a greater number of firms (Great Britain and Germany) and two industries which contribute a significantly larger number of firm-year observations (Metals & Mining and Chemicals) to the sample.

This cross-sectional experimental sample is spread over five countries, eight industries and six years. The implementation of the EU ETS across industry sectors focuses on market events rather than firm-specific items and, thus, limits the amount of potential noise. The use of an extended longitudinal data collection captures the pre and post EU ETS strategies employed by firms and mitigates short term horizon events and potential noise implications (Clarkson et al., 2006a).

The EU ETS covers industry sectors that generate 70-80% of the industrial emissions of CO₂. These sectors are electricity generation, gas and fuel refining, steam and cogeneration, pulp and paper, steel production, and concrete production. The nature of these industries makes the Ohlson model useful in detecting the effects of the EU ETS on MV. There is a substantial scale effect given the firms in these industries are larger and have substantial capital requirements.

Variable measurement:

Dependent Variable

I use market value of firms to evaluate the effects of EU ETS membership. The selection of market value as the dependent variable captures the markets response to all publically available information as to the effect of a firm joining the EU ETS. Market value suffers from its own scale issues. In small samples it is often skewed by a few large firms. Prior literature offers several potential remedies for the econometric problems arising from scale effects, including deflation by a scale proxy or the inclusion of the scale proxy as an additional independent variable (Barth et al., 2001). For measuring size, Barth & Clinch (2009) identify the use of market value of equity, share price, equity value-to-book ratio, price-to-lagged price as appropriate dependent variables in value relevance research. I use market value divided by total assets. Since this measure is skewed, I normalised its distribution using logarithmic transformation.

Experimental Variables

In this study, the key issues are whether the firm is part of the EU ETS and the influence of PED on stock price. The EU ETS began in January 2005 and the first abatement period ran to the end of December 2007. To identify whether a firm is in the EU ETS, I use a dichotomous variable called *EU ETS*. This variable is assigned a value of 1 for firm year observations from 2005 to 2007 and a 0 for years prior to January 2005. The use of a dichotomous variable to convey information about an environmental effect is common in accounting research (Barth & McNichols, 1994; Plumlee et al., 2007).

There are several market concentration metrics available to act as a proxy for PED. I considered three of them. Market concentration ratios measure the proportion of sales or production that is accounted for by the largest firms in an industry. The concentration ratios capture the competitive nature of an industry, one such ratio is CR4. CR4 measures the market share of the largest four firms in an industry as a percentage of the total sales for the industry. CR4 indicates the market dominance of firms, and market dominance is closely linked with PED (Weisman, 2007; World Bank, 2008). My expectation was that CR4 would act as a proxy for PED and that the higher the CR4, the more dominant the firms are in that industry. Thus firms in high PED industries have the ability to maintain a greater pass

through rate with respect to environmental costs. In this study, given the skewness of the data for each industry sector a small number of firms dominated the results and made CR4 ineffective as an indicator of PED.

Another measure of market concentration considered is the Hirschman-Herfindahl index (HHI). HHI is calculated as the sum of the squares of the market shares of each individual firm. The HHI has been used as a proxy for market competition and firm dominance in numerous accounting studies (Fisher-Vanden & Thorburn, 2008). HHI also suffers from severe skewness. A third proxy, the price cost margin index (PCM) measures the firm's ability to set its prices above its marginal costs. The most widely used PCM index is the Learner index which is defined as the difference between price and marginal cost relative to price (Weisman, 2007). PCM is not used, as appropriate data is not available for many sample firms.

Due to the outlined difficulties with the aforementioned PED proxies, I utilise a dichotomous elasticity variable to denote the elasticity of an industry. Those industries deemed to have low elasticity ($\eta < 1$) are denoted with a value 0, and those with high elasticity ($\eta > 1$) are denoted the value 1. The source for denoting industry elasticity is the Carbon Trust (2008) and the European Union (2003). The industries classified as inelastic are, Oil, Gas and Consumable Fuels, Electricity Utilities, Gas Utilities and Multi-utilities. The elastic industries are Chemicals, Construction Materials, Metals & Mining and Paper & Forest Products.

Prior research has noted that adequate control of scale effects is dependent on the scale-free economic relation and the variability of the scale factor, which are generally unknown (Barth & Clinch, 2009; Gu, 2005). There is a choice of available deflators when controlling for scale. I scale the control variables *BV*, *OPI*, Δ *OPI* and *LEV* by total assets to account for size and industry effects. The nature of the industries selected by the EU for emission into the EU ETS means that they are all firms of significant size with large sales volumes and significant assets. Barth & Clinch (2009) note that although a sample contains several large firms, scale effects do not necessarily exist in samples where there is a substantial size variation across the firms in the sample. It is the relation of the explanatory variables to size that may create a correlation effect issue. The EU ETS system targets large industry polluters, and the research sample contains a number of large firms which means the sample has a potential bias towards large firms. In testing for scale effects, typically value relevance studies report that

inferences are unaffected by scaling (Barth et al., 2001). Barth & Clinch (2009), in their investigation into scale effects, determine that price and market value of equity specifications most consistently result in the correct inferences being drawn.

Control Variables

In the value relevance model, other variables are used to capture valuation effects unexplained by equity and earnings (Barth et al., 2001; Barth & Clinch, 1998; Bernard, 1995). The control variables applied are:

BV: Equity (net assets) at the start of the year

OPI: Earnings during the year

$\Delta OPI:$ Growth or decline in earnings during the year

LEV: Leverage at the start of the year, which also captures a firms risk exposure and the effects of industry and country

RESULTS

Descriptive Statistics

The descriptive statistics by country sub-samples and for the merged sample are shown in Table 3. Table 4 provides similar statistics for industry sectors. The statistics show that while there are fewer firms in France, Spain and Italy, the firms in these countries are, on average, larger than those of Germany and the UK. The standard deviation of market value (*MV*) is very large in all the countries. Given that the medians of all countries are very small compared to the mean, there is a large positive skewness. This is also reflected in the merged sample statistics (last column of Table 3). This justifies the need for scaling by total assets and the normalisation of the distribution using logarithmic transformation.

Great Britain and France have large standard deviations for *MV* and this is caused by the presence of some significantly large firms as well as a proliferation of small firms. In Great Britain's case it has a large number of small Mining and Oil and Gas exploration companies and in the case of France the sample is skewed because of the presence of some very large companies in the electricity and oil and gas sectors. Table 4 shows that for industries, Electric

Utilities is the least skewed and Metals & Mining are the most skewed. Most Electric Utility companies are very large.

The statistics show that book value (*BV*) is also skewed. It has a merged sample group mean of 1,881 a median of 49 and a standard deviation of 9,239. The statistics by each country also confirm such skewed distributions. Italy has the least skewness and Great Britain has the most. Great Britain's mean as well as median are significantly less than the other countries' due to the inclusion of a number of small capital base companies in the Oil and Gas and Metals and Mining sectors. Germany also illustrated similar tendencies with a high proliferation of smaller companies in the Chemical sector. Table 5 shows that the Multi-Utilities industry is the least skewed and Metals & Mining are the most skewed.

Operating Income (*OPI*) is also highly skewed. In the merged sample the mean is 457, the median is 3 and a standard deviation is 2,438. Once again, skewness is also endemic at the country level with Spain having the least and France the most affected data. Great Britain's inclusion of a large number of small capitalised exploration companies in the Mining and Oil and Gas sectors heavily skews the sample as a number of these companies make significant losses and this is reflected in both the mean and the median. The results for France confirm the impact of a small number of significantly large companies on their overall results. For industry sectors, Oil, Gas & Fuels has the highest skewness and Construction Materials has the least.

For ΔOPI the mean is 47, the median is 0.0 and the standard deviation is 542. All except Spain and Italy share the same median of 0.0 and the standard deviation ranged from 749 for France to 340 for Spain. No country had any real growth in profitability across their market as a general trend and for each country it is a small number of large firms that contribute to the increase in earnings. There is skewness in both the country and industry statistics.

LEV in the merged sample has a mean of 811, a median of 7 and a standard deviation of 3,015. The spread in means ranged from 1,836 for Spain to 445 for Great Britain. Italy, France and Germany have means of 1,365, 1,348 and 1,061 respectively. The medians ranged from 138 for Italy to 0.2 for Great Britain and again the medians are much smaller than the means indicating a large skewness in the data. *LEV* is also skewed at both the country and industry levels. As mentioned earlier, the scale effect generated skewness is reduced by deflating all of the above discrete variables by total assets. Skewness is statistically corrected after the

deflation and normalisation (only for market value) indicates that the data is sensibly normalised.

Additional industry, by country, descriptive results are contained within tables 12 in Appendix 2. The results in these tables and Table 4 show that the utility and manufacturing sectors have a greater reliance on debt and have more consistent returns in operating income and change in operating income. Market value is also larger for these sectors as would be expected. Electric Utilities are the largest of these, Oil and Gas and Metals and Mining showed large variations in Market Value and again both sectors had a substantial amount of small firms that skew the results.

In contrast Chemicals, Gas utilities, Multi Utilities, Paper and Construction Materials all show greater consistency in *OPI*. The industry results also confirm the observed trends and *LEV* of utilities and manufactures having high debt gearing most likely linked to infrastructure and plant assets where as Oil and Gas and Mining had a greater reliance on *BV* to fund their exploration activities. The constant trend was the stagnation in ΔOPI with the median for all industries being zero with the exception of Multi Utilities which have a median of 10.

The overall trend observed is that the data are skewed with all industries having two to three market dominate participants that contributed to a significant part of the market value for that sector. In the case of oil and gas and mining and metals, both of these industry sectors contain a large number of similar firms that soften the significance of the market dominant firms in these sectors. As most of these firms are contained in the Great Britain and German industry results they have a similar effect on these country results. Germany also had a number of smaller firms contained within its chemical industry sector which again softened the market dominant firms' results at the sector and country levels.

Bivariate Statistics

T tests are conducted for both the sample and the sub-samples. In each of the tests, *MV* for the firms is significantly greater ($p \leq 0.01$) when they are members of the *EU ETS* then when they were non-members. This is indicative of the variations in market value between the two sets of firms and suggests an information effect. However it is not conclusive as it is not controlled for time and other influences; this is further examined in the multivariate tests.

When the t tests are repeated using *EU ETS* equals 0 to signify the firm year observations prior to EU ETS membership and *EU ETS* equals one to signify firm year observations post EU ETS implementation (Panel B), the results show that elastic firms have a significantly higher *MV* than inelastic firms prior to EU ETS membership. Post EU ETS membership this difference disappears. This could be attributed to the information effect response that is observed in panel B of the t tests and is further examined in the multivariate analysis.

[Insert Table 5 here]

Pearson correlations are conducted between each of the variables for each country sample (not reported), the merged sample, and each industry sector sample. The coefficients of correlation for the merged sample are reported in table 6. Where a coefficient is significant at $p < 0.05$ level, it is shown in bold.

The Pearson coefficients in all six tables show that EU ETS has a significant positive correlation with *MV*, which is what H1 posits. However, *PED* has a significant negative correlation with *MV* only for Germany, France and Italy, which is what H2 posits. Contrary to H2, *PED* has a significant positive correlation with *MV* for Spain. The anomalous results for *PED* are most likely caused by the weighting towards elastic industries in the firm samples for these countries.

Contrary to the predictions of the Ohlson (1995) model, *MV* has significant negative correlation with *BV* and *OPI* in the merged sample. Again, except for France and Great Britain, for all countries *OPI* has significant positive associations with *MV*. The results for ΔOPI and *LEV* also show that except for France both variables have the expected sign for all of the samples. One of the reasons for the anomalous results for France is that some of its firms had experienced drastic reductions in shareholder equity in recent years.

For Germany, France, Spain and Italy, the *MV* versus ΔOPI relation is not significant. Great Britain had a significant p-value for ΔOPI and this would be expected given that ΔOPI is related to *OPI* and Great Britain experienced a significant reduction in earnings over the sample time frame for their sample. The results illustrate some of the fundamental differences between these countries, German and French firms favour capital structures dependent on large block holders whereas British firms have a reliance on a multitude of smaller shareholders (Van der Elst, 2004).

Spanish and Italian firms traditionally rely on greater equity contributions and hence borrowings have less correlation with market value. The correlation of *MV* with *LEV* for the sample countries resulted in a negative sign with the exception of France. France's results can be explained by the nature of their reliance on debt funding. *BV* proved to be significantly correlated at $\leq 5\%$ to *OPI* and *LEV* for the merged sample and for all of the countries individually. As discussed previously, this would be expected given the relationship of equity, debt and earnings to market value. For *BV* correlated to ΔOPI it proved to be significant at $\leq 5\%$ level for only Great Britain and the merged sample, again reflecting the earnings issues in the British market as well as the weighting of the British sample in the merged results. For *BV*'s correlation to *ETS*, it is significant for Germany and Great Britain as well as for the merged sample. The correlation between *OPI* and ΔOPI is significant for all countries and the merged sample because of the obvious interaction of earnings to change in earnings calculated on a yearly basis.

[Insert Table 6 here]

The bivariate statistics indicate that there is a correlation between the experimental variable EU ETS membership and the dependent variable firm valuation. Each country, with the exception of Great Britain demonstrated a significant correlation between the second experimental variable elasticity and market value. This means that the two experimental variables selected for this study are useful estimation variables. The result for Great Britain most likely reflects its sample composition which contains a large number of oil and gas and mining and metals firms which are of an exploration nature and many are not necessarily located within the EU ETS.

Multivariate Statistics

I use time adjusted ordinary least squares (OLS) regressions to estimate the multivariate models. The time adjusted OLS regressions adjust potential autocorrelation/serial correlation of variables between years.

(H1) Effects of EU ETS

The purpose of Model 1 is to determine the effect of EU ETS on *MV*. It is significant at $p \leq 1\%$ level for Germany, Great Britain, Spain and Italy and the merged sample. For each of these significant results the sign is positive and the results confirm that EU ETS has a positive

impact on the market valuation of firms and rejects H_{O1} . The lack of significance in the French result is likely due to strong government shareholding within some of the large firms and the fact that several industrial sectors such as electricity and petroleum had only one significant firm meaning that industry sector concentration was extreme. Large government ownership reduces the free float of shares, thus reducing the market effects of firm performance. Other possible reasons and scenarios will be covered in the discussion section that follows.

As was expected the variable BV proved to be significant at the 1% level for all countries. Under Ohlson's model BV is a significant determinant of MV and given a number of the firms are utilities, they have significant fixed asset infrastructures which are generally correlated to high BVs . Therefore, the market value of these firms is heavily driven by their infrastructural assets. OPI was significant at the 1% level for Germany, Great Britain, France and Italy but is not significant for Spain. The negative sign of the earnings for Great Britain is due to the large number of small oil and gas and mining firms that experienced significant losses.

In the regression, the ΔOPI estimate for the French variable is -0.524 and is not significant. No country was significant for ΔOPI ; Germany, France and Italy all had negative signs for the change in earnings on a yearly basis. For the control variable LEV , Germany was significant at $p < 1\%$ level and Great Britain at $p < 5\%$ level, and is not significant for any of the other countries. The signs of the coefficients for Germany and the merged sample were negative meaning that as debt increases market value decreases. The control variables are generally of the magnitude and sign as expected except for France.

[Insert Table 7 here]

(H2) Effects of PED

Table 8 contains the results from Model 2. The purpose of this estimation is to evaluate the significance of PED . Results show that PED is significant for Germany at $p < 1\%$ level and for Spain and Italy at $p < 5\%$ level. It is significant for Great Britain at the 10% level and it is not significant for France which confirms the lack of correlation in the Pearson correlations for France for the variable PED .

The negative signs for each of the estimates indicate that PED is negatively associated to market value, which confirms the expectation that cost internalisation affects market values if

the opportunity to pass this cost on is limited due to PED elasticity. This result can also be explained by the economic justification that as PED elasticity increases, consumers having greater choice can substitute goods and services with greater ease in response to price changes. This translates to firms having greater competition which decreases earnings. France's results, once again, are a reflection of the large government influence and control over the industry sectors that are covered by the EU ETS.

The variable *EU ETS* remained unchanged and was still significant at $p < 1\%$ level for Germany, Great Britain, Spain, Italy and the merged sample. It was not significant for France which is to be expected because if price elasticity is not a concern for market valuation then EU ETS membership would not cause any increase or decrease in valuation. The other variables remain unchanged from the estimate of Model 1, with the exception of *LEV* for Spain which is significant at $p < 10\%$ and positive sign rather than negative as expected under the Ohlson model. The significance of this is most likely a reflection of Spanish firm's heavy reliance on debt as shown in the univariate statistics analysis Table 3.

[Insert Table 8 here]

(H3) Effects of PED and EU ETS

Tables 9 & 10 contain the results of estimating model 1 for hypotheses H3a and H3b by country and for the merged sample. As stated in H3a, *EU ETS* was not significant for any country, with the exception of Italy at $p < 1\%$ level and Great Britain at $p < 5\%$ level. This result indicates that inelastic firm's valuations are uncorrelated with EU ETS membership with the exception of Italy and to a lesser degree Great Britain. Great Britain's inelastic industries also include deregulated electric and gas utilities industry sectors and because of the weighting of Great Britain in the merged sample *EU ETS* is also positive and significant for the merged sample. This is unexpected, and H3a cannot be supported. For H3b, all country sub-samples show a positive effect for EU ETS membership, with significant results for Germany, Great Britain, Spain and the merged sample, as expected and H3b is supported.

Inelastic firms do not have to absorb the cost increases of EU ETS membership and regulation nor does the market perceive that such legislation will have an impact on their future earnings. Italy's market is small and contains 43 firms, of that, 26 are classed as inelastic and 7 of these are classed as multi-utilities, which is the highest ratio of multi-

utilities in any country. In the industry regressions, Italy was the only country to have a significant correlation with Multi-Utilities and this correlation is what is most likely to influence the Italy's inelastic firm's results. The result of Italy's inelastic firms being significant for *EU ETS* can be explained by its geography and the sensitivity of some of these industries to geographical substitution of products. The inability of a firm's customers to substitute suppliers allows it to maintain *MV* via higher pricing levels of products.

The results for *BV* are all significant at $p < 1\%$ level for all countries and the merged sample. The results for *OPI* were not significant for Germany, Great Britain and France whereas *OPI* is significant for Spain and Italy. The nature of the inelastic industries is they are generally infrastructure based firms who have high investments in capital and this is reflected in the significance of book value being such a major component of market value. ΔOPI is insignificant for all countries and *LEV* is significant at the 1% level for Italy and at the 5% level for Great Britain.

[Insert Table 9 & 10 here]

The table 10 results indicate that at least for Germany, Great Britain and Spain elastic industries are very sensitive to EU ETS membership and for all countries the sign is positive. This means that the market favours membership of the EU ETS, conveying information that helps predict future earnings. The information effect is most likely related to the potential liabilities and costs being quantified and allows better estimations to be formed.

For France the neutral response is a confirmation of the findings in the first two models where it is noted that both *EU ETS* and *PED* appear to have little relevance to French firms' valuations. For Italy, the lack of significance of *EU ETS* is most likely attributed to the higher book value of Italian firms as noted in the descriptive statistics. If a greater portion of Italian firms' market values is attributed to book value rather than earnings, then the impact of *EU ETS* on market value via its influence on earnings is less significant. The elastic firms' industry sectors in both France and Italy also contain instantaneous where only one firm is represented in the sector such as in the case of France, only the firm "Total" is present in the oil and gas industry sector. In these instances with no competition the significance of *PED* can be expected to be less and thus sensitivity to *EU ETS* membership would decrease as is detected in the results in table 10.

EU ETS membership affects the earnings component of market value because the cost effects of EU ETS membership are either passed through or absorbed by the firm, the greater the ability of the firm to pass through the cost effects the less its earnings and thus market valuation will be affected. The results for *BV* and *OPI* confirm the expectations of elastic firms being sensitive to EU ETS membership. Germany, Great Britain and France are all significant at $p < 1\%$ level for *BV* and Italy is significant at $p < 5\%$ level. Only Germany, Great Britain and France were significant to *OPI* at $p < 1\%$ level and only Great Britain was significant for ΔOPI which is at $p < 5\%$ level. From an economics perspective the more inelastic the PED is for a market the easier it is for a firm to pass on cost increases or price raises. Elastic PED means customers have a choice and elastic PED firms are aware that their customers have alternative viable options rather than merely accepting price increase. EU ETS membership costs will decrease net earnings unless these costs are passed through. The results confirm that as a firm becomes more reliant on the earnings component of its market valuation, the firm becomes more sensitive to elasticity, the ability to pass on cost increase to customers, and thus EU ETS membership.

The results for elastic firms when compared to inelastic firms show that the reliance on earnings as part of market valuation is reversed in Spain and Italy which are significant at $p < 1\%$ level for inelastic firms and not significant for elastic firms. This runs counter to Germany, Great Britain and Frances results and may indicate some other local market factor at work. I rerun the data for all firms using an interaction variable *EU ETS x PED* the results (not reported) are positive but not significant. The lack of significance may be caused by the collinearity between the interaction variable and the main-effects variables as the VIFs are between 4 and 6 for these variables, even though, generally, a $VIF < 10$ is acceptable.

[Insert Table 10 here]

The R^2 score for each of the hypotheses consistently illustrate the strength and fit of the models employed. For the merged samples the R^2 scores are 26.5%, 29.04%, 37.82%, 32.35%, for H1 to H3b respectively. Individual country R^2 scores range from 18.00% to 60.89% across the models. For the sub-sample regressions the R^2 scores are constantly higher and this is observed in the industry regressions where the R^2 scores range from 22.73% to 74.49%. Multicollinearity is assessed by reference to the VIF (variance inflation factors)

which are all well below 10 with the highest not exceeding 3. The use of autoregressive regressions bring all of the Durbin Watson scores above 2.00 and thus removes the bias that arises from time series auto correlation or serial correlation.

Sensitivity Tests by Industry:

Tables 33-40 in Appendix 2 contain the correlations conducted for the explanatory variables on an industry sector bases. They closely replicate the findings determined on a country basis and illustrate the significance of *BV* and *OPI* in determining market value as well as the significance of *EU ETS*. As in the country correlations, ΔOPI and *LEV* have less explanatory value. From an industry perspective if there is a valuation effect for *PED* then elasticity, when tested on an industry sector basis, should highlight which industry sectors are responsive to *PED*. From the sign of the *EU ETS* coefficient, the nature of the response as well as the strength of the response can be ascertained. Therefore, I conduct additional tests using Model 1 by industry. Industry tests also provide the opportunity to test the empirical model from two additional perspectives. For hypothesis H3b I expect high PED industries to have a higher association between market value and EU ETS membership and for low Elasticity firms to have no association between book value and EU ETS membership.

[Insert Table 11 here]

Table 11 contains the results for H3b conducted on an individual industry sector basis. The inelastic industry sectors are grouped to the left of the table (Oil, Gas & Consumable Fuels, Electric Utilities, Gas Utilities and Multi-utilities). The elastic industry sectors are grouped to the right of the table (Chemicals, Construction Materials, Metals & Mining and Paper & Forest Products). The results of the regression are as expected and support the country results previously reported.

For the inelastic industries, *EU ETS* is significant at $p < 5\%$ level for Oil, Gas & Consumable Fuels and $p < 10\%$ level for Electric Utilities. *EU ETS* is not significant for Gas Utilities or Multi-Utilities. These results confirm the previous findings from the regressions performed at the country level for the elastic and inelastic groups. The significance of *EU ETS* for Oil, Gas & Consumables Fuels and Electric Utilities is not strong enough to influence the inelastic sample as a whole. These industry sectors may have stronger correlation to *EU ETS* because in the case of Oil & Gas they have more readily available substitutes and are more susceptible

to elasticity as documented in economics literature (Bernstein & Griffin, 2006). In the case of electricity, the potential to profit from the production of carbon credits may have influenced this result (Carbon Trust, 2008).

The country results for inelastic industries contained in table 9 show that *EU ETS* is significant for Italy and the merged sample at $p < 1\%$ and for Great Britain at $p < 5\%$. Great Britain contains the highest number of oil and gas firms of any of the sample countries and Italy has the highest exposure to multi utilities. Electricity utilities in the industry sample tested significant at $p < 10\%$, Germany and Great Britain had the highest number of electricity utilities in the sample countries. As the number of electricity utilities decreased it is expected that opportunities for substitution would decrease meaning that the market becomes more inelastic. This expectation would be subject to geographical considerations and the clustering together of electricity utilities thus enabling substitution opportunities for consumers at specific geographic locations only.

For the elastic industries the explanatory variable *EU ETS* is significant at $p < 1\%$ level for Chemical, Paper & Forest Products and Metals & Mining and is significant at $p < 5\%$ level for Construction. The results show that the market responds positively to elastic firms joining the *EU ETS*. When this is contrasted to the country's results for elastic industries contained in table 10, *EU ETS* was significant at $p < 1\%$ for Germany, Great Britain and Spain as well as the merged sample. Great Britain and Germany contain the largest number of elastic firms with the samples dominated by the chemical and mining and metals sector.⁸ Spain has an evenly distributed number of construction, mining and metals and paper and forest product firms which cause EU ETS membership to be significant. Overall the country results correlate well to the industry results and support the significance of EU ETS membership.

The results for H3b and the subsequent sensitivity tests by industries suggest that firms with high *PED* enjoy the most amounts of benefits of *EU ETS*. These benefits mostly arise from informational efficiencies created in the market place by the mandatory requirements of externality performance and disclosure. However, low *PED* firms also seem to enjoy similar benefits, but at a lower level.

⁸ See table 2 for a summary of firm industry categories.

The use of the sensitivity tests for industry also confirms the country results when the analyses of the country results are aligned to each industry. When the country results are divided into industry sectors and the relevant PEDs are applied, the differences between countries at the industry sector level become evident.

DISCUSSION

A firm's valuation has a significant component derived from future earnings; the impact of internalising any additional costs will affect future earnings and hence market values. In elastic industries, EU ETS membership and PED are significantly value relevant. The internalisation of the cost is expected to have a negative effect on earnings and, thus, market value. The informational effect appears to counter the internalised cost effect. The value of this information effect is that when the carbon exposure⁹ is fully disclosed the risk premium for that firm can be refined. The results suggest that the lowered discount caused by the informational effect has a positive effect on firm market valuation.

Institution and Regulatory Effects

Each country has its own regulatory framework, culture, history and macroeconomic variables that influence market values. In Europe and, especially Germany, the banking system operates differently than in the US. Banks tend to take larger shareholdings within the companies that they lend to (Schmidt, 2003). These differences in capital composition make country comparisons difficult. There are several difficulties in trying to account for institutional or government holdings on the market value of firms. The information available for free float, block shareholdings and government holdings is not easy to obtain, and the identification of institutional holdings and the related party connections is difficult to establish. Given the large sample size, which extends over a six year time frame, it is difficult to review each company's capital structure and the resulting effect on value, although leverage has been included as a control variable. Given that the focus of this study is the informational value of EU ETS membership and the implications of industry sector PEDs, the effects of capital structures arising from institutional differences has been relegated for investigation in future studies.

⁹ The risks associated with the move to a mandatory environment where the cost of CO₂ emissions is internalised.

Another factor for consideration is that many of these industries are involved in large scale infrastructure and plant investments that have long payback terms and need substantial funding as well as government guarantees of regulatory environment stability before such investments can be undertaken. I use long term debt divided by assets as a measure of leverage to account for the influence of different borrowing strategies between industries and the effect of different country's capital structure traditions. The differences in firm size, equity composition and industry sector elasticity combine to determine the effect of EU ETS membership on market value. The current industries were selected on an emission basis by the EU, and as the EU ETS programme is expanded to include other GHGs and other industries, these firm size and valuation composition issues will need to be given greater consideration.

The results indicate that when a firm has to internalise a cost rather than pass it through, then it is far more susceptible to a negative impact from an imposed cost such as EU ETS membership. The positive effect of the information component appears to be in the quantification of the firm's carbon exposure. In an inelastic industry, the negative effects of cost internalisation are limited. For elastic firms, the negative cost effects depend on the pass through rate and the overall effect is dependent on the size of the negative cost effect countered by the positive informational effect.

The importance of the price of carbon

For the EU ETS to influence a firm's value, the costs or benefits of belonging to the EU ETS must be material enough for the market to factor this into its valuation. If carbon credits are cheap the cost of compliance is small and the valuation effect is minimal. The oversupply of credits in the first EU ETS round, 2005 – 2007, was caused by the adherence to a 1990 base year. During the 15 years prior to the EU ETS establishment, a number of significant macroeconomic events have occurred. The collapse of heavy industry in Russia and the Eastern bloc, the shifting of heavy industry in Western Europe to developing nations and voluntary actions by a number of firms had already mitigated significant levels of CO₂ production.

During the 2005-2007 period there was a significant over allocation of credits within the member states, and national allocation plans had not been adjusted to reflect industry changes

since the original allocation plans were drafted. Carbon prices dropped to almost €13.35 per tonne of CO₂ in April 2006 as several countries including Sweden, France, Belgium, Spain and the Czech Republic reported surpluses in allowances causing the EU ETS market to collapse to a 13 month low. Following the second round of country settlements in 2007, it became apparent that CO₂ emissions for the period were 3% less than the total allocated and CO₂ prices dropped to €0.08 by September 2007 (Bird et al., 2008; Ellerman & Buchner, 2008; Veith, Werner, & Zimmermann, 2008).

This loss of value for carbon credits meant that the material significance of the cost of compliance of EU ETS membership may have an insignificant impact on firm's earnings and thus have little relevance to the market as the cost of compliance is insignificant. The value relevance of an amount is only significant if it influences the share price (Barth et al., 2001). In this situation, the information effect of knowing the firms carbon exposure would outweigh any cost effect and improvement in market value can be expected as the carbon risk premium is eliminated.

For future research it is important to note that the significance of EU ETS is set to increase. The second phase of cap-and-trade reductions has already been decided and the third phase is currently being planned. The EU has spent considerable time investigating the underlying causes of the over-allocation and it is unlikely to occur again. By September 2008 prices had recovered to €20.70 per tonne of CO₂ with analysts predicting further increases in the coming years (Ellerman & Buchner, 2008). The cost effect of the EU ETS is set to increase correspondingly and as the price of carbon increases so will the impact on earnings for those firms forced to internalise the cost. The SO₂ market in the US suffered a similar fate in its early stages when it was revealed that the implied demand for allowances had been significantly less than projected. As further reductions limited the market allocations, prices rebounded and achieved stability (Ellerman et al., 2000).

The decrease in the financial cost of EU ETS membership caused by a low carbon price may have other consequences in that information takes time for its apparent consequences to be recognised and fully imputed by the market (Barth et al., 2001). The lack of materiality of CO₂ in the first phase of the EU ETS may have a dampening effect on how the market responds to changes under the second and third phases.

Separate to the cost effect issue, there is the additional information problem created when the market price for Emission Allowance Units (EAU) credits collapses because of over allocation. If the market has already calculated that the number of EAUs available for allocation is approximately equal to the number of units required to settle contractual and regulatory obligations, then the need to purchase additional EAU units for compliance would be minimal and this is reflected in the cost effect argument. A component of the information effect is that any additional units purchased by firms would provide a real option with respect to increasing opportunities for future production output and technology changes provided that they were dependent on utilising additional credits.

Without a source of credits, a firm's ability to increase production is limited by the technology available for a low CO₂ emitting methodology. The ownership of credits thus has an asset value and an option value. In prior studies on the US SO₂ market, these two events were observed in the market value model estimation. Firstly, the purchase of an asset in exchange for cash has an effect on the firm's cash position and represents either a cost to the firm or the acquisition of an asset. Secondly, by purchasing a SO₂ credit the firm also acquires a real option.

This real option provides the additional benefit of choice and allows the owner to either produce more SO₂ or to sell the right; the value of the option is the decision to act one way or another at some time in the future. In the EU ETS market during phase one, the lack of scarcity of carbon credits meant the carbon credit price collapsed. This also meant that the real option did not hold a value because at any time a firm could have acquired the credit and thus the right to pollute for an insignificant amount (Johnston et al., 2008). Without an appreciation of both the cost and option value of a carbon credit, the information effect cannot be fully ascertained. Thus, in a market situation where carbon becomes a significant cost then the value of the information effect may change considerably.

CONCLUSIONS, LIMITATIONS & FUTURE RESEARCH

Using the Ohlson model (1995), I extend prior research into the investigation of the economic consequences of a regulated setting for the recognition of externalities, the mandatory EU ETS membership of European firms. By using PED and the resulting pass-through rate predictions and observations, I examine the effect of EU ETS membership on firm value at a country and industry level.

The results indicate that there is a significant effect on company valuations as a consequence of joining the EU ETS. For inelastic firms, the finding is that EU ETS membership is neutral and for elastic firms EU ETS membership has a positive effect. When the results are analysed with the inclusion of the elasticity variable, it is apparent that the effect is nominal if a firm can pass through the cost.

This suggests that EU ETS membership has a positive effect on firm value for elastic industry firms as the negative cost internalisation effect is countered by a positive information effect. For inelastic industries, the market is neutral towards EU ETS membership. I conclude that the disclosure of a firm's carbon exposure through a regulatory-enforced emissions cap-and-trade system quantifies the risk and reduces adverse selection risk.

By repeating the study in phase II of the EU ETS, the strengthened carbon price should confirm the findings from this study, and the strength of the effect should be greater. This research illustrates that markets perceive EU ETS membership for firms belonging to inelastic industries as being of limited significance and EU ETS regulation merely confirms information already known to the market. In the case of firms belonging to elastic industry sectors, EU ETS membership provides information to the market that allows it to improve the accuracy of its valuation and the market responds to this in a positive fashion by lowering its discount for asymmetric information.

In markets that are inelastic, the opportunity to pass compliance costs to consumers mitigates the potential risk of undisclosed carbon exposure, and the market is neutral to EU ETS membership (Carbon Trust, 2008; Veith et al., 2008). I observe neither beneficial advantages from EU ETS membership for firms operating in inelastic industry sectors as predicted by several researchers, nor the negative consequences predicted by industry representative organisations during the establishment phase of the EU ETS. Prior to the formation of the EU

ETS, numerous industry lobby groups claimed that the increased cost of EU ETS compliance would be more significant than those estimated by the EU and would have to be absorbed by the firm. The result of this would be earnings decline and value destroyed (Markussen & Svendsen, 2005).

The current benefits of the information effect may then be mitigated as firm earnings are affected by increased costs and the retention of margins controlled by the degree of firm pass through rate. Industry segmentation, price elasticity and the availability of product substitution will determine ongoing profitability, and ultimately, market value. These effects are observable at the firm and industry level and future studies will need to account for market elasticity as a key determinant in analysing the effect of the forced internalisation of externalities by regulatory means. The cap-and-trade mechanism is no different than a tax or tariff in mitigating cost increases, and market forces determine whether margins can be retained.

Limitations and future research

There are several limitations of this study. The first limitation relates to the way the EU ETS was implemented on a facility basis whereas data was collected for this study on a firm basis. The use of selected industry codes to define firms is useful in aligning the core business functions of firms with EU definitions. It does not account for firms that have many or all of their facilities outside of the EU and are unaffected by the EU ETS nor does it take into account facilities below the regulation threshold or operations that use non GHG producing processes such as the use of hydro in electricity generation. In any future study, this issue will need to be addressed. The companies could be weighted to reflect the portion of their business activities directly affected by EU membership or the sample can be divided into two groups, one which contains companies with facilities only in Europe and one with companies that also have facilities outside of Europe.

The second limitation is the institutional effect on market value. Several of the sample firms have large institutional shareholdings because they contribute significantly to the market indices within the markets in which they are listed. Superannuation and indices tracking funds maintain significant holdings and trade these shares in order to maintain investment portfolio percentages in line with indices. Several of the firms have large government shareholdings or in the case of some of the electricity generation companies, are entirely

controlled by the government through regulation. Industries that are deemed to be of significant national importance have traditionally had strong government stakes in the ownership structure.

Government ownership and regulatory policy may suppress market forces and alter firm's behaviour when choosing whether to internalise a cost or pass it through. Some of these institutional effects may be attributed to the legal origin of the countries in which the firms are domiciled. Common law countries like Great Britain provide more shareholder-based information whereas code law countries such as France, Germany, Italy and Spain provide more stakeholder-based information (La Porta et al, 1997). These legal origin subtleties create informational differences across the sample.

A third limitation is the assignment of elastic and inelastic labels on an industry basis, which may not be representative of each firm's particular situation. A better indicator of elasticity may produce cleaner results and prove useful for further developing this research.

Considerations could also be given to differentiating between short-term and long-term consumer responses so that any material shifts in consumer behaviour can be identified. The threshold for elasticity restated as a significant demand-driven shift in consumer behaviour could be misinterpreted as a price response rather than a technology shift, and this may bias the results.

A potential issue is that even though an auto-regressive estimation is used to account for autocorrelation issues arising from the sample spanning six years, there is still the possibility that some underlying event may be responsible for the information effect. For example, International Financial Reporting Standards (IFRS) were adopted in Europe in 2005 and have improved the reporting standards of European firms thus improving the quality of information available to the market. Recent research on the effects of IFRS implementation indicates that there has been little market reaction to the introduction of IFRS (Beuselinck, et al., 2009; Holthausen 2009).

If IFRS is responsible for the information effect detected in this research then it would have been present in both sub-samples during the H3a and H3b model estimations. The interpretation of accounting standards as with any form of codification is susceptible to influence through social forces at the local implementation level. There are numerous country and regional specific variables such as local government policy, regulation changes, rate

control and institutional effects (Hail et al, 2009). The estimations used do not remove the possibility of an evenly distributed undetected underlying variable.

For a limited number of companies, there may be an opportunity to generate windfall profits from the introduction of regulation. The elasticity of demand allows firms in certain industries to exploit pricing opportunities. In the case of electricity generators that derive some or all of their power generation from hydro or wind applications, the EU ETS provides these firms with additional sources of revenue. Another source of profit arises from the sale of carbon credits from their Joint Investment (JI) and certified emission reduction certificate activities outside of the EU ETS, and from selling electricity at the spot market rate which reflects the pass through of EU ETS compliance costs.

Some industries benefit from the allocation of carbon credits as local national allocation plans (NAP) provide the opportunity to profit from the sale of over allocated allowances (Veith et al., 2008). Elastic industries such as concrete and steel may create windfall profits by sourcing from non-EU ETS covered facilities and selling on the local EU ETS market at the carbon compliance price. It is expected that this practice will be limited by decreasing caps and regulatory policy changes instigated by the EU ETS (Carbon Trust, 2008). The business opportunities contained within the EU ETS mandatory scheme have not been considered in this research and their potentially positive effect on firm or industry valuations will need to be considered in future research.

This line of enquiry also provides an opportunity for future research to identify what aspects of PED have the greatest influence on market values. It also asks the question at what point does the information value of defining an externality liability become outweighed by the cost of mitigating the externality. Any form of regulation that aims to change consumer behaviour through market forces is only as effective as the PED determinants of the industry in question. The proportion of a firm's valuation determined by its future earnings is directly linked to EU ETS membership through its PED.

REFERENCES

- Acton, J. P., & Dixon, L. S. (1992). *Superfund and Transaction Costs: The Experiences of Insurers and Very Large Industrial Firms*. Santa Monica: Rand Institute for Civil Justice.
- Aerts, W., Cormier, D., & Magnan, M. (2008). Corporate environmental disclosure, financial markets and the media: An international perspective, *Ecological Economics*, Elsevier, 64(3), 643-659.
- Akbar, S., & Stark, A. W. (2003). Discussion of Scale and the Scale Effect in Market-based Accounting Research. *Journal of Business Finance & Accounting*, 30(1-2), 57-72.
- Al-Tuwaijri, S. A., Christensen, T. E., & Hughes, K. E. (2004). The Relations Among Environmental Disclosure, Environmental Performance, and Economic Performance: A Simultaneous Equations Approach. *Accounting, Organizations and Society*, 29(5-6), 447-441.
- Barth, M. E., Beaver, W., & Landsman, W. R. (2001). The Relevance of the Value Relevance Literature for Financial Accounting Standard Setting: Another View. *Journal of Accounting & Economics*, 31, 77-104.
- Barth, M. E., & Clinch, G. (1998). Revalued Financial, Tangible, and Intangible Assets: Associations with Share Prices and Non Market-Based Value Estimates. *Journal of Accounting Research*, 36(Supplement), 199-213.
- Barth, M. E., & Clinch, G. (2009). Scale Effects in Capital Markets-Based Accounting Research. Working Paper. Stanford University.
- Barth, M. E., & McNichols, M. (1994). Estimation and Market Valuation of Environmental Liabilities Relating to Superfund Sites. *Journal of Accounting Research*, Supplement.
- Bayon, R., Hawn, A., & Hamilton, K. (2007). *Voluntary Carbon Markets*. London: Earthscan.
- Beaver, W., Lambert, R., & Morse, D. (1980). The Information Content of Security Prices. *Journal of Accounting & Economics*, 3-28.
- Bebbington, J., & Larrinaga-González, C. (2008). Carbon Trading: Accounting and Reporting Issues. *European Accounting Review*, 17(4), 697-717.
- Bernard, V. L. (1995). The Feltham-Ohlson Framework: Implications for Empiricists. *Contemporary Accounting Research* 11(2), 733-747.
- Bernstein, M. A., & Griffin, J. (2006). *Regional Differences in the Price-Elasticity of Demand for Energy*. Santa Monica: RAND Corporation. (N. R. E. Laboratory).
- Berthelot, S., Cormier, D., & Magnan, M. (2003). Environmental Disclosure Research: Review and Synthesis, *Journal of Accounting Literature*. 22, 1-44.

- Beuselinck, C., Joos, P., Khurana, I. K., & Van der Meulen, S. (2009). Mandatory IFRS Reporting and Stock Price Informativeness. Working Paper. <http://ssrn.com/abstract+1381242>.
- Bird, L. A., Holt, E., & Carroll, G. L. (2008). Implications of carbon cap-and-trade for US voluntary renewable energy markets. *Energy Policy*, *36*, 2063-2073.
- Bohi, D. R., & Zimmerman, M. B. (1984). An Update on Econometric Studies of Energy Demand Behaviour. *Annual Review of Energy*, *19*, 105-154.
- Botosan, C. (1997). Disclosure Levels and the Cost of Equity Capital. *The Accounting Review*, *72*, 323-349.
- Botosan, C., & Plumlee, M. (2002). A Re-examination of Disclosure Level and the Expected Cost of Equity Capital. *Journal of Accounting Research*, *40*, 21-41.
- Brown, J., & Rosen, H. (1982). On the estimation of structural hedonic price models. *Econometrica*, *50*, 765-769.
- Campbell, K., Sefcik, S. E., & Soderstrom, N. S. (2001). Disclosure of Private Information and Reduction of Uncertainty: Environmental Liabilities in the Chemical Industry. University of Colorado.
- Carbon Trust. (2008). *EU ETS Impacts on Profitability and Trade*: Carbon Trust. London.
- Carter, D. W., & Milon, J. W. (2005). Price Knowledge in Household Demand for Utility Services. *Land Economics*, *81*(2), 265-283.
- Case, K. E., & Fair, R. C. (1999). *Principles of Economics* (5th ed.): Prentice-Hall.
- Caves, R. E., & Porter, M. E. (1978). Market Structure, Oligopoly, and Stability of Market Share. *The Journal of Industrial Economics*, *26*(4), 289-313.
- Cazals, C., Fève, F., Fève, P., & Florens, J.-P. (2005). Simple structural econometrics of price elasticity. *Economics Letters*, *86*, 1-6.
- Chapple, L., Clarkson, P. M., & Gold, D. L. (2009). The Cost of Carbon: Capital Market Effects of the Proposed Emission Trading Scheme (ETS). Working Paper. <http://ssrn.com/abstract=1526895>. 25 January 2009.
- Clarkson, P. M., Li, Y., Richardson, G. D., & Vasvari, F. P. (2006a). Does it really pay to be green? Determinants and Consequences of Proactive Environmental Strategies. UQ Business School University of Queensland.
- Clarkson, P. M., Li, Y., Richardson, G. D., & Vasvari, F. P. (2006b). Revisiting the Relation Between Environmental Performance and Environmental Disclosure: An Empirical Analysis.
- Climate Exchange PLC. (2007). *Climate Exchange Interim Six Month Statement*. London: Climate Exchange PLC.

Cogan, D. C. (2006). *Corporate Governance and Climate Change: Making the Connection*. Boston MA: CERES.

Collins, D., & P, K. S. (1989). An Analysis of the Intertemporal and Cross-Sectional Determinants of the Earnings Response Coefficients. *Journal of Accounting & Economics*, 143-181.

Dhaliwal, Dan S., Li, Oliver Zhen, Tsang, Albert H. & Yang, Yong George, (February 15, 2009). Voluntary Non-Financial Disclosure and the Cost of Equity Capital: The Case of Corporate Social Responsibility Reporting, SSRN.

Downing, P. (1997). Upping the Stakes. *CA Magazine*, (June and July), 41–43.

Dye, Ronald A., An Evaluation of 'Essays on Disclosure' and the Disclosure Literature in Accounting. *Journal of Accounting & Economics*. 32, 1-3, December 2001, 181-235.

Ellerman, D. A., & Buchner, B. K. (2008). Over-Allocation Or Abatement? A Preliminary Analysis of the EU ETS Based on the 2005-06 Emissions Data. Massachusetts Institute of Technology.

Ellerman, D. A., Joskow, P. L., Schmalensee, R., Montero, J.-P., & Baily, E. M. (2000). *Markets for Clean Air: The U.S. Acid Rain Program*. Cambridge: Cambridge University Press.

European Union. (2003). Establishing a Scheme for Greenhouse Gas Emissions Allowance Trading Within the Community. *Official Journal of the European Union*, L 275(Directive 2003/87/EC), 32-46.

European Union. (2004). *Guidelines for the Monitoring and Reporting of Greenhouse Gas Emissions*.

European Union. (2005). *Commission Communication*.
<http://ec.europa.eu/environment/climate> May 30 2009.

European Union. (2008). EU Actions Against Climate Change. In Publications.europa.eu (Ed.): European Union.

Fama, E., & Miller, M. (1972). *The Theory of Finance* Hinsdale IL: Dryden Press.

Fisher-Vanden, K., & Thorburn, K. S. (2008). Voluntary Corporate Environmental Initiatives and Shareholder Wealth. Working Paper. Tuck School of Business at Dartmouth.

Garcia-Cerutti, M. L. (2000). Estimating Elasticities of Residential Energy Demand from Panel Country Data Using Dynamic Random Variables Models with Heteroskedastic and Correlated Error Terms. *Resource and Energy Economics*, 22, 355-366.

Garrett, D. E. (1987). The effectiveness of marketing policy boycotts: environmental opposition to marketing. *Journal of Marketing*, 51(April), 46–57.

Global Reporting Initiative. (2002). Sustainable Reporting Guidelines [Electronic Version]. www.globalreporting.org. June 30 2009

Gu, Z. (2005). Scale Factor R squared, the Choice of Levels versus Returns Models. *Journal of Accounting, Auditing & Finance*, 20(1 (Winter)), 71-91.

Gunther, M. (2008). Doing well by clearing the air: money.cnn.com. Accessed 31 /12/08

Hail, L., Leuz, C., & Wysocki, P. (2009). Global Accounting Convergence and the Potential Adoption of IFRS by the United States: An Analysis of Economic and Policy Factors. Working Paper. <http://ssrn.com/abstract=1357331>. Pages 103.

Hann, R. N., Lu, Y. Y., & Subramanyam, K. R. (2007). Uniformity versus Flexibility; Evidence from the Pricing of Pension Obligation. *The Accounting Review*, 75, (Ail)), 209-228.

Hasselt, L., Nilote, H., & Nyaquisme, A. S. (2005). The Value Relevance of Environmental Performance. *European Accounting Review*, 14(1), 41-61.

Hoffman, A. J. (1998). *Global Climate Change: A Senior-Level Debate at the Intersection of Economics, Strategy, Technology, Science, Politics and International Negotiation*. San Francisco: New Lexington Press.

Hoffman, A. J. (2001). *From Heresy to Dogma* Stanford Business Books. Stanford.

Hoffman, A. J. (2007). *Carbon Strategies: How Leading Companies are Reducing Their Climate Change Footprint* (1st ed.). Ann Arbor: University of Michigan Press.

Holthausen, R. W.,. (2009). Accounting Standards, Financial Reporting Outcomes, and Enforcement. *Journal of Accounting Research*, 47(2), 447-458.

Houthakker, H. S., Verleger, P. K., & Sheehan, D. P. (1974). Dynamic Demand Analyses for Gasoline and Residential Electricity. *American Journal of Agricultural Economics*, 56(2), 412-418.

Hughes, K. E. (2000). The Value Relevance of Non-financial Measures of Air Pollution in the Electric Utility Industry. *The Accounting Review*, 75, 209-228.

Hughes, K. E., & Reynolds, J. K. (2001). Uncertainty Associated with Future Environmental Costs and the Market's Differential Response to Earnings Information. *Journal of Business Finance & Accounting*, 28(9&10), 1351-1386.

IASB. (2008). Emissions Trading Schemes [Electronic Version]. www.iasb.org. June 30 2009

IETA. (2007). Trouble-Entry Accounting - Revisited. Uncertainty in Accounting for the Emissions Trading Scheme and Certified Emissions Reductions [Electronic Version].

- Johnston, D. M., Sefcik, S. E., & Soderstrom, N. s. (2008). The Value Relevance of Greenhouse Gas Emissions Allowances: An Exploratory Study in the Related United States SO₂ Market *European Accounting Review*, 17(4), 747-764.
- Kahn, S., & Lang, K. (1988). Efficient estimation of structural hedonic systems. *International Economic Review*, 29, 157-166.
- Keim, D. B., & Stambaugh, R. F. (1986). Predicting Returns in the Stock and Bond Markets. *Journal of Financial Economics*, 17, 357-390.
- Kolk, A., Levy, D., & Pinkse, J. (2008). Corporate Responses in an Emerging Climate Regime: The Institutionalization and Commensuration of Carbon Disclosure. *European Accounting Review*, 17(4), 719-745.
- La Porta, R., Lopez-de-silanes, F., Shleifer, A., Vishny, R. (1997). Legal Determinants of External Finance. *The Journal of Finance*, L11,(3), 1131-1150
- Leake, J. (2008). The Fool's Gold of Carbon Trading. *Sunday Star Times* p. 5,
- Leuz, C., & Verrecchia, R. E. (2000). The Economic Consequences of Increased Disclosure *Journal of Accounting Research*, 38, 91-124.
- Lijesen, M. G. (2007). The Real-Time Price Elasticity of Electricity. *Energy Economics*, 29, 249-258.
- Maddala, G. S., Trost, R. P., Li, H., & Joutz, F. (1997). Estimation of Short-Run and Long-Run Elasticities of Energy Demand from Panel Data Using Shrinkage Estimators. *Journal of Business and Economics Statistics*, 15(1), 90-101.
- Markussen, P., & Svendsen, G. T. (2005). Industry Lobbying and the Political Economy of GHG trade in the European Union. *Energy Policy*, 33, 245-255.
- Menon, A., & Menon, A. (1997). ‘‘Enviropreneurial’’ marketing strategy: the emergence of corporate environmentalism as market strategy. *Journal of Marketing*, 6, 51–67.
- O'Brien, J. M. (2008). Big Blue's Big Plan: www.cnnmoney.com.
- Orlitzky, M., Schmidt, F. L., & Rynes, S. L. (2003). Corporate Social and Financial Performance A Meta-analysis. *Organisation Studies*, 24(3), 403-411.
- Patten, D. (2002). The Relation Between Environmental Performance and Environmental Disclosure: A Research Note. *Accounting, Organizations and Society*, 27, 763-773.
- Plumlee, M., Brown, D., & Marshall, S. R. (2007). The Impact of Voluntary Environmental Disclosure Quality on Firm Value.
- Porter, M. E., & Linde, C. v. d. (1995). Toward a New Conception of the Environment-Competitiveness Relationship. *Journal of Economic Perspectives*, 9(4), 97-118.
- Reyes, M. G., & Grieb, T. (1998). The external performance of socially responsible mutual funds. *American Business Review* (January), 1–7.

Richardson, A., & Welker, M. (2001). Social disclosure, financial disclosure and the cost of equity capital. *Accounting, Organizations and Society* 26 597–616.

Schmidt, R. H. (2003). Corporate Governance in Germany: An Economic Perspective. Johann Wolfgang Goethe-Universität.

Scott-Thomas, C. (2008). Cadbury Research Tool Combines Efficiency with Green Credentials [Electronic Version]. *Foodnavigator-usa.com*. Retrieved 1 December 2008.

Stern, N. (2006). *The Economics of Climate Change: The Stern Review*. Cambridge. C. U. Press.

Taylor, L. D. (1975). The Demand for Electricity: A Survey. *The Bell Journal Of Economics*, 6(1), 74-110.

Van der Elst, C. (2004). Industry-specificities and size of corporations: determinants of ownership structures. *International Review of Law and Economics*, 24, 425-446.

Verrecchia, R. E. (1983). Discretionary Disclosure. *Journal of Accounting and Economics*. 179-194

Veith, S., Werner, J. R., & Zimmermann, J. (2008). Economic Consequences of Emission Trading Schemes: Evidence from the European Power Sector. University of Bremen.

WBCSD. (2004). *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*. Geneva: World Business Council for Sustainable Development.

Weisman, D. L. (2007). Market Power Measurement for Multimarket Dominant Firms. *The Antitrust Bulletin*, 52(2), 169-178.

Weitzman, M. (1974). Prices vs. Quantities. *The Review of Economic Studies*, 41(4), 477-491.

World Bank. (2008). *State and Trends of the Carbon Market 2008*. Washington DC.

Wright, C. (2006). Carbon Neutrality Draws Praise, Raises Expectations for HSBC [Electronic Version]. www.ecosystemmarketplace.com/,

Table 1- Carbon Allowances of Sample Countries

Member State	CO2 allowances in millions (Tonnes)	Share in EU allowances *	Installations covered **	Registry function ***	Kyoto target ****
Germany	1,497.0	22.8%	1,849	Yes	-21%
United Kingdom	736.0	11.2%	1,078	Yes	-12.5%
France	469.5	7.1%	1,172	Yes	0%
Spain	523.3	8.0%	819	Yes	+15%
Italy	697.5	10.6%	1,240	No	-6.5%
<i>Sample Total</i>	3,923.3	60.5%	6158		
Total for EU	6,572	100.0%	11,428		

*The percentage of EU allowances granted by the EU government on a member state basis.

**The number of installations that must comply to reporting and mitigation legislation and this does not differentiate between public and private facilities, company ownership, type, size or amount of CO₂ production

***Registry function indicates that the state maintains its own registry for carbon credit allocation, creation and retirement.

****The percentage change in Kyoto allocation created by adherence to the EU ETS scheme.

Table 2 - Sample Distribution by Industries and Countries

Industry Code (SIC)	Description	Totals by Industry	Firms				
			Germany	UK	France	Spain	Italy
101020	Oil, Gas & Consumable Fuels	126	7	100	6	6	7
151010	Chemicals	100	29	45	17	2	7
151020	Construction Materials	32	7	11	2	6	6
151040	Metals & Mining	183	10	147	16	7	3
151050	Paper & Forest Products	29	9	7	5	7	1
551010	Electric Utilities	40	18	6	3	6	7
551020	Gas Utilities	12	2	2	1	2	5
551030	Multi-Utilities	18	5	2	3	1	7
Total by Country		540	87	320	53	37	43

Table 3 - Country Descriptive Statistics

		MV_{t+1}	BV_t	OPI_{t+1}	ΔOPI_{t+1}	LEV_t
DEU						
N		364	385	383	528	383
Mean		3865.298	1987.559	416.655	38.411	1061.149
Median		457.826	172.254	21.456	0.000	19.326
Std. Deviation		9909.475	5736.960	1197.130	423.868	3287.767
Minimum		1.357	-46.835	-528.000	-3279.000	0.000
Maximum		91957.962	49374.000	7891.000	4850.000	24145.000
Percentiles	20	43.400	21.535	1.388	-1.442	0.400
	40	202.490	82.989	12.523	0.000	10.281
	60	909.629	356.679	60.516	0.000	55.975
	80	4376.174	1569.549	308.886	14.595	646.497
	100	91957.962	49374.000	7891.000	4850.000	24145.000
GBR						
N		1366	1608	1550	2172	1595
Mean		3575.861	1732.624	356.900	42.716	444.926
Median		45.849	18.881	-0.174	0.000	0.178
Std. Deviation		20089.540	10950.550	2611.986	556.800	2095.095
Minimum		0.000	-3383.000	-6439.000	-5648.000	0.000
Maximum		265423.480	145393.000	41062.000	11992.000	38614.000
Percentiles	20	10.038	2.328	-2.099	-0.788	0.000
	40	27.412	10.928	-0.516	0.000	0.000
	60	85.883	34.288	0.893	0.000	1.516
	80	467.271	177.475	22.771	1.230	45.564
	100	265423.000	145393.000	41062.000	11992.000	38614.000
FRA						
N		274	296	296	318	296
Mean		5541.641	2064.297	764.033	86.484	1347.815
Median		68.538	72.401	8.658	0.000	16.951
Std. Deviation		20995.270	6496.973	3037.873	748.735	4027.698
Minimum		1.929	-948.663	-897.000	-4714.400	0.000
Maximum		148459.974	44858.000	24882.000	6300.000	23318.000
Percentiles	20	17.642	14.269	0.347	-2.635	6.040
	40	48.127	46.178	3.963	0.000	13.229
	60	154.375	122.862	18.823	1.037	29.640
	80	1669.519	1089.854	196.120	13.836	352.135
	100	148460.000	44858.000	24882.000	6300.000	23318.000

*in Millions €

Table 3 - Country Descriptive Statistics Continued

		MV_{t+1}	BV_t	OPI_{t+1}	ΔOPI_{t+1}	LEV_t
ESP						
N		200	208	208	216	207
Mean		4783.607	2075.793	561.190	40.163	1836.324
Median		540.368	258.722	78.549	0.364	114.931
Std. Deviation		9533.287	4133.777	1192.494	340.499	4103.004
Minimum		17.199	-92.509	-36.345	-2250.208	0.000
Maximum		67008.688	25537.219	6097.000	2773.860	19772.000
Percentiles	20	101.642	100.282	3.930	-5.953	11.976
	40	251.418	169.456	23.344	0.000	64.905
	60	1339.782	580.870	152.275	4.975	189.381
	80	7082.943	3071.486	728.960	41.043	1987.282
	100	67008.688	25537.219	6097.000	2773.860	19772.000
ITA						
N		193	212	212	246	212
Mean		5252.459	2364.507	729.801	59.825	1365.216
Median		435.813	329.360	33.023	0.137	137.877
Std. Deviation		15822.270	6782.058	2700.740	460.153	4614.188
Minimum		37.470	-29.300	-188.721	-1894.000	0.000
Maximum		93776.549	40428.000	19633.000	4293.000	51189.000
Percentiles	20	102.062	75.350	7.223	-1.691	19.596
	40	319.198	213.120	23.737	0.000	75.616
	60	614.624	566.765	49.307	2.137	201.876
	80	3059.712	1285.525	239.566	23.002	805.436
	100	93776.549	40428.000	19633.000	4293.000	51189.000
Merged						
N		2397	2709	2649	3480	2693
Mean		4080.288	1880.894	456.917	47.113	811.205
Median		104.490	48.693	3.252	0.000	6.812
Std. Deviation		17977.330	9238.809	2437.543	542.235	3015.411
Minimum		0.000	-3383.000	-6439.000	-5648.000	0.000
Maximum		265423.480	145393.000	41062.000	11992.000	51189.000
Percentiles	20	15.735	5.332	-1.267	-1.093	0.000
	40	53.881	25.312	0.326	0.000	1.196
	60	213.011	101.006	10.679	0.000	18.194
	80	1667.023	622.764	114.023	4.126	190.915
	100	265423.000	145393.000	41062.000	11992.000	51189.000

*in Millions €

Table 4 - Descriptive Statistics All Industries*

	Inelastic Industries					Elastic Industries				
	Oil, Gas & Fuels	Electric Utilities	Gas Utilities	Multi-Utilities		Chemicals	Construction Materials	Metals & Mining	Paper & Forest Products	
(N)	490	144	55	100		473	147	722	130	
<i>Market Value</i>										
Mean	8337.242	12105.221	3020.745	6975.338		1435.081	1802.488	1735.870	156.384	
Med	126.555	5000.254	506.380	2022.42		100.435	446.435	32.040	41.627	
Std Div	33539.700	20625.630	4407.408	10500.410		4624.783	6576.103	8072.811	330.825	
<i>Shareholders Equity</i>										
Mean	3394.000	5798.563	1410.633	2560.886		627.936	681.971	695.862	159.345	
Med	50.996	1832.900	331.327	1145.148		50.620	175.722	13.646	38.766	
Std Div	13967.090	9448.649	2031.084	3750.179		2219.601	1088.959	3011.653	475.520	
<i>Operating Income</i>										
Mean	1132.821	1386.351	313.878	852.203		137.006	131.977	207.346	18.400	
Med	0.448	443.590	44.874	160.240		7.081	40.925	-0.243	1.682	
Std Div	4773.252	2359.610	434.972	1427.517		614.409	231.177	1060.046	68.345	
<i>Change in Operating Income</i>										
Mean	78.608	92.893	11.847	141.909		13.903	8.169	34.244	3.267	
Med	0.000	0.000	0.000	9.875		0.000	0.000	0.000	0.000	
Std Div	855.106	743.421	253.122	851.048		147.712	73.589	288.385	47.144	
<i>Long Term Debt</i>										
Mean	653.993	5093.816	1047.683	3320.386		274.632	433.906	252.327	55.599	
Med	1.672	1289.800	84.492	695.372		12.673	56.838	0.000	10.864	
Std Div	2422.602	7617.675	1473.630	5699.548		871.639	1256.555	1635.830	155.040	

*in Millions €

Table 5 – T Test

	<i>EU ETS</i>	<i>N</i>	<i>Mean MV</i>
<i>Full Sample</i>	0	1125	-0.195
	1	1200	0.047
	Diff (0-1)		0.243
<i>DF = 3232</i>	<i>T value = -12.85</i>	<i>P < 0.0001</i>	

Panel A

	<i>EU ETS</i>	<i>N</i>	<i>Mean MV</i>
<i>PED=0</i>	0	362	-0.158
	1	405	0.046
	Diff (0-1)		0.205
<i>DF = 765</i>	<i>T value = -6.82</i>	<i>P < 0.0001</i>	

<i>PED=1</i>	0	704	-0.22
	1	719	0.056
	Diff (0-1)		0.276
<i>DF = 1421</i>	<i>T value = -10.96</i>	<i>P < 0.0001</i>	

Panel B

	<i>PED</i>	<i>N</i>	<i>Mean MV</i>
<i>EU ETS=0</i>	0	362	-0.158
	1	704	-0.220
	Diff (0-1)		-0.062
<i>DF = 765</i>	<i>T value = 2.053</i>	<i>P < 0.05</i>	

<i>EU ETS=1</i>	0	405	0.046
	1	719	0.056
	Diff (0-1)		-0.01
<i>DF = 1421</i>	<i>T value = -0.375</i>	<i>P > 0.1</i>	

Table 6 - Correlations Merged

	BV_t	OPI_{t+1}	ΔOPI_{t+1}	LEV_t
MV_{t+1}	-0.058	-0.251	0.08	0.048
BV_t	--	0.801	0.734	-0.347
OP_{t+1}		--	0.948	-0.063
ΔOPI_{t+1}			--	-0.032
LEV_t				--

Bolded values indicate that the correlation for the sample is significant at a 5% level or less.

Pearson Correlation

MV_{t+1}	=	Log of the market value of the firm having been divided by its total assets.
BV_t	=	Shareholders equity divided by total assets.
OPI_{t+1}	=	Operating income divided by total assets.
ΔOPI_{t+1}	=	Change in operating income divided by total assets.
LEV_{t+1}	=	Long term debt divided by total assets.

Table 7 - Regression Results - H1 - All firms by Country

	Germany	Great Britain	France	Spain	Italy	Merged
<i>Intercept</i>	-0.541	-0.306	-0.469	-0.632	-0.714	-0.022
	(-8.29)	(-7.33)	(-14.31)	(-8.27)	(-12.71)	(-1.30)
	***	***	***	***	***	
<i>BV_t</i>	0.623	0.424	-0.258	0.657	0.513	0.005
	(5.01)	(8.61)	(-5.78)	(4.40)	(5.06)	(0.99)
	***	***	***	***	***	
<i>OPI_{t+1}</i>	1.633	-0.243	2.311	-0.237	2.120	-0.246
	(5.06)	(-8.35)	(6.16)	(-0.69)	(7.08)	(-8.70)
	***	***	***		***	***
<i>ΔOPI_{t+1}</i>	-0.658	0.012	-0.524	0.658	-0.388	0.009
	(-1.88)	(1.23)	(-1.48)	(1.21)	(-0.82)	(0.92)
<i>LEV_t</i>	-0.628	0.250	0.039	0.238	0.134	-0.007
	(-3.28)	(0.10)	(1.19)	(1.09)	(1.07)	(-1.00)
	***	**				
<i>EU ETS_t</i>	0.143	0.150	0.068	0.190	0.103	0.168
	(3.27)	(0.24)	(1.48)	(3.85)	(3.39)	(9.15)
	***	***		***	***	***
Total R2	32.99%	18.00%	36.78%	21.18%	49.91%	26.51%
Regressive R2	32.38%	17.54%	35.95%	22.17%	49.85%	26.15%
Number of Firm-year observations	284	1164	218	164	155	1985

***, **, *, significant at 1%, 5%, 10% level (two-tailed test).

<i>MV_{t+1}</i>	=	Log of the market value of the firm having been divided by its total assets.
<i>BV_t</i>	=	Shareholders equity divided by total assets.
<i>OPI_{t+1}</i>	=	Operating income divided by total assets.
<i>ΔOPI_{t+1}</i>	=	Change in operating income divided by total assets.
<i>LEV_{t+1}</i>	=	Long term debt divided by total assets.
<i>EU ETS_t</i>	=	Dichotomous variable denoting membership of the EU ETS, 1 if a member 0 if not a member.
<i>PED_t</i>	=	The dichotomous variable denoting inelasticity or elasticity industry sector membership.

Table 8 - Regression Results - H2- All firms by Country

	Germany	Great Britain	France	Spain	Italy	Merged
<i>Intercept</i>	-0.456 (-6.64) ***	-0.351 (-7.14) ***	-0.393 (-7.02) ***	-0.787 (-8.84) ***	-0.616 (-9.39) ***	0.019 (0.87)
<i>BV_t</i>	0.690 (5.59) ***	0.543 (9.77) ***	-0.250 (-5.50) ***	0.653 (4.53) ***	0.494 (4.96) ***	0.006 (1.31)
<i>OPI_{t+1}</i>	1.647 (5.21) ***	-0.259 (-8.77) ***	2.252 (5.91) ***	-0.111 (-0.33)	1.884 (6.29) ***	-0.267 (-9.14) ***
<i>ΔOPI_{t+1}</i>	-0.515 (-1.49)	-0.012 (1.27)	-0.450 (-1.26)	0.592 (1.12)	-0.277 (-0.60)	0.007 (0.74)
<i>LEV_t</i>	-0.543 (-2.87) ***	0.247 (2.33) *	0.045 (1.36)	0.542 (2.32) *	-0.090 (-0.61)	-0.008 (-1.22)
<i>EU ETS_t</i>	0.137 (3.27) ***	0.146 (5.79) ***	0.061 (1.28)	0.191 (4.06) ***	0.105 (3.39) ***	0.173 (9.30) ***
<i>PED_t</i>	-0.160 (-3.40) ***	-0.046 (-1.84) *	-0.101 (-1.78)	0.175 (3.08) ***	-0.194 (-2.85) **	-0.048 (-2.49) **
Total R2	35.45%	22.56%	37.41%	25.69%	52.95%	29.04%
Regressive R2	35.22%	22.46%	37.03%	27.14%	52.77%	28.91%
Number of Firm-year observations	284	1047	218	164	149	1868

***, **, *, significant at 1%, 5%, 10% level (one-tailed test).

<i>MV_{t+1}</i>	=	Log of the market value of the firm having been divided by its total assets.
<i>BV_t</i>	=	Shareholders equity divided by total assets.
<i>OPI_{t+1}</i>	=	Operating income divided by total assets.
<i>ΔOPI_{t+1}</i>	=	Change in operating income divided by total assets.
<i>LEV_{t+1}</i>	=	Long term debt divided by total assets.
<i>EU ETS_t</i>	=	Dichotomous variable denoting membership of the EU ETS, 1 if a member 0 if not a member.
<i>PED_t</i>	=	The dichotomous variable denoting inelasticity or elasticity industry sector membership.

Table 9 - Regression Results - H3_a - Inelastic Industries by Country

	Germany	Great Britain	France	Spain	Italy	Merged
<i>Intercept</i>	-0.217	-0.335	-0.532	-1.516	-0.689	-0.378
	(-2.44)	(-4.62)	(-5.70)	(-9.27)	(-10.52)	(-7.37)
	**	***	***	***	***	***
<i>BV_t</i>	0.541	0.607	0.779	1.461	0.530	0.667
	(3.17)	(7.14)	(3.26)	(5.26)	(4.99)	(10.53)
	***	***	***	***	***	***
<i>OPI_{t+1}</i>	-0.790	-0.124	0.643	2.210	2.660	-0.067
	(-1.05)	(-1.54)	(1.45)	(3.38)	(7.96)	(-0.97)
				***	***	
<i>ΔOPI_{t+1}</i>	-0.825	-0.088	-0.135	-1.204	-0.395	-0.101
	(-1.36)	(-1.17)	(-0.43)	(-1.51)	(-0.73)	(-1.54)
<i>LEV_t</i>	-0.783	-0.029	-0.189	2.014	-0.016	0.078
	(-2.78)	(-0.16)	(-0.64)	(6.77)	(-0.13)	(0.67)
	**			***		
<i>EU ETS_t</i>	0.082	0.109	0.059	0.025	0.091	0.100
	(1.22)	(2.45)	(0.94)	(0.36)	(3.65)	(3.78)
		**			***	***
Total R2	45.76%	23.47%	32.35%	50.59%	60.89%	37.82%
Regressive R2	39.86%	23.49%	33.30%	47.94%	61.15%	39.03%
Number of Firm-year observations	71	359	54	72	98	654

***, **, *, significant at 1%, 5%, 10% level (one-tailed test).

<i>MV_{t+1}</i>	=	Log of the market value of the firm having been divided by its total assets.
<i>BV_t</i>	=	Shareholders equity divided by total assets.
<i>OPI_{t+1}</i>	=	Operating income divided by total assets.
<i>ΔOPI_{t+1}</i>	=	Change in operating income divided by total assets.
<i>LEV_{t+1}</i>	=	Long term debt divided by total assets.
<i>EU ETS_t</i>	=	Dichotomous variable denoting membership of the EU ETS, 1 if a member 0 if not a member.
<i>PED_t</i>	=	The dichotomous variable denoting inelasticity or elasticity industry sector membership.

Table 10 - Regression Results - H3_b - Elastic Industries by Country

	Germany	Great Britain	France	Spain	Italy	Merged
<i>Intercept</i>	-0.644 (-7.72) ***	-0.390 (-6.90) ***	-0.532 (-13.52) ***	-0.316 (-3.40) ***	-0.760 (-5.29) ***	-0.030 (-1.35)
<i>BV_t</i>	0.699 (4.34) ***	0.505 (6.90) ***	-0.270 (-4.07) ***	0.306 (1.83)	0.608 (2.63) **	0.003 (0.56)
<i>OPI_{t+1}</i>	1.784 (5.12) ***	-0.267 (-8.25) ***	2.752 (5.39) ***	0.139 (0.36)	1.342 (2.02)	-0.254 (-7.75) ***
<i>ΔOPI_{t+1}</i>	-0.235 (-0.58)	0.0124 (1.24) **	0.180 (0.27)	0.103 (0.18)	-0.110 (-0.13)	0.010 (1.00)
<i>LEV_t</i>	-0.547 (-2.33) **	0.326 (2.47)	0.133 (2.08) *	-1.078 (-3.18) **	0.034 (0.06)	-0.008 (-1.18)
<i>EU ETS_t</i>	0.164 (3.36) ***	0.166 (5.40) ***	0.059 (1.07)	0.248 (3.87) ***	0.109 (1.57)	0.193 (8.23) ***
Total R2	36.99%	23.37%	43.31	38.92%	41.74%	32.35%
Regressive R2	36.96%	23.40%	41.03	35.57%	43.34%	32.27%
Number of Firm-year observations	212	687	153	91	56	1209

***, **, *, significant at 1%, 5%, 10% level (one-tailed test).

<i>MV_{t+1}</i>	=	Log of the market value of the firm having been divided by its total assets.
<i>BV_t</i>	=	Shareholders equity divided by total assets.
<i>OPI_{t+1}</i>	=	Operating income divided by total assets.
<i>ΔOPI_{t+1}</i>	=	Change in operating income divided by total assets.
<i>LEV_{t+1}</i>	=	Long term debt divided by total assets.
<i>EU ETS_t</i>	=	Dichotomous variable denoting membership of the EU ETS, 1 if a member 0 if not a member.
<i>PED_t</i>	=	The dichotomous variable denoting inelasticity or elasticity industry sector membership.

Table 11 - Regression Results - Industry Sector

	Inelastic Industries				Elastic Industries			
	Oil, Gas & Fuels	Electric Utilities	Gas Utilities	Multi-Utilities	Chemicals	Construction Materials	Metals & Mining	Paper & Forest Products
<i>Intercept</i>	-0.423 (-6.00) ***	-0.618 (-7.82) ***	-0.638 (-7.36) ***	-0.949 (-9.58) ***	-0.391 (-7.34) ***	-0.659 (-6.59) ***	-0.130 (-3.85) ***	-0.537 (-4.18) ***
<i>BV_t</i>	0.689 (7.80) ***	0.546 (4.09) ***	-0.407 (-2.40) **	1.171 (7.90) ***	0.468 (6.22) ***	0.688 (3.89) ***	-0.007 (-1.29) ***	0.675 (3.69) ***
<i>OP_{t+1}</i>	-0.150 (-1.89) ***	3.357 (2.96) ***	10.54 (10.02) ***	5.179 (6.49) ***	-0.181 (-2.14) *	1.360 (6.41) ***	-0.311 (-7.71) ***	0.852 (1.67) ***
<i>ΔOP_{t+1}</i>	-0.070 (-0.93) ***	-1.441 (-0.79) ***	-3.35 (-2.55) ***	-1.943 (-4.21) ***	0.041 (-2.39) **	0.641 (1.09) ***	-0.029 (-1.32) **	-0.171 (-0.36) ***
<i>LEV_t</i>	-0.111 (-0.67) ***	-0.206 (-1.01) ***	-0.681 (-4.75) ***	0.142 (0.69) ***	-0.233 (-1.32) **	-0.266 (-1.10) **	-0.015 (-1.90) *	-1.889 (-3.54) ***
<i>EUETS_t</i>	0.102 (2.349) **	0.122 (2.14) *	0.063 (1.68) ***	0.037 (0.77) ***	0.121 (3.47) ***	0.108 (2.21) **	0.242 (5.67) ***	0.205 (2.69) ***
<i>DEU</i>	-0.143 (-1.33) ***	0.292 (2.99) ***	0.458 (6.48) ***	0.292 (6.48) ***	-0.034 (-0.82) ***	-0.034 (-0.82) ***	-0.455 (-7.28) ***	-0.155 (-1.64) ***
<i>GBR</i>	-0.200 (-2.38) ***	-0.200 (-2.38) ***	0.150 (2.91) **	0.102 (1.27) **	0.101 (1.51) **	0.101 (1.51) **	0.101 (1.51) **	-0.093 (-0.96) ***
<i>FRA</i>	-0.074 (-0.94) **	0.299 (2.46) **	0.018 (0.52) **	-0.126 (-2.12) *	-0.14 (-2.85) ***	-0.015 (-0.18) ***	-0.702 (-13.19) ***	-0.299 (-3.02) ***
<i>ESP</i>	-0.515 (-7.79) ***	0.159 (4.44) ***	0.159 (4.44) ***	*	-0.295 (-2.28) **	0.207 (2.66) **	-0.422 (-6.26) ***	
<i>ITA</i>	-0.244 (-0.94) ***	0.000 (0.00) ***	0.000 (0.00) ***	-0.138 (-2.50) **	-0.24 (-3.78) ***	-0.189 (-2.28) **	-0.720 (-5.97) ***	
Total R2	24.29%	28.54%	74.49%	71.51%	26.42%	49.99%	22.73%	46.06%
Regressive R2	23.76%	27.33%	74.23%	67.96%	26.48%	49.33%	18.26%	46.28%
Number of Firm-year observations	418	103	38	72	384	113	593	96

***, **, * significant at 1%, 5%, 10% level (one-tailed test).

MV_{t+1} = Log of the market value of the firm having been divided by its total assets. BV_t = Shareholders equity divided by its total assets. OP_{t+1} = Operating income divided by total assets. ΔOP_{t+1} = Change in operating income divided by total assets. LEV_{t+1} = Long term debt divided by total assets. $EUETS_t$ = Dichotomous variable denoting membership of the EU ETS, 1 if a member 0 if not a member. PED_t = The dichotomous variable denoting inelasticity or elasticity industry sector membership.

Appendix 1: *Carbon Market Mechanism*

Carbon Market Mechanism

Carbon markets are based upon a cap-and-trade structure where the initial pool of available credits in the market is generated a number of ways. At the firm level the incentive to produce less GHGs either by limiting production or changing the production process can be significant. The possible monetary savings has already provided a stimulus for the invention of several new industry technologies. There are numerous examples of this such as the advances in the use of carbon anodes in the alumina smelter industry to limit CO₂, the advances in the nylon and plastics industries to avoid tail pipe emissions of nitrous oxide (N₂O), and the capture of methane (CH₄) from land fuels for flaring. Under Kyoto the primary greenhouse gases are carbon dioxide (CO₂). The additional gases are methane (CH₄), nitrous oxide (N₂O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulphur hexafluoride (SF₆). The primary unit of measurement is carbon dioxide. The unit measurement is the metric tonne so in greenhouse gas accounting one tonne of carbon dioxide is the base unit. The other gases are converted back to tonnes of carbon dioxide by applying a conversion rate. This conversion factor is called the global warming potential (GWP) and for one ton of methane its GWP is 14 so it would equate to 14 tonnes of carbon dioxide where as one tonne of nitrous oxide has a GWP of 340 and therefore would equate to 340 tonnes of carbon dioxide.

GWPs have been calculated by the UNFCCC and are predetermined under the Kyoto protocol. Many processes are well documented for example the consumption of petrol and diesel as an automotive fuels, the production of electricity via coal and the production of CO₂ from the alumina smelting process. As a result of these standardised events the UNFCCC has developed a series of tables to provide assistance in determining the amount of CO₂ produced as part of a standardised process and often the calculation of the amount of CO₂ produced is determined by accounting for the appropriate inputs and multiplying them by the GWP. This is the basic premise behind carbon accounting as specified in both the greenhouse gas accounting protocol compiled by the World Resource Institute (WRI) and the ISO standard created by the International Standards Authority (ISO).

The production of carbon by a firm or individual is called its carbon footprint. Once a firm has calculated its carbon footprint this forms the upper limit of its production quota in voluntary systems. In regulated markets the government allocates a limit based upon production of carbon form a previous pre selected year, normally expressed as a percentage. This pre-selected year is termed a baseline year.

When a company produces less carbon then the amount allocated in their carbon footprint they may have excess allocated carbon credits. Theses surplus credits can then be either saved to offset further emissions or sold. The selection of the baseline year under Kyoto, the EU ETS and the CCX are all predetermined by the governing body where as under other voluntary schemes there is the opportunity to select a year and this can introduce opportunity for manipulation.

The reduction of carbon is also a signal of the utilisation of the input sources better. Offsets gained through innovation will be common because reducing pollution is often coincident with improving the productivity with which resources are used. In short, firms can actually benefit from properly crafted environmental regulations that are more stringent (or are imposed earlier) than those faced by their competitors in other countries. By stimulating innovation, strict environmental regulations can actually enhance competitiveness (Porter & Linde, 1995).

The opposite of this is when the firm generates more carbon than it has been allocated a limit for and/or credits. As a result the firm is now in a deficit and at the balance up time which under most schemes is done annually. It is expected that the firm would then enter the market and buy appropriate credits to offset their liability. The supply of these credits can come from a number of sources.

Governments have several opportunities to modify market behaviour. They can allocate or supply credits that they have already been allocated from the UNFCCC, alternatively they can purchase credits and make them available in the local market either by gifting them or alternatively by selling them. They could opt to subsidise the price of these credits as part of a wider economic policy or alternatively they can buy credits up on the local market and increase scarcity driving up the price.

Governments can also generate credits that they then sell or auction off or alternatively they can allocate credits on a predetermined basis. This allocation of permits can be done to favour one industry over another which is often the case where industries are considered strategic or are at risk of moving overseas if support is not provided. Carbon flight or leakage are the terms used to describe the situation when a company which formally produced in one region but with the introduction of a carbon trading system chooses to relocate to another region. If the subsidy has a time frame or is intended to be decreased over a period of time then the purpose of the subsidy is to ease the industry into the new market environment and lighten the initial burden of the additional cost. This buffering effect is referred to as grandfathering.

EU ETS Cap and Trade Example

Companies A and B both emit 100 000 tonnes of CO₂ per year. In their national allocation plans their governments give each of them emission allowances for 95 000 tonnes, leaving them to find ways to cover the shortfall of 5 000 allowances. This gives them a choice between reducing their emissions by 5 000 tonnes, purchasing 5 000 allowances in the market or taking a position somewhere in between. Before deciding which option to pursue they compare the costs of each.

In the market, the price of an allowance at that moment is EUR 10 per tonne of CO₂. Company A calculates that cutting its emissions will cost it EUR 5 per tonne, so it decides to do this because it is cheaper than buying the necessary allowances. Company A even decides to take the opportunity to reduce its emissions not by 5 000 tonnes but by 10 000. Company B is in a different situation. Its reduction costs are EUR 15 per tonne, i.e. higher than the market price, so it decides to buy allowances instead of reducing emissions. Company A spends EUR 50 000 on cutting its emissions by 10 000 tonnes at a cost of EUR 5 per tonne, but then receives EUR 50 000 from selling the 5 000 allowances it no longer needs at the market price of EUR 10 each. This means it fully offsets its emission reduction costs by

selling allowances, whereas without the emissions trading system it would have had a net cost of EUR 25 000 to bear (assuming that it cut emissions by only the 5 000 tonnes necessary).

Company B spends EUR 50 000 on buying 5 000 allowances at a price of EUR 10 each. In the absence of the flexibility provided by the ETS, it would have had to cut its emissions by 5 000 tonnes at a cost of EUR 75 000.

Emissions trading thus brings a total cost-saving of EUR 50 000 for the companies in this example. Since Company A chooses to cut its emissions (because this is the cheaper option in its case), the allowances that Company B buys represent a real emissions reduction even if Company B did not reduce its own emission (European Union, 2008).

The Role of Governments in GHG Trading

Besides meeting the international requirements under Kyoto for those governments that have committed themselves to the treaty, there are a number of other reasons why governments have embraced GHG market trading. There is a belief that the public will reward such action and that significant numbers of the voting public view positive climate actions as desirable. It is an opportunity for governments to stimulate innovation in the business community and provides them another tool to manage the economy and direct economic stimulation through non-tax or tariff-based incentives, providing opportunities for revenue generation.

Governments themselves are buying carbon credits. A number of EU member states intend to use these credits to assist companies within their own country, providing a state sponsored buffer to the increased environmental costs. The two preferred forms of credits are the Clean Development Mechanism (CDM) or Joint Investment (JI) credits¹⁰. These credits are directly exchangeable for Emission Unit Allowances (EUA) which are used to settle yearly EU ETS commitments. Member state governments can supply additional credits over those already granted to meet current commitments of companies under their reduction targets with the intention of removing these reductions at a slower rate than the statute or legislative requirements currently demand. This effectively acts as a state funded dispersion of the externality back to the wider economy through the use of the taxpayer funded assistance (European Union, 2008). The ability for industry to move to a “lower cost” environment is directly governed by the state’s response with tariffs and protectionism measures. The loss of industry from one country to another in response to the introduction of GHG or Carbon tax or cap-and-trade is termed leakage. It also relates to the transportability of the product in question and the geographical barriers, limitations, transport costs and properties of the goods.

¹⁰ CDMs and JIs are generated through UNFCCC authorised projects in developing countries. These projects are designed to mitigate the potential release of GHGs by utilising technology resulting in GHG savings which are then available for sale as allowance credits.

Appendix 2: *Additional Tables*

Table 12 – Industry Statistics - Inelastic Firms

	MV_{t+1}	BV_t	OPI_{t+1}	ΔOPI_{t+1}	LEV_t
Oil& Gas					
N	490	577	562	756	573
Mean	8337.242	3394.000	1132.821	78.608	653.993
Median	126.555	50.996	0.488	0.000	1.672
Std. Deviation	33539.290	13967.090	4773.252	855.106	2422.602
Minimum	0.029	-62.124	-97.000	-5648.000	0.000
Maximum	265423.480	123960.000	41062.000	10884.000	15651.000
Percentiles					
20	23.964	5.868	-1.846	-1.290	0.000
40	68.087	27.966	-0.377	0.000	0.000
60	211.746	95.239	5.134	0.000	9.551
80	954.393	356.313	68.423	2.655	109.081
100	265423.000	123960.000	41062.000	10884.000	15651.000
Electric Utilities					
N	144	147	147	240	147
Mean	12105.221	5798.563	1386.351	92.893	5093.816
Median	5000.254	1832.900	413.590	0.000	1289.800
Std. Deviation	20625.630	9448.649	2249.610	743.421	7617.675
Minimum	20.370	-3383.000	-442.000	-3279.000	0.000
Maximum	148459.974	49374.000	12069.000	5293.000	51189.000
Percentiles					
20	961.237	230.000	48.915	0.000	11.225
40	3056.207	1025.944	217.926	0.000	715.960
60	6715.845	2928.357	723.600	0.000	2530.464
80	14127.270	8750.640	2357.176	70.681	10791.800
100	148460.000	49374.000	12069.000	5293.000	51189.000
Gas Utilities					
N	55	57	57	72	57
Mean	3020.745	1410.633	313.878	11.847	1047.683
Median	506.379	331.327	44.874	0.000	84.492
Std. Deviation	4107.408	2031.084	434.972	253.122	1473.630
Minimum	49.364	-901.000	4.102	-1404.000	0.000
Maximum	17919.986	6070.000	1563.000	1404.000	5712.000
Percentiles					
20	95.422	63.320	9.343	-1.107	9.028
40	256.398	219.083	29.868	0.000	53.760
60	1785.730	408.241	122.565	1.335	227.640
80	6745.440	3809.800	845.772	34.720	2624.036
100	17919.986	6070.000	1563.000	1404.000	5712.000
Multi-Utilities					
N	100	108	108	90	108
Mean	6975.338	2560.886	852.203	141.909	3320.386
Median	2022.420	1145.148	160.240	9.875	695.372
Std. Deviation	10500.410	3750.179	1427.517	851.048	5699.548
Minimum	77.679	6.977	-897.000	-4714.400	0.000
Maximum	53486.613	17953.000	5894.000	4937.800	24145.000
Percentiles					
20	780.405	325.199	33.032	-15.745	69.928
40	1626.896	771.830	108.219	0.764	321.263
60	3149.002	1367.539	235.586	37.944	973.310
80	12837.225	3565.520	1685.400	269.144	4728.200
100	53486.613	17953.000	5894.000	4937.800	24145.000

Table 12 Continued - Industry Statistics - Elastic Firms

	MV_{t+1}	BV_t	OPI_{t+1}	ΔOPI_{t+1}	LEV_t
Chemicals					
N	473	522	518	600	520
Mean	1435.081	627.936	137.006	13.903	274.632
Median	100.435	50.620	7.081	0.000	12.673
Std. Deviation	4624.783	2219.601	614.409	147.711	871.639
Minimum	0.589	-948.663	-528.000	-741.000	0.000
Maximum	48492.724	19126.699	7450.398	1760.498	9541.000
Percentiles					
20	22.527	12.253	-0.254	-1.265	0.519
40	62.694	32.557	3.245	0.000	6.508
60	169.030	91.209	13.469	0.687	26.111
80	820.577	279.822	57.396	5.742	130.604
100	48492.724	19126.699	7450.398	1760.498	9541.000
Metals and Mining					
N	722	831	795	1104	823
Mean	1735.869	695.863	207.346	34.244	252.327
Median	32.041	13.646	-0.243	0.000	0.000
Std. Deviation	8072.811	3011.653	1060.046	288.385	1635.830
Minimum	0.000	-30.382	-373.000	-720.000	0.000
Maximum	105564.996	29667.000	14025.000	4316.000	38614.000
Percentiles					
20	6.344	1.549	-1.927	-0.937	0.000
40	20.166	8.643	-0.541	-0.020	0.000
60	52.294	24.596	-0.040	0.000	0.687
80	295.668	120.417	15.570	0.487	28.400
100	105565.000	29667.000	14025.000	4316.000	38614.000
Construction					
N	147	155	155	198	155
Mean	1802.488	681.971	131.977	8.169	433.906
Median	446.435	175.722	40.925	0.000	56.838
Std. Deviation	6576.103	1088.959	231.177	73.589	1256.555
Minimum	6.193	-46.835	-52.664	-539.300	0.000
Maximum	67008.688	6996.961	1647.848	503.538	13249.152
Percentiles					
20	66.028	61.568	7.547	-1.027	3.298
40	358.301	143.858	20.567	0.000	24.280
60	623.081	352.494	64.453	1.382	87.477
80	1718.211	1041.102	195.066	15.432	545.732
100	67008.688	6996.961	1647.848	503.538	13249.152
Paper					
N	130	143	143	174	142
Mean	156.384	159.345	18.400	3.268	55.600
Median	41.627	38.766	1.682	0.000	10.864
Std. Deviation	330.825	475.520	68.345	47.145	155.010
Minimum	1.357	-92.509	-49.700	-276.300	0.000
Maximum	2994.765	2986.000	485.000	459.700	1234.000
Percentiles					
20	13.348	6.413	-2.614	-2.274	0.168
40	28.363	26.162	0.347	0.000	8.001
60	106.005	59.642	3.661	0.000	15.966
80	199.790	131.529	20.722	2.002	45.081
100	2994.765	2986.000	485.000	459.700	1234.000

*in Millions €

**Table 13 – Correlations MV_{t+1} By Independent Variable
By Country**

	BV_t	OPI_{t+1}	ΔOPI_{t+1}	LEV_t
<i>Germany</i>	0.461	0.322	0.007	-0.348
<i>Great Britain</i>	0.285	-0.268	0.102	-0.155
<i>France</i>	-0.407	-0.366	0.002	0.264
<i>Spain</i>	0.33	0.213	0.076	-0.031
<i>Italy</i>	0.427	0.557	0.127	-0.093

Bolded values indicate that the correlation for the sample is significant at a 5% level or less.

Pearson Correlation

MV_{t+1} = Log of the market value of the firm having been divided by its total assets.

BV_t = Shareholders equity divided by total assets.

OPI_{t+1} = Operating income divided by total assets.

ΔOPI_{t+1} = Change in operating income divided by total assets.

LEV_{t+1} = Long term debt divided by total assets.

$EU ETS_t$ = Dichotomous variable denoting membership of the EU ETS, 1 if a member 0 if not a member.

PED_t = The dichotomous variable denoting inelasticity or elasticity industry sector membership.

**Table 14 – Correlations MV_{t+1} By Independent Variable
By Industry**

	BV_t	OPI_{t+1}	ΔOPI_{t+1}	LEV_t
<i>Oil, Gas & Consumable Fuels</i>	0.476	-0.215	-0.094	-0.292
<i>Chemical</i>	0.359	-0.301	0.327	-0.227
<i>Construction Materials</i>	0.437	0.458	0.096	-0.255
<i>Metals & Mining</i>	-0.139	-0.321	-0.053	0.097
<i>Paper & Forest Products</i>	0.578	0.163	-0.016	-0.525
<i>Electric Utilities</i>	0.370	0.246	0.117	-0.098
<i>Gas Utilities</i>	0.163	0.677	-0.053	-0.033
<i>Multi-Utilities</i>	0.688	0.366	-0.311	-0.423

Bolded values indicate that the correlation for the sample is significant at a 5% level or less.

Pearson Correlation

MV_{t+1}	=	Log of the market value of the firm having been divided by its total assets.
BV_t	=	Shareholders equity divided by total assets.
OPI_{t+1}	=	Operating income divided by total assets.
ΔOPI_{t+1}	=	Change in operating income divided by total assets.
LEV_{t+1}	=	Long term debt divided by total assets.
$EU\ ETS_t$	=	Dichotomous variable denoting membership of the EU ETS, 1 if a member 0 if not a member.
PED_t	=	The dichotomous variable denoting inelasticity or elasticity industry sector membership.