Green and profitable?

The potential returns to good environmental management

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Abstract

This thesis uses modern panel data techniques to analyse a new Japanese dataset in an investigation into the professed link between good environmental performance and corporate returns. It also builds some very simple models to further examine two frequently quoted drivers of firms' environmental performance, reputation and eco-efficiency. The analysis finds both theoretical rationales and empirical evidence that more environmentally friendly firms have higher profits. These findings are not general however, but specific to particular industrial sectors and appear to depend on the degree to which production is exposed to consumer pressures, and the environmental impact of the production process itself. Seen jointly, the theoretical discussion and empirical findings seem to imply that the ability of modern panel data techniques to reduce some endogeneity issues, makes these especially appropriate in the 'environmental performance – corporate returns' context. Finally, the thesis empirically investigates an alleged link between environmental performance and managerial quality. It finds significant evidence that such a link exists in the sample.

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‘Amongst the causes which tend to the cheap production of any article, and which are connected with the employment of additional capital, may be mentioned, the care which is taken to prevent the absolute waste of any part of the raw material.’

Charles Babbage (1835)

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Chapter 1

Green and profitable?

Environmental performance[1] as a profit opportunity has been a hotly debated theme since Harvard management guru Michael Porter's momentous 1991 article looking at potential profit opportunities arising from environmental legislation. Alongside this debate the last few decades have seen the rise of corporate social responsibility[2] (CSR) as a concept employed both in corporate strategies, and, with the growth of socially responsible investments (SRI), as an investment criterion. The questions discussed in this thesis are therefore of interest to managers[3] and investors[4] alike.

Two much cited green success stories are the technology company 3M's claim to have saved US$530 millions between 1975-1990 due to lower energy use, and British Petroleum's (BP) public relations bonanza following CEO Lord Browne's 1997 speech where he acknowledged the existence of climate change and announced the oil giant's plan to tackle it.

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[1] Environmental performance and environmental management will be used interchangeably in what follows.

[2] Environmental management is in many ways just a sub-category of CSR. In what follows general references to CSR will always also imply environmental management. This might be somewhat confusing to the reader, but facilitates the flow of a discussion utilising the entire CSR/ environmental management literature. Following Portney (2005) this thesis treats CSR as a beyond compliance concept.

[3] Sociopolitical issues such as environmental concerns present real risks to the future profitability of corporations according to CEOs surveyed by the *McKinsey Quarterly* for January 2006. However only 18% see this as an opportunity, 41% see it as mainly a risk to their business.

[4] Three quarters of institutional investors surveyed by Mercer Investment Consulting (2006) believe that environmental, social and governance factors can be material to investment performance. Nonetheless 72% do not include SRI factors in their investment decisions.

These two examples illustrate the complexities involved when assessing the potential for profit opportunities which lie in good environmental management. The former is an example of eco-efficiency[5], simply related to improved process efficiency leading to direct savings due to lower costs of production. The latter is entangled in a more complex web of strategic processes thought to affect brand value, consumer reputation, and even employee loyalty and recruitment (Hoffman 2001).

This thesis attempts to disentangle some of these processes and achieve a deeper understanding of the potential causal dynamics between environmental performance and profitability. Starting in chapter 2 with a brief literature review it notes that in recent studies, at least, there are signs of an emerging consensus that such a link exists. Then in chapter 3, looking narrowly at some of the processes underlying such a relationship, it seeks to present a more thorough theoretical discussion, closing with three simple models.[6] It concludes that theory would imply that the question is not so much whether it pays to be green, but where and when. The insights from the theoretical discussion have useful implications for the empirical modelling in chapter 4.

The two empirical chapters constitute the core of the thesis, and represent the more important intellectual and academic contribution. They evaluate some of the cautious claims made in the earlier chapters. Chapter 4 presents the

[5] Eco-efficiency can be loosely defined as amount of waste produced scaled by the magnitude of a firm's production.

[6] Two of these models utilise well known game-theoretic concepts and follow Gibson's (2003) claim that game theory has a central place in business ethics theory as it puts the issue of whether there can be a 'prudential ethics front and center' (Gibson 2003 :56).

dataset, which is made up of Japanese manufacturers drawn from different Japanese stock exchanges. It also discusses how modern panel data techniques can be applied to further causally examine a potential link between environmental performance and profitability. Chapter 5 reports the results of regressions utilising the techniques outlined in chapter 4, and analyses these, bearing in mind the theoretical insights from chapter 3.

Overall, the empirical findings go some way to supporting a link between good environmental management and profits within some strategically similar sectors or industries. We also find evidence of a link between the environmental indicator and a variable thought to capture managerial quality.

The thesis adds to the existing literature in five ways. Firstly, with the notable exception of Hoffman (2001) and to a lesser extent Guenster *et al* (2005), hitherto little attempt has been made to explicitly identify and model the different dynamics at play in any hypothesised relationship between environmental performance and higher returns[7]. While in no way exhaustively done here, such a more thorough investigation is important in order to understand a potential relationship. Empirical work without theoretical foundations is like building 'a bridge from nowhere'. In this thesis, the insights from the theoretical chapter highlight potential estimation-related issues which the empirical chapters then address. Moreover, a more thorough

[7] This point is especially true for the empirical literature. The business studies literature offers some good theoretical discussions. Leading authors on the subject include professor Forest Reinhardt at the Harvard Business School and professor David Vogel at the Haas School of business at UC Berkeley.

‘theory-empirics’ approach, when developed further, might have important implications for both managers and investors.

Secondly, and perhaps more importantly in terms of what is actually achieved here, the thesis uses modern panel data techniques in the empirical analysis. Such techniques allow for a more direct evaluation of causality and have never, to our knowledge, been used before in this context.[8] Linked to this second point are two somewhat less direct contributions of the thesis. It adds to the existing pool of applied work taking advantage of some recently developed GMM methods for panel data and extends the us, and our experience of these, to a new area. It also explores empirically for the first time a link between environmental performance and good management more generally. This link, whilst saying little of causality, has received considerable attention amongst asset managers in recent years.

Finally whilst most empirical work on this topic so far has concerned samples of large firms[9], here, the empirical analysis employs a previously unused indicator of environmental management with data on firms of various sizes.

[8]King & Lenox (2001) uses a fixed effects regression. The GMM methods discussed in chapter 4 have, to the author’s knowledge, never been used in this context before.
[9] Or as noted by Margolis and Walsh 2001 (p 7) ‘many studies are based on exemplary, notorious or large firms’.

Chapter 2

Literature Review

This chapter examines the empirical part of the 'environmental performance, economic returns' debate. Chapter 3 reviews the theoretical part of this literature, which then sits alongside the development of the models.

The last decade has seen an increasingly vibrant debate about the potential link between environmental performance and corporate returns. While this relationship was traditionally held to be negative where significant, more recent research has found evidence of a positive relationship (White and Kiernan 2004).

Alexander and Buckholz (1978), Porter and van der Linde (1995), and more recently Guenster *et al* (2005) hypothesise that eco-efficiency is a sign of production efficiency and so potentially a proxy for good management, which, to the extent it is true, creates some interesting causal dynamics, but also potential estimation problems. The theoretical and empirical implications of this will be discussed in more detail in chapters 3, 4 and 5.

Generally the literature can be divided into three broad categories, identified by Wagner and Wehrmeryer (2002): (1) event studies that explore the immediate effects of social or environmental performance proxies on short-term stock price variability; (2) cross-sectional regression analyses that attempt to establish a longer-term relationship between environmental

performance and stock returns; and (3) portfolio studies that investigate the benefits of embedding environmental management into investment decisions (Guenster *et al* 2005). We examine the three types in turn.

2.1 Event studies

Event studies are interesting as they are the only studies to offer any direct evidence of a causal link between environmental and financial performance. The focus has naturally been on the relationship between such events and stock market measures of profitability, because event studies consider the immediate effects on profitability of a particular environmental event.[10]

The insights gained from event studies are strongly restricted by the fact that they concern themselves with very limited time horizons and therefore shed relatively little light on long-term, dynamic relationships. Guenster *et al* (2005) nonetheless argue that event studies historically provide the best evidence of a link between environmental and financial performance. This body of research, which includes studies by Shane and Spicer (1983), Hamilton (1995), and Klassen and McLaughlin (1996), suggests that although environmental pollution figures generally tend to have an influence on stock market performance, there is also an asymmetry in stock return sensitivity to environmental news (Guenster *et al* 2005). Klassen and McLaughlin (1996) find, for example, that stock price changes are more responsive to negative than positive news about a firm's environmental performance. Casual evidence seems to underline the overall positive findings of most event studies. Relevant examples include the Bhopal and Exxon Valdez disasters. In

[10] Accounting based measures do not capture immediate effects.

fact, Blacconiere and Patten (1994) estimate that Union Carbide lost $1 billion in market capitalization, or 28%, following the Bhopal chemical disaster in 1984.

Interesting information might also be extracted from the reaction of firms to bad environmental news. Konar and Cohen (1997) find that firms with the largest stock price decline on the day negative environmental information became public, subsequently reduced emissions more than their industry peers. Konar and Cohen (1997) see this as consistent with the view that financial markets may provide strong incentives for firms to change their environmental behaviour.

2.2 Regression studies

The second category of studies, to which this thesis belongs, uses regression analysis to evaluate the effect of changes in environmental performance on financial or operating performance. Regression studies allow for the long term analysis not available to the event studies, but cannot capture causality as easily. Broadly speaking, such studies have historically been prone to endogeneity (Vogel 2004) and have overall demonstrated relatively little in terms of finding a clear link between environmental performance and profits.

In 1978, Spicer reported that companies in the U.S. pulp and paper industry with better environmental performance tended to have higher profitability, a lower risk profile and a higher price/earnings ratio. However, Chen and Metcalf (1980) replicated Spicer's (1978) analysis and argued that his findings fail to hold once controls were included for the impact of firm size. Chen and

Metcalf (1980) and Mahapatra (1984) also fail to confirm the idea that pollution control initiatives are rewarded with improved stock performance.

More recently, apart from Freedman and Jaggi (1998), who find little evidence that there is an unambiguous relation between environmental performance and operating performance, the results seem to indicate a positive link. Hart and Ahuja (1996) show that changes in pollution[11] predate changes in operating performance including return on sales (ROS), return on assets (ROA) and return on equity (ROE). Moreover, they find that firms with the highest pollution levels stand the most to gain. Russo and Fouts (1997) find a significant positive correlation between companies' ROA and environmental ratings measured by the Franklin Research and Development Corporation. They also find that this relationship is more pronounced for high growth industries. Dowell *et al* (2000) report that firms that adopt a single, stringent environmental standard worldwide have higher market valuation than firms that do not adopt such standards. Konar and Cohen (2001) find evidence that poor environmental performance has a significantly negative effect on the intangible asset value and Tobin's Q of U.S. S&P500 companies. Similarly, King and Lenox (2001) find evidence of an association between pollution reduction and increases in Tobin's Q. Finally, Guenster *et al* (2005), in a rigorous and insightful study, use Innovest's[12] eco-efficiency ratings to

[11] Measured as U.S. TRI emission per sales dollar

[12] Innovest Strategic Value Advisors currently has over US$1.1 billion under structured sub-advisory mandates with asset management partners. They use information on company performance not captured or explained by traditional, accounting driven security analysis to create 'a well-rounded picture of any hidden risk or opportunity within a portfolio'. The Ecovalue21 index ranks the environmental performance of 90 percent of the firms by market capitalization listed on the S&P 500, FTSE 350, FTSE Eurotop, Nikkei, and MSCI World (Salo 2005).For more information see www.innovestgroup.com.

provide evidence of a positive (and asymmetric) relationship between eco-efficiency and both Tobin's Q and ROA.

In terms of the econometrics employed,[13] none of the previous studies fully exploit the potential of panel data to mitigate against endogeneity issues and hence achieve a more causal analysis. This represents a serious empirical shortage in the existing literature.

2.3 Portfolio studies

Portfolio studies involve a comparison of average risk-adjusted returns between two or more mutually exclusive portfolios (Guenster *et al*, 2005). The key message from these studies is that there appears to be at least no negative association between environmentally screened universes and risk-adjusted returns.

Cohen *et al* (1997) show findings which suggest that there exists neither a penalty nor premium to green investments and Guerard (1997) find that the portfolios derived from a socially-screened investment universe did not perform differently from those obtained from an unscreened set during the period 1987-1996. In contrast, White (1996) reports that his green investment portfolio showed significantly higher risk-adjusted returns as measured by Jensen's alpha[14], than the overall market. Similarly, Blank and Daniel (2002) find that an equally-weighted eco-efficiency enhanced portfolio delivered

[13] For a critical view see Koehler (2004).
[14] Jensen's alpha is a risk-adjusted performance measure that represents the average return on a portfolio over and above that predicted by the CAPM, given the portfolio's beta and the average market return

somewhat higher performance than the benchmark S&P500 during the period 1997-2001. Finally, using the aforementioned Innovest ecovalue21 rating, Derwall *et al* (2005), in an interesting study, find that companies labelled more eco-efficient outperformed their least eco-efficient counterparts by around 6% per annum over the period 1995-2003, even after differences in risk, investment style and sector exposure was controlled for (Derwall *et al* 2005). Dervall *et al* (2005) also find evidence that corporate environmental performance is incorporated slowly into a company's stock price. This recent evidence of a positive relationship between higher risk adjusted portfolio returns and environmental performance, is referred to by Derwall *et al* (2005) as the eco-efficiency premium puzzle[15].

Although the positive link story appears to have gathered strength in recent years, overall it seems that there is little evidence of a clear cut link between good environmental management and firm profitability to be found in the empirical literature. Due to differences in the time at which the research was conducted, the methods used and the data origin, this might not be too surprising. To expect a relationship to be robust across all these factors might be unrealistic. This will become clearer in the next chapter which seeks to explore some of the theoretical reasons for, and aspects of, any relation between environmental performance and profits.

[15] A puzzle since generally research suggests that return anomalies can best be interpreted as proxies for various types of risk (Fama and French 2004, Vasselou and Xing 2004). Alternatively they could stem from market inefficiencies (Haugen and Baker 1996; Lakonishok, Schleifer and Vishny 1994). A market which prices eco-efficiency with a lag is consistent with this latter view (Guenster *et al* 2005) and explains why these anomalies might exist in the short run.

Chapter 3

Theoretical discussion

> ‘‘The law does not say that there are to be no cakes and ale, but there are to be no cakes and ale except such are required for the benefit of the company…charity has no business to sit at boards of directors qua charity. There is, however, a kind of charitable dealing which is in the interest of those who practice it, and to that extent and in that garb (I admit not a very philanthropic garb) charity may sit at the board, but for no other purpose.’

Lord Bowen (1883)

As this chapter shall show, strategic advantages lie at the heart of any discussion concerning a link between environmental performance and profits. In a modern economy, mere environmental compliance is not enough for a company to distinguish itself from its competitors, as they are likely to be affected by the same regulatory requirements (Guenster *et al* 2005), Hart and Ahuja (1996) and Russo and Foust (1997) therefore posit that any link between environmental performance and profitability must concern proactive environmental governance. Proactive environmental governance involves structural change in the production processes and innovative management which lie at the core of firms’ competitive advantage (Guenster *et al* 2005). It is hence also linked to a firm’s institutional attributes.

What might constitute such strategic advantages? The literature often identifies the following main drivers of corporate environmental performance (Russo and Fouts 1997; Hoffman 2001; Reinhardt 2004; UK Environment Agency 2004; Guenster *et al* 2005)

(i) Operational (eco)efficiency

(ii) Reputation

(iii) Strategic direction[16]

(iv) Risk management[17]

(v) Human resource management[18]

(vi) Product differentiation[19]

At a different level, Per Just Skaret[20] (2005) mentions investors as the ultimate driver of environmental performance. As Konar and Cohen (1997) showed empirically, the ability of the market to influence corporate environmental responses can be considerable.

Portney (2005), reviewing the extensive literature on the topic, laments that none of the studies derive testable hypotheses from theoretical models of the firm. He is correct to the extent that the theorising and the testing has tended to be rather un-integrated in the literature[21]. This chapter will not placate him — we do not attempt to develop an all-inclusive model of the firm to test the existence of any such relationships. However, what we do examine, in greater

[16] Attentiveness to regulatory and consumer developments might reduce future compliance costs and provide firms with first mover advantages.

[17] Swiss Re, for example, actively approaches individual clients to voice its concerns about carbon risk management issues (World Business Council for Sustainable Development (WBCSD) 2006). The risk point is linked to the attentiveness to regulatory and consumer developments point, but might also lead to more appropriate risk management of all business concerns through enhanced foresight and flexibility. This point will be implicitly returned to in this chapter which discusses environmental efficiency as a proxy for good management.

[18] Good environmental performance might be a selling point to attract better qualified employees, and make existing employees more motivated and loyal.

[19] A good example is Toyota who with its Prius hybrid car has managed to exploit a niche in the emerging market for green vehicles.

[20] Skaret is a manager at Mallin Venture, a firm which specialises in clean technology ventures.

[21] The empirical literature discussed in the last chapter obviously builds on theoretical literature and hypothesis to some degree. Guenster *et al* (2005) explicitly use empirical models to investigate theoretical hypothesises. This chapter will show that there is considerable theoretical writing on the topic, and highlight how a more direct use of this might benefit the empirical analysis.

depth, are the factors that drive corporate environmental performance. Focussing particularly on reputation and eco-efficiency drivers, this chapter attempts to achieve a fuller view of the potential linkages between environmental performance and profitability. The choice to look at reputation and eco-efficiency specifically is based on the fact that these drivers seemed best suited to also be approached in the empirical analysis. They are also the two most widely cited drivers of firms' environmental performance.[22]

Overall this chapter will show that whilst, theoretically, a link between environmental performance and profitability may well exist, the extents of any such link depend on a variety of strategic factors. The link is, for example, likely to be heterogeneous across firms. The chapter will also highlight some potentially confusing causal dynamics representing some empirical challenges.

The entire body of research looking at the environmental performance and profitability debate can be regarded as a subset of the wider CSR literature[23]. Indeed, analysing more general insights from that literature are helpful in framing our subsequent analysis. The CSR-profitability relationship is still widely debated (Guenster *et al* 2005) and much like the more narrow

[22] In addition to this, Christine Meisingseth (2005), head of environmental screening at Storebrand, a Norwegian bank and pension fund, suggests that some of the other drivers mentioned above, with the exception of risk management might have been 'discovered' as good ways to *ex post* rationalise environmental investments. Storebrand is one of 8 global members of the WBCSD behind *From challenge to opportunity,* a recent report on environmental management.

[23] Environmental management stands apart from general CSR due to its potential to have direct effects on profits through efficiency improvements. Other arguments in favour of environmental management are also applicable to the broader CSR context.

environmental case, 25 years of empirical research has been conducted in the absence of an adequate theoretical synthesis (Griffin and Mahon 1997). Before developing three simple models to analyse reputation and eco-efficiency drivers, in what follows we first provide an overview of the CSR literature. Sections 3.1 through to 3.4 hence concern the CSR debate, starting in section 3.1 with Milton Friedman's view of the social responsibility of business. In section 3.2 we compare the Friedmanian view with more recent literature and highlight some challenges as well as opportunities presented by endorsing more CSR informed firm objectives. Section 3.3 and 3.4 look at the more institutional aspects of CSR and also presents for the first time a hypothesis that CSR/ environmental management might proxy good overall management. This is a fundamental hypothesis which if true has implications for the empirical analysis.

Sections 3.5 through to 3.8 discuss three models looking at the reputation and eco-efficiency rationale for improving environmental performance. Section 3.9 concludes this chapter and identifies some implications which the empirical chapters will have to consider.

3.1 Milton Friedman and the social responsibility of business

'When I hear businessmen speak eloquently about the social responsibility of business in a free enterprise system, I am reminded of the wonderful line about the Frenchman who discovered at 70 that he had been speaking prose all his life'

Milton Friedman (1972)

The last decade has seen the rise of CSR reporting by most listed companies, published with or alongside the annual report. Concepts such as sustainable,

‘closed loop’ production and ‘triple bottom line’ reporting[24] (Elkington 1997) now feature prominently on most large industrial corporations’ websites and other public relations playgrounds. Although there is strong reason to expect this to be at least partly window-dressing, firms appear to be becoming greener, and being green is now a part of (and increasingly central to) most corporations’ strategies (KPMG 2005).

If CSR is a buzzword in today’s corporate world, to academia the concept is not new. Theories about the role of ethics and altruism in business relationships can be traced back to Max Weber (1915), who concluded that religion was one of the determinants of business ethics.[25] There might however be considerable theoretical problems associated with assuming, like former Harvard business scholar Ira Jackson, that we are about to enter an era of capitalism with ‘a conscience’.[26]

Evident from the quote introducing this chapter, one counterargument to the ‘scrupulous capitalism’ claim is simply legal. As argued by Joel Bakan (2004) in his book *The Corporation*, in most countries a corporation is bound by law to act in the interest of its shareholders. In other words, CSR that does not increase private profits is unlawful. Elhauge (2005) offers a slightly different view when he notes that while a manager’s discretion is bounded by legal and market constraints, the law gives managers considerable discretion to sacrifice

[24] Elkington (1997) argues that in the dynamic context of the 21st century economy a firm will need to take into account performance by profit, environmental quality and social justice shall it survive and prosper.
[25] “Zu den Determinanten der Wirtschaftsethik gehört als eine – wohlgemerkt: nur eine – auch die religiöse Bestimmtheit der Lebensführung” Weber (1915 : 85)
[26] See Bakan (2004) for more details.

profits for public interest.[27] This is primarily because minimising total agency costs gives managers a 'business judgement rule deference'.

Economically, it is clear that some sort of maximisation of shareholder wealth is needed for allocative efficiency. In the absence of this, as already noted by Adam Smith (1776), company directors cannot be trusted to apply the same anxious vigilance to manage other people's money as they can with their own. Milton Friedman (1970) argues along the same lines in his article *The Social Responsibility of Business*. In his view, in a free enterprise, private property system, a corporate executive is an agent of the owners of that business. His aim is to make as much money as possible whilst conforming to the basic rules of society (Friedman 1970)[28]. This business manager can privately have a social conscience, but to act according to this in his business dealings would be using other people's money. Somebody, be it the shareholders, employees or customers would have to pay the price of the social responsibility (Friedman 1970). From this point of view, CSR, when not used as another way to increase or sustain profits, becomes morally complex[29]. In some ways, however, Friedman meets Weber when he mentions that there will be some, formal or informal, rules of societal behaviour by which a corporation is morally constrained.

[27] Elhauge's comment concerns U.S. laws.
[28] Incidentally this view is shared by the radical professor and prominent social critic Noam Chomsky, Friedman's great intellectual and ideological adversary (Bakan 2004).
[29] In fact Friedman (1970) uses the word immoral, and both philosophically and politically it is hard to justify a manager's discretion to spend what are essentially other people's resources on what might be honourable, yet still, personal and subjective social goals.

Together with the obvious, but often neglected, fact that Friedman does not say that profitable CSR opportunities should not be exploited, this latter part of Friedman's thesis is worth noting. Different social contexts will give rise to different CSRs.

3.2 Is Friedman right?[30] The stakeholders v profit maximisers debate

A first direct argument in favour of the stakeholder perspective was laid out by Dodd (1932) who asserted that company directors must become trustees of the entire society[31]. Grayson and Hodges (2005) note that a few significant international corporations have discovered the fact that the same forces that raise stakeholder expectations of environmental behaviour are also creating new opportunities for business strategies, and they refer to this as corporate social opportunity (CSO).[32] The CSO concept of Grayson and Hodges (2005) goes to the core of the question discussed here. Stakeholder theory, as stated by amongst others Freeman (1984) and Clarkson (1995) argue that a manager should take the interests of all a firm's stakeholders into account in his decision making. Such stakeholders are often thought to include financial claimants, employees, customers, communities, governmental officials and the environment (Jensen 2001). Following this, Tirole (2001) proposes a definition of corporate governance as 'the design of institutions that induce or force management to internalise the welfare of stakeholders' (Tirole 2001 : 4).

[30] A *McKinsey Quarterly* (2006) report of global business leaders show that only 16% support the Friedmanian 'focus solely on shareholder return' view, with 84% saying their aim is to generate high returns to investors but balance this with contributions to the broader public good.

[31] As social contexts go it is interesting to note that the emergence of these sorts of arguments coincide with the experiences of the great depression, and the tremendous social conundrums of the inter-war years.

[32] DuPont for example plans to reduce its CO_2 emissions by 65% from its 1990 levels (Brown 2001). This is quite clearly not done in order to go out of business (although that would certainly achieve the goal!)

This is not simple however. Tirole (2001) notes that managerial performance becomes noisier when the manager pursues many tasks, and that CSR therefore is likely to be costly[33]. Holmström and Milgrom's (1991) more general multitask explicit incentives theory has shown how designing pay that is sensitive to the performance of a single task leads to the other tasks being neglected. Tirole (2001), whilst he recognises the arguments in favour of the stakeholder approach, due to the problem of defining focussed objectives for managers, therefore concludes that maximisation of shareholder wealth provides an attainable second-best. Jensen (2001) goes further and argues that the stakeholder approach to management is fundamentally flawed[34] due to the fact that the there is no good mechanism to decide how to make the necessary trade-offs between each stakeholder objective's importance. Consequently, Jensen (2001) returns to Friedman and argues that since, in the absence of weights to reduce dimensionality, it is logically impossible to maximise in more than one dimension, the corporate objective function should be single valued, and the object to maximise should be long term profits[35] (Jensen 2001). Noting however, like Carrol (1991) with his 'pyramid of social responsibility' that being profitable is the foundation upon which all other social responsibilities rest, he goes on to argue that a firm cannot maximise profits if it ignores its stakeholders.

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[33]Tirole (2001) interestingly notes that Japan is traditionally sympathetic to the stakeholder society, and this has produced a legal, regulatory and fiscal environment which is assessed by most economists as creating weaker governance systems than the Anglo-Saxon equivalents (Tirole 2001)

[34] For a good summary of the debate on what should constitute the corporate objective function see Sundaram and Inkpen (2004)

[35] This point is also repeated by the WBCSD (2006) who conclude "Simply by adding the word *long-term* to *shareholder value*, we embrace everything necessary for the survival and success of the company. (WBCSD 2006 : 8)

The debate about what should constitute the corporate objective function is hence often falsely presented as stockholders versus stakeholders, when the two are in reality intimately linked (Jensen 2001). What is needed, Jensen (2001) argues, is enlightened profit maximisation, where managers and other participants in an organisation think more generally and creatively about how 'the organisation's policies treat all the important constituencies of the firm' (Jensen 2001 : 13). In order to do this stakeholder theory has a role, but not as an objective framework in its own right. As will be clear below, in terms of adding to returns, it might be more important as a cognitive framework.

3.3 The importance of institutional learning and the implications of enlightened profit maximisation.

How best to ensure that enlightened profit maximisation is achieved is therefore the question that should be addressed. As with other potentially profitable opportunities, which investments that appear worth making will be affected by a firm's institutional character, for example its management structure.

Theory suggests that search costs and expectations (Arrow 1974; Jensen 1982) could prevent managers from identifying, let alone exploiting, profitable environmental opportunities (King and Lenox 2001). In other words, if managers' *a priori* expectation is that pollution prevention is costly, then they are less likely to devote time and energy on investigating pollution prevention technologies. Approaching this topic directly, Bleischwitz (2003) highlights the role played by cognition and institutions in the adaptation of green

technologies by firms. Eco-efficiency and new system design, he argues, rely on the creativity of the human mind and the ability of institutions to evolve over time. Following the arguments of Douglas North (1990) that technological change depends on the interaction and creation of a variety of institutions he concludes that path dependencies will matter. If one does not realise the cognitive and institutional dimensions of eco-efficiency decisions, costs of changing from one path to another will become higher. This claim can be substantiated by research which shows that the biggest barrier to the adaptation of greener technologies is not the knowledge of these technologies as such, but the absence of an appropriate management structure, the lack of a defined 'environmental decision-maker institution' (ICF Consulting 2003). In a less theoretical language than Bleischwitz (2003), Blank and Daniel (2002) argue that eco-efficiency is an indicator of the likelihood that a firm might rise above unknown challenges[36], particularly those which are complex and interdisciplinary. From this point of view, eco-efficiency can be seen as a proxy for deeper firm specific institutional attributes. The empirical implications of this will become clear in chapter 4.

3.4 A story of missed opportunities?

Some economic models assume that firms are so well run that benefits from green strategies should not exist. The world is a dynamic place however, and more so, in reality few firms are well run: they operate below the level of

[36] Goldman Sachs (2005) notes that the companies with the best potential for creating significant value are those that have the most strategic options available to embrace a low-carbon world.

optimum efficiency (Vogel 2004)[37]. Since potential environmental gains are often perceived as future benefits which cannot be part of current revenues, cognition might 'misfilter' information on eco-efficiency (Bleischwitz 2002). Lovins *et al* (1999) argue this point when they conclude that rather than trading off costs and benefits of one eco-efficiency improving investment, 'whole system thinking', looking at effects on the entire system of production, is needed for all profitable eco-efficiency solutions to be exploited in an economy[38]. Vogel (2005) argues that because managers are invariably myopic, environmental profit opportunities might be missed until managers get focussed on issues outside their managerial conventions.

The implications of some of these last points are returned to in section 3.8 with a simple model of eco-efficiency investments.

3.5 Consumers, and the social responsibility of business

Individual consumers are the ultimate decision makers of the free market economy. They can 'vote with their feet' to attain socially beneficial goals. The much cited reputation argument for enhancing environmental performance shows that this sort of interaction is not complete utopia. Nor is it necessarily unwarranted from an economic point of view. When it is impossible to internalise all externalities, first-best levels of social efficiency are unattainable. There might therefore be room for consumer involvements to move productive outcomes in the first-best direction. The direct internalisation

[37] McKinsey (2006) report that 41% of global CEOs see significant room for improvement in how they manage socio-political issues.
[38] For example they claim that 18 distinct economic benefits can be derived from investing in modern daylight adjusting electric dimmers of fluorescent lights to replace old fashioned manual ones.

of externalities by consumers — potentially reflected by buying patterns or pressure on firms — does not affect the profit maximisation objective, and in some ways combine the potentials of both democracy and the free market economy[39]. However the ability of consumers to affect environmental performance outcomes depends crucially on the assumptions we make of their ability and willingness to sustain pressure on firms. Reinhardt (1999) concludes that there is a lot of scope for future research into consumers' willingness to pay for environmental quality in different sectors. A very simple analysis into some of the effects affecting consumers' willingness to pay is attempted in the following. Model 1 approaches firms' ability to take advantage of asymmetric information relating to their 'true' environmental performance by falsely pretending to be green. Model 2 is a coordination related model, showing how, since beyond the eco-efficiency argument, green products might cost more, individual consumers might decide not to buy green, even when, overall, the social benefits outweigh the costs. The models have in common that they show how, in many instances, a latent market for green products (and so a green profit opportunity) might fail to materialise. Both models are extremely simple and apply well-known economic concepts, but nevertheless provide a useful, light formalisation of the relevant issues.

3.6 Model 1: Asymmetric information and window -dressing

'Dishonest dealings tend to drive honest dealings out of the market'

Akerlof (1970)

The quote by Akerlof (1970) refers directly to markets where goods have

[39] A version of this argument is recently put forward by Heal (2005) who sees CSR primarily as a response to market failure.

credence attributes (Cole and Harris 2003). This certainly applies in the context of environmental attributes: how is a consumer to know all the environmental aspects of a good's production? The model that follows is a very simple formal representation of some the processes referred to by Erdem *et al* (1999) when they argue: 'It is clear that brand equity accrues over time via consumer learning and decision making processes. Thus, there is a need to know how consumer learning and choice processes shape and drive brand equity formation'[40] (Erdem *et al* 1999 : 302). Signalling is an important observed way in which producers seek to capture a 'latent' market in green products. At the same time Bougherara and Grolleau (2002) argue that information overload can create market failure[41].

Big corporations spend increasing efforts on publishing environmental reports. Generally, the only audit performed on CSR reports is an assurance statement. These are written by consulting firms, and increasingly by the accounting firms auditing other parts of a corporation's business.[42] It is clear that, in the absence of stricter frameworks on this type of corporate auditing, an incentive to window-dress exists. This point is of interest to the empirical part of this thesis because the Nikkei environmental management survey which we later employ as our environmental performance indicator is questionnaire based, and as such might be prone to window-dressing, thus

[40] Erdem *et al* (1999) develops different approaches to this and draws on cognitive psychology and behavioural economics in their analysis. Whilst their analysis is much more detailed than what is presented below, they do not directly look at the asymmetric information aspects addressed here.

[41] Bougherara and Grolleau (2002) provide a good theoretical discussion into some of the issues modelled here in their article *Could Eco-labeling Mitigate Market Failures? An Analysis Applied to Agrofood Products.*

[42] Ernst &Young prepared BPs assurance statement in 2003 (The Economist, 4th Nov, 2004)

obscuring any link between environmental performance and returns.[43]

Grayson and Hodges (2005) quote evidence that business is facing a trust crisis. According to the 2003 MORI Trust Monitor 60% of British adults do not expect business leaders to tell the truth, and only 25% believe that the profits of large companies will make things better for everyone who uses their products and services (Grayson and Hodges 2005). Globally, 48% of the public have little or no trust in big corporations, with another 38% having only some trust (Grayson and Hodges 2004). More specifically, it can be very hard for consumers to judge whether a firm which signals its green credentials is truthful or not. Eco-labelling[44] is primarily such a communication mechanism between producers and final consumers (Cole and Harris 2003). Nonetheless, Comras (2005) quotes a Wall Street Journal Article describing eco-labelling as 'a swampy mess of competing acronyms and conflicting claims'. A number of eco-labels are actually industry fronts, and in this way not independent ratings at all. One US example is the Sustainable Forestry Initiative (SFI), a screen for sustainable lumber that is really made up of a consortium of timber companies (Comras 2005). This is what West (1995) has in mind when he argues that voluntary eco-labelling schemes are rapidly degenerating into a means whereby an industry can set the standard it likes. In our context, it

[43] But so too will be other approaches to environmental performance measuring. As Reinhardt (2005) argues using content analysis of annual reports risk conflating environmental performance with environmental rhetoric, or ,in other words, window-dressing.

[44] While the treatment is different (and necessarily more simplistic) in what follows good examples of modelling the dynamics of eco-label adoption include Arora and Gangopadhyay (1995), Swallow and Sedjo (2000), and Amacher *et al* (2003). The former article interestingly provide a theoretical rationale for over-compliance, in markets where consumers value environmental quality.

seems clear that distrust in firms' environmental signals will affect the reputation rationale for being green.

Bougherara and Grolleau (2002) provide ample evidence from the food market that large segments of consumers are willing to pay more for environmentally superior goods. Loureiro *et al* (2002) looking at the market for green products, conclude that consumer disbelief reduces consumers' willingness to pay, and so covering the higher costs of green production becomes harder[45]. Finally, Bjørner *et al* (2004) in a uniquely thorough empirical investigation into the effects of eco-labelling find that the Nordic Swan label has had a significant effect on consumers' brand choices for toilet paper, corresponding to a marginal willingness to pay for the certified environmental label of 13–18% of the price[46].

To begin the model, consider a firm which can invest to make its product greener. The investment carries a cost f but also means that the producer can sell its good at a higher price than before: $p_g > p$. Therefore a firm will carry out the investment so long as $p_g - f > p$. However, a firm can window-dress and 'fool' consumers by investing in a signal at a cost ε. Such a signal might for example be an eco-label intended to make the consumer believe a firm's

[45] For an opposing view, see Vogel (2005) who argues that in the US at least, few consumers appear to be willing to pay a premium for green goods, unless there are direct benefits, such as for organic food. Evidence from Japan however supports Bougherara and Grolleau (2002). According to a report produced by the Japanese Ministry of the Economy, Trade and Industry (METI), the proportion of Japanese people who consider environmental impacts of products in their shopping increased from 66% in 1997 to 75% in 2001. Moreover, according to the study, 7.5% of respondents will pay for eco-friendly products even though they are more expensive, and 26.2% of them will probably pay for them (METI 2003).

[46] The empirical results produced by Bjørner *et al* (2004) stem from one specific, notoriously successful eco-labelling environment. Its main implication is not its lack of generality however, but the fact that it offers empirical proof that eco-labelling can work.

product to be green. A firm will invest and be green if $f \leq \min\{\varepsilon, p_g - p\}$, such that benefits outweigh costs, and window-dressing is unprofitable.

Now consider a dynamic[47] setting where consumers slowly manage to mitigate the information problem described above[48]. Assume that this 'learning process' is reflected by an exponential decrease in the probability, α, that a consumer will buy from a 'window-dresser',[49] where $\alpha(t) = (1-\mu^{n-t})$ and $\mu \in [0,1]$, n represents the end period of interaction, and t refers to each period from 1 to n. The discounted future profits for a firm investing in the environmental technology are therefore:

$$p_n - f + \beta p_n + \beta^2 p_n + \beta^3 p_n + ... + \beta^n p_n = \frac{p_n}{1-\beta} - f$$

where β is the consumer's discount factor. The discounted profits for a window dresser are:

$$p_g - \varepsilon + \beta p_g (1-\mu^{n-1}) + \beta^2 p_g (1-\mu^{n-2}) + \beta^3 p_g (1-\mu^{n-3}) + ... + \beta^{n-1} p_g (1-\mu) + 0$$

It is clear that in the repeated case, this model limits the incentives to window-dress due to the negative impact on future sales. The credibility of the signal is improved. Whether the future discounted profits from actually making the investment outweigh those of window-dressing is here dependent on the relative difference f-ε, and the amount of new information gathered per

[47] Shapiro (1982) shows how with consumer learning, there is an incentive to produce high quality that does not exist in a static, adverse selection story. The reason is that high quality today increases demand tomorrow. This is the fundamental idea of the analysis in this section.
[48] Helped by for example media scrutiny, environmental events, corporate whistle-blowers and government watchdogs.
[49] This in a very simplistic way follows Schmalensee's (1978) idea that quality is positively related to repeat purchase. It has been criticised by Shapiro (1982) as not based on rational consumer decision making. It illustrates the points made here well however.

period[50]. Window-dressing becomes likely when the costs of making the investment are small relative to the costs of window-dressing, and where the chances of being caught are high. This makes intuitive sense and illustrates both the need for clear and regulated eco-labels and government watchdogs, as well as a good regulatory environmental reporting framework in general.[51] This will both directly increase the costs of window-dressing, and reduce the future benefits from window-dressing[52].

There is potentially a bit more to this story. If consumers appreciate the potential for window-dressing, even if they experience higher utility from buying environmental goods, they might, due to the initial information asymmetries, decide not to buy a seemingly environmental good. The long run forces favouring truthfulness discussed above, might never be brought into play. Again, the market for green products collapses. To paraphrase Akerlof (1970), only environmental lemons are produced. The problem is that the signal is unreliable.[53] Signalling might not mitigate the asymmetric information problem, but exacerbate it.[54] As an example of this, the German

[50] As Shapiro (1982) argues the extent to which information asymmetries create quality deterioration depends crucially on the speed at which learning occurs.

[51] The international Organization for Standardization (ISO) -14000 certification will capture some elements of a firms' environmental performance. The ISO-14000 series of international standards have been developed to integrate environmental aspects into operations and product standards. Guenster *et al* (2005) report that several governments are considering the introduction of corporate reporting standards aimed at increasing transparency.

[52] Vogel (2005) argues that especially in Northern Europe due to better quasi-public eco-labelling schemes consumers seem more ready to pay a premium for green goods, at least for a number of visible products, notably chlorine free paper.

[53] As already noted by Wilson (1979) the conditions for effective signalling might not always be satisfied.

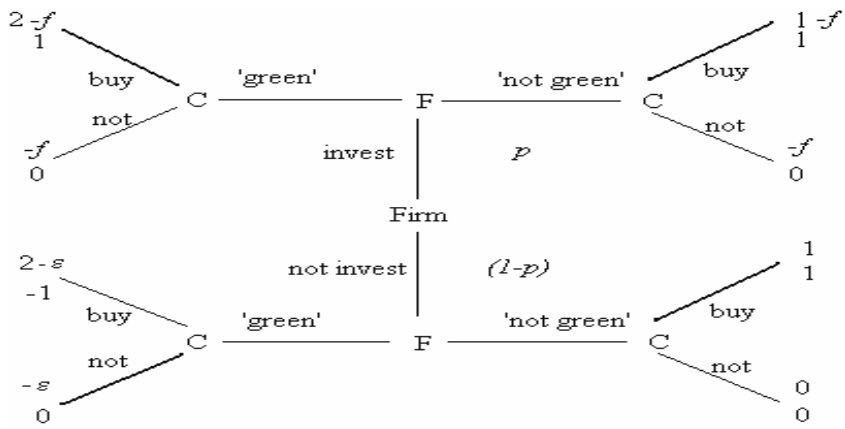
[54] In Akerlof's second hand car market this is famously solved by the introduction of a different signal (i.e. a warranty) which works because it is costly for the providers of the inferior cars and cheap for the providers of high quality cars. The somewhat unrealistic analogy might be an eco-label that promised money back x 10 if the company had accreditation removed, or a strict regulation regime which included fines.

Federal Environment Agency in a 2002 report conclude that competition between eco-labels and other impulses for attention can provoke market failure.

To extend our highly simplistic model by one further step, now assume that consumers decide whether or not to buy the good based on their beliefs of the average chance of being 'fooled'. The model is now essentially a textbook 'beer-quiche' (Gibbons 2002) type representation of consumer-firm interaction. The firm is faced with a decision on whether or not to make an environmental performance investment. The investment carries a cost of f but will generate benefits of 2 if the new, greener product is sold to a consumer. Without the investment a sale of the original product generates a payoff of 1 to the firm. A firm which decides not to make the investment then faces a choice on whether to invest in an environmental signal meant to persuade the consumer that it has made the investment. This signal will carry a cost of ε to the firm, and this cost can be interpreted as the ease with which a firm can cheat the consumers. Signalling carries no additional cost to a firm that has made the investment. Information about the firm's environmental investment decision is *a priori* hard to get hold of for the consumer, but she believes a firm to have made the investment and thus to be selling green products, with a probability p. The consumer can choose whether or not to trade with the firm after she has observed the firm's environmental signalling. The consumer cares about price and environmental quality. She is indifferent between buying a less expensive non-green good and a more expensive green good, but

dislikes paying more for inferior quality. The game's payoffs are illustrated below.

(Figure 3.1) *A signalling model of window dressing*



Is a separating equilibrium, where a firm either invests or not and signals this truthfully, possible here? If a firm signals 'not green' then a consumer will always buy the good and both firm and consumer gain a payoff of 1. If however a firm signals 'green', not knowing whether this is true or not, the consumer will base its decision on whether to buy or not on her initial belief about *p.* For a consumer to buy we need $p(1)+(1-p)(-1)\geq 0 \therefore p \geq ½$. If p is less than ½, consumers will not buy a green product. Firms have no incentive to ever make the green investment or even to signal to be green and will pool on not making the investment and report this truthfully since $-\varepsilon < 1$. Our candidate perfect Bayesian separating equilibrium (and with it our market for environmental goods) collapses. Only pooling on not making the investment is sustainable.

If p> ½ however, and $f>\varepsilon>1$, then this pooling equilibrium collapses, as there is an incentive on the firm to deviate and signal 'green'. It is crucial to note, though, that in this model, so long as $f>\varepsilon$ and this is known to the consumer,

she should believe p, the probability a firm is really green, to be 0 and so never buy from a green firm. It follows that this candidate equilibrium collapses too. The only stable equilibrium in this model is hence the one with no environmental investments.

What are the implications of the model above to the question discussed in this thesis? It shows that for a market to exist in green goods, the incentive to window-dress needs to be eliminated, and that this must be appreciated by consumers. The crucial point to note more generally is that even when consumers value environmentally friendly products, any returns to good environmental management are susceptible to the assumptions we make about trust and information asymmetries in the market[55]. It highlights the fragility of one of the most cited rationales for 'going green', reputation, and it shows how different sectors might be affected in different ways depending on their informational transparency.

A further extension lends itself easily to the model. As noted by Holmstrom and Tirole (1993), financial markets provide us with measures of managerial performance that cannot be directly extracted from accounting data. Changing consumer for investor in the asymmetric information story one can see how the markets' valuation of a firms' environmental performance might easily be affected by informational asymmetries. Erdem and Swait (1998) conclude that consumer-based brand equity is the value of a brand as a credible signal of a

[55] Interestingly *McKinsey Quarterly* (2006) report that 35% of global CEOs view transparency rather than media-public relations as most effective in terms of getting a socio-political message across.

product's position. Now, with firms producing potentially flawed environmental reports due to the absence of a common regulatory framework, investors may decide to ignore or place less importance on the information given in such reports. Consequently, environmental friendliness would not affect the market valuation of the firm[56].

3.7 Model 2: Benign self-interest: A coordination problems model

Gibson (2003) uses the iterated prisoners' dilemma as a good example on how businesses can learn to act with benign self-interest. Here we examine another textbook formalisation of the potential of consumer coordination to obtain Pareto improving environmental management outcomes. Consider a standard prisoner's dilemma situation with two consumers. The consumer can purchase green or dirty products. There is an externality — each one agent's action will affect the other agent's payoff. The payoff matrix could look something like the following.

(Figure 3.2) *The consum*ers*' dilemma*

		Consumer II	
		Green	Dirty
Consumer I	Green	4 4	5 0
	Dirty	0 5	2 2

In this situation it is quite easy to see how a consumer will always deviate and go dirty from the Pareto optimal [green, green] since a deviation to dirty

[56] This lends some support to an inefficient market explanation to the anomaly reported in the portfolio studies. A recent report developed by global asset managers for the UN concludes that financial analysis is obstructed by the lack of good environmental and CSR reporting (UNEP Finance Initiative 2004).

means that you pay less for the good whilst still benefit from your benign fellow citizens. The potentially Pareto optimal equilibrium collapses and [dirty, dirty] is left as the only possible Nash equilibrium. From the point of view of the consumers, theirs is a problem of coordination. From the point of view of the producer – again the market for green products collapses.

In the simple example above, it was enough that one agent bought the green product, for the positive externalities to be felt. Now consider a world of *n* identical consumers. There is one strategic input per consumer, g_i, how much extra they are willing to pay for green products, with $g_i \in \left[0, \overline{g}\right]$. Suppose the utility of consumer *i* is $U = w - g_i + V(\sum_{n=1}^{n} g_i)$, where *w* is wealth endowment and $V(\sum_{n=1}^{n} g_i)$ the utility received by consumer *i* of all *n* consumers' extra expenditure on green products. Now assuming $\frac{\partial V}{\partial g_i} > 0$ and $\frac{\partial^2 V}{\partial g_i} < 0$ we can take the first derivative of each consumer's utility function with respect to g_i to get the symmetric[57] Nash equilibria (SNE):

$$\frac{\partial U}{\partial g_i} = -1 + \frac{\partial V}{\partial g_i} = 0 \therefore \frac{\partial V}{\partial g_i} = 1$$

This shows that at the optimum the marginal utility consumer *i* derives from all other consumers expenditures on 'greeness' must equal 1, and in equilibrium everybody chooses a *g** which ensures this outcome. Is this equilibrium unique and Pareto optimal? As demonstrated by Cooper and John

[57] Symmetric games can have asymmetric equilibria but this does not apply here.

(1988) strategic complementarities are needed for multiple SNE. Positive spillovers are needed for any SNE to be dominated by all agents increasing their efforts, in our case, *g,* by a small amount.

Strategic complementarities are trivially not existent in this setting since all agents choose a similar $g_i = g$ in equilibrium and we have already assumed $\frac{\partial^2 V}{\partial g_i} < 0$. This is a model of strategic substitutability. Positive spillovers exist when the derivative of an agent's utility function with respect to the other agents' strategic variable is larger than zero. These exist in this model, all agents choose similar *g*, $\frac{\partial V}{\partial g_i} = \frac{\partial V}{\partial g_{-i}} > 0$. The SNE we have found is unique, and it is also Pareto suboptimal. Since no other equilibrium exists is credible coordination then impossible?

Heal (1976) shows that once you allow for repeated interactions, other, higher value equilibria than the one above can be sustained[58]. Let us assume the game above to be played infinitely and see if there is some 'grim-trigger' strategy which can sustain an equilibrium where all consumers choose $\overline{g} > g^*$, the Pareto suboptimal SNE level. The strategy would imply that all consumers play $\overline{g}$ so long as no consumer has deviated from this level. Hence for this to be sustained we need, for each consumer:

$$\frac{1}{1-\beta} U(\overline{g} \mid \overline{g}_{-i}) > U(g' \mid \overline{g}_{-i}) + \frac{\beta U(g^* \mid g^*_{-i})}{1-\beta}$$

[58] This is really just a version of the folk theorem or general possibility theorem (Myerson 1991). A much quoted proof can be found in Rubinstein (1979)

It follows that it is possible to imagine an infinitely repeated game in which a 'grim-trigger' strategy is played and the cooperative, Pareto optimal outcome is sustained. From the above it is also clear that the bigger is the difference between the SNE outcome and the cooperative outcome $\left[\overline{g}_i, \overline{g}_{-i}\right]$ the easier will such an outcome be to sustain. From this it seems likely that we can expect consumers to behave with a larger degree of social responsibility in markets where consumption goods have a relatively high environmental impact[59]. This provides us with a rationale in chapter 5 to investigate a sub-sample of firms' whose environmental impact is judged to be high. A good example is the oil and gas sector, with the observed changing position in recent years of the main high street oil producers, such as Royal Dutch Shell and British Petroleum (BP) on issues such as Kyoto and global warming[60]. Interestingly, in the US ExxonMobil remains sceptical of global warming and actively part of the coalition against the Kyoto agreement, misleadingly named the Global Climate Coalition (GCC). Vogel (2005) notes that Europeans seem more willing than Americans to pay for environmental services. While it is hard to pin point any particular event which makes the European oil giants more susceptible to consumer pressure on green issues than American ones it is a good example how different social contexts might produce different environmental management outcomes.

[59] While such 'grim-trigger' strategies clearly are not played by consumers, one could imagine a tacit 'grim-trigger' like outcome, where all consumers are disciplined by fear of a tit-for-tat like response should it be known that they (and others with them) are cheating by a cooperating majority. Whilst not theoretically explored here, such an outcome seems to be more likely to emerge in markets for environmentally more damaging goods.

[60] Shell was the first oil company to break ranks with its competitors on Kyoto, and Shell's chairman Sir Philip Watts, opened a new Shell Center for Sustainability at Rice University in Houston in 2003. BP meanwhile are running advertisement campaigns with the new slogan Beyond Petroleum and claiming to be the biggest spender on solar energy in the world.

Overall, this model highlights the problems involved with expecting individual consumers to behave in a collectively beneficial way – when there are private benefits from deviation. It used simple and well-known game-theoretic analysis to show why just because society would benefit, we cannot automatically expect there to exist a market for green products.

3.7.1 Strategic complementarities and multiple SNEs

If the model above was changed so that all other consumers being green implies that consumer *i* also wants to be green, then we would have strategic complementarities and multiple SNEs. A realistic framework within which this would arise might be the conjecture that being green is a social statement, or a fashion, reinforced by other people's actions. Without further formalisation, it is clear that were this to be our social framework trends and impulses might affect which equilibrium is reached at what time. There might also be a case for a degree of government intervention[61] to mitigate the coordination problem, and promote the Pareto optimal equilibrium.

3.8 Model 3: A simple model of eco-efficiency improvements

Dealing with waste is high on the agenda of most industrial companies, due mainly to tighter legislations and higher disposal costs (Jackson 2004). At the same time the Environment Index 2004, published by the British organisation Business in the Community (BITC) show that only few companies appear to be focussing on reducing waste at source (BITC Environment Index, 2004).

[61] Say a marketing campaign highlighting environmental aspects of industrial production.

Productive eco-efficiency is not just driven by regulation, it might also directly increase a firm's profitability. This sets environmental priorities apart from CSR priorities more generally. Russo and Fouts (1997) provide good theoretic reasons why eco-efficiency of production may have a direct causal effect on operating performance. The extent to which a firm can make efficiency gains will depend on what sort of production it is involved in, with the potential gains generally looming larger for firms with a larger environmental impact[62]. Using Innovest's eco-efficiency data Guenster *et al* (2005) have provided evidence that a strong corporate eco-efficiency policy can be beneficial from an operating performance point of view. The following model attempts to add to the literature by formalising these ideas in a very simple way.

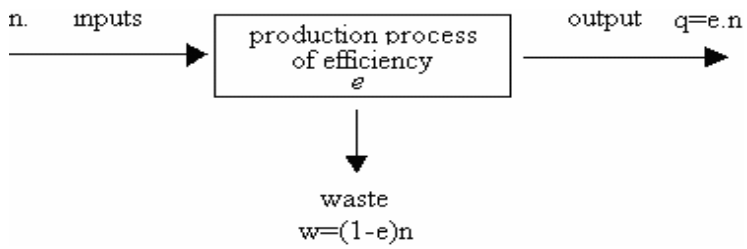
Consider a firm in a competitive market, producing output $q = e.n$. Here, e is a resource efficiency measure with $e \in [0,1]$ and n is a measure of inputs. The waste produced is the proportion of inputs, n, that do not become output: $w(e) = (1-e)n$. With unit costs of production, $c(e)$, assumed to be linear in e[63] so that $c(e) = \zeta e$, the profit function becomes:

$$\pi = pq - c(e)q = e.n(p - \zeta e) \qquad (3.1)$$

Letting figure 3.4 illustrate the production process of the firm, we would expect the firm to optimise and invest in the level of efficiency which maximises profits.

[62] A firm like Microsoft has a lower environmental impact than General Motors.
[63] Efficiency investments increase marginal costs here.

(Figure 3.3) *A very simple production process*



As efficiency improvements are not usually costless,[64] assume there are fixed costs associated with the efficiency investments given by:

$$F(e) = \kappa e \tag{3.2}$$

The introduction of fixed costs might normally mean that a competitive market structure is inappropriate – due to the potential the fixed costs create for barriers to entry. The fixed costs introduced here are a small proportion of total costs however[65] – and they are not fixed costs of production as such, but the costs of investing in an efficiency enhancing mechanism. For simplicity we have assumed these costs to be linear in *e*, although decreasing costs are probably more plausible. With the introduction of the $F(e)$ variable, the profit function becomes:

$$\pi = pq - c(e)q - F(e) = en(p - \zeta e) - \kappa e \tag{3.3}$$

Since the firm operates in a competitive market, and takes prices as given, we can now maximise equation (3.3) with respect to the choice variable *e* to find optimal *e*.

$$\text{FOC: } \frac{\partial \pi}{\partial e} = 0 \quad \rightarrow e^* = \frac{p - \kappa / n}{2\zeta} \tag{3.4}$$

[64]In deed Konar and Cohen (2001) quote evidence that the hidden costs of environmental protection, including product design, waste disposal and depreciation could account for up to 22% of an oil refinery's operating budget.
[65] Explicitly we assume $q\zeta >> \kappa$.

Second order conditions verify that this is maximum[66]. Equation (3.4)[67] indicates that increases in ζ, the marginal cost of production with respect to e will decrease e^*. The same is true for increases in κ, the marginal direct cost of implementing the efficiency enhancing mechanism. For two otherwise equal firms, if one has higher e^* than the other, this might reflect that it is overall more cost efficient – that it has lower ζ or κ parameters, or both[68]. Equation (3.4) also shows that the higher is n, the higher is e^*. To the extent that the model here reflects real life relationships, eco-efficiency might be expected to increase with size. This makes controlling for company size crucial in any regression analysis[69].

The above analysis illustrates the eco-efficiency argument for environmental investments but it is by no means exhaustive of the issues involved in optimal waste reduction. More realistic, but also complicating changes to the model could include making inputs n a function of e so that improved eco-efficiency also leads to lower use of inputs through another direct effect on the cost function. One could also make the costs of efficiency improvements become a function of changing technologies, which again would affect the optimal level of e, or one could give both $c(e)$ and $F(e)$ nonlinear functional forms.

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[66] $\frac{\partial^2 \pi}{\partial e^2} = 0 \rightarrow -2\zeta n < 0$

[67] It is clear that from this expression, mathematically e could take a value other than between 0 and 1. We defined $e \in [0,1]$. A value of e higher than 1 does not make intuitive sense. It would imply that more resources come out of a production than those utilised in that production. Mathematically it would also require a large price-cost ratio.

[68] Along these lines Porter and van der Linde (1995) argue that poor environmental performance is an indicator of a firm's operational inefficiencies.

[69] As demonstrated by Chen and Metcalf (1980)

3.8.1 A simple intertemporal treatment

This simple extension of the above model is meant to capture the idea that there might be a link between 'forward-lookingness' and investments in *e.* In a simple two period model the firm faces the following profit function:

$$\pi(e) = pq(e) - c(e)q(e) - F(e) + \beta\left[pq(e) - c(e)q(e)\right] \qquad (3.5)$$

In equation (3.5) β <1 is the firms discount factor – and the fixed costs of implementing the ecoefficiency enhancing mechanism only apply in period 1. If we substitute in for q(e) we get equation (3.6) which we maximise to get optimal e^* in equation (3.7).

$$\pi(e) = pen - \zeta e^2 n - \kappa e + \beta\left[pen - \zeta e^2 n\right] \qquad (3.6)$$

FOC: $$\frac{\partial \pi}{\partial e} = 0 \rightarrow e^* = \frac{p - \kappa/n + \beta p}{2\zeta} = \frac{(1+\beta)p - \kappa/n}{2\zeta} \qquad (3.7)$$

From equation (3.7) we see that the higher the discount factor, β, the higher is e^*. This has interesting implications in the context of assessing the information a company's sector relative *e* entails. β reflects a particular weighted average cost of capital. In other words it reflects the firm's opportunity cost. *Ceteris paribus*, one could expect a more long term outlook to imply a higher β. For reasonably homogenous firms, a higher *e* might be related to a manager's belief about his company's future profitability. Higher eco-efficiency may therefore serve as a plausible proxy for a company's future performance. This is a very interesting insight, and it is pleasing that it emerges from such an extraordinarily simple model.

This observation, together with the cost efficiency point made in the static analysis, might provide a good rationale for eco-efficiency to be relevant to

how companies are priced in the financial markets, in excess of any direct causal gains implied by the environmental performance as such. Indeed, it is this sort of logic which underlies firms as Innovest's view of eco-efficiency as a proxy for good management[70]. In a very crude way, this might be seen as a direct representation of the cognitive-institutional factors discussed at the beginning of this chapter. The model has also highlighted the temporal differences between costs and benefits of eco-efficiency enhancing investments. The former have a short term impact, the latter might be accruing in the long run. This has implications for how we construct our regression models on the relationship between environmental and operating performance.

3.9 A link with profitability? The growth of the environmentally responsible corporation

What does the preceding discussion tell us about the growth of the environmentally responsible corporation? Rheinardt (2004) argues that if it pays to be green, then one would expect all firms to become greener. Salo (2005) finds that in terms of environmental performance as measured by Ecovalue21, firms improved their median rating by 1 point between 2000 and 2003. KPMG report a threefold increase in environmental reporting in this period between 1993 and 2004 (KPMG 2005). Interestingly, Japanese and British corporations are leaders in terms of environmental reporting (KPMG 2005). Asked what drives such a change in priorities, 75% of business leaders

[70] Interestingly whilst this is the backbone of Innovest's asset management approach, Salo (2005) investigating the relationship between the Ecovalue21 index and Belgian company Deminor's corporate governance rating find no evidence of a link. To the extent that measures of good corporate governance are an observable proxy for overall good management and institutions Salo's (2005) findings hence seem to run counter to much of the discussion in this chapter.

quote economic reasons, with 50% giving ethical reasons (KPMG 2005). This discussion has shown that the distinction between the economical and the ethical can be rather fluid.[71]

Salo (2005) finds strong evidence that corporate environmental performance is influenced by a firm's sector (rather than home country). The analysis here has shown that the more exposed to consumer pressures a firm is or the higher its environmental footprint, the higher may be the strategic and direct benefits from investing in environmental performance. This is due to a combination of effects on the costs of production, the risks of a consumer fall out, the costs of window-dressing and the risks of future liabilities. In such sectors it might be reasonable to expect environmental laggards to show lower long run profitability than environmental leaders. The chapter has thus illustrated the possible need to break a general sample down to more homogenous sub-samples in order to obtain unambiguous results in a regression analysis.

Nonetheless, once we take on board the heterogeneity of consumers and the strong forces promoting differentiation in real world markets (Tirole 2003) the expectation of a link between good environmental management and profitability remains complicated. For example, environmental leaders and laggards might just be strategically positioning themselves in a market made up by consumers with different environmental preferences. It seems likely that in the long run some firms might benefit from selling cheap, environmentally

[71] Of the 50% that give an ethical reason for environmental priorities many mention integrity as a driving ethical factor (KPMG 2005). There is no doubt that a reputation for integrity is an important competitive tool in many industries, and so establishing integrity might just as well be classified as an economic reason.

unfriendly goods, just as some firms do well by selling cheap, low quality foodstuffs or clothing.

Finally this chapter also discussed why a link between environmental performance and profits may be based on a firm's ability to re-evaluate production processes and adopt new managerial and technological innovations in order to respond to strategic opportunities which arise in any dynamic market. This sort of relationship implies a link between good management or institutions and environmental performance. However it does not say a great deal of the relative causality of the relationship. Does good management simultaneously cause green production and higher returns? Or do production techniques lead directly to financial benefits? Or perhaps is the causation reversed, so financially successful companies have more to spend on green initiatives?

The above has concerned itself with trying to explore beyond compliance corporate environmental outcomes, and to provide a necessary theoretical background for the empirical analysis. It has shown that there are good reasons why links might exist between environmental performance and profitability. Any potential links are however susceptible to changes in the strategic and sectoral settings under analysis. On the individual firm level, many a case study of successful environmental strategies can be found, and, to quote King and Lenox (2001: 105) perhaps the question should be 'when does it pay to be green – rather than does it pay to be green?' The former is explored in the next chapters.

Chapter 4

Empirical analysis

After briefly describing the dataset in section 4.1, and discussing the choice of dependent and independent variables in sections 4.2 and 4.3, this chapter discusses the use of modern panel data methods to achieve a more causal analysis of linkages between environmental performance and profits. It also discusses some tests and diagnostics that can be used to make choices between estimators. Primarily to enable further stability analysis a brief description of a standard application of the Fama-Macbeth (1973) regression method used by Guenster *et al* (2005) is given towards the end of the chapter. Finally is outlined a method for directly addressing a link between environmental performance and managerial ability, and so the more institutional characteristics discussed in chapter 3

The empirical analysis of this thesis is mainly based on 'small *T*, large *n*[72]' dynamic panel data techniques. Panel data, involving repeated observations of the same cross section of individual units enables us to model dynamics and control for some sources of potential endogeneity, particularly that arising from unobserved individual effects. This allows us to mitigate against what Koehler (2004) argues is the largest empirical failure of the literature to date: the inability to sufficiently control for issues of endogeneity, omitted variable bias and coincidental dynamics. The results of applications based on the models discussed in this chapter are presented in chapter 5.

[72] Asymptotic properties based on $n \to \infty$, T fixed.

4.1 The dataset

The sample of firms consists of publicly listed Japanese companies, drawn from different Japanese stock markets, including Japan's two stock markets for medium and small sized venture companies, JASDAQ and Tokyo Mothers. The companies therefore vary much more in size than in previous studies which have tended to concentrate only on large firms, often drawing from the S&P 500. This has the advantage that any significant findings of regressions run on the entire data can be said to be reasonably general. The potential disadvantages should be quite clear from chapter 3. There are compelling theoretical reasons why an unambiguous overall effect should not exist. Breaking the sample down into sub-samples might be needed to attain any clear results.

Also implied by the last chapter is the point that environmental profit opportunities, to the extent that they exist, seem likely to lie in proactive environmental governance. The Nikkei Environmental Management Survey[73] (hereafter the Nikkei survey) seeks to capture the various aspects of this concept. It is therefore well suited for an empirical investigation into the potential returns to environmental performance. The survey questionnaire is changed every year to reflect frequent changes in the environmental legal system and company behaviour and differs slightly in its emphasis depending on the industrial sector. The questionnaire for manufacturers had 126 questions in 2004. The score set in each question is added up in one of the

[73] The Nikkei survey has been conducted every year since 1997 and its purpose is to rank companies based on their environmental management. The results of the survey are published in the Nikkei Sangyo Shimbun and Nihon Keizai Shimbun business newspapers with joint circulations of over 3 million.

following 7 categories: (i) management structure and risk disclosure, (ii) vision, (iii) pollution risk, (iv) recycling, (v) eco-friendly products, (vi) measures against global warming and (vii) environmental measures at non-manufacturing sites. Rather than being a measure purely of eco-efficiency, the score captures very neatly the sort of different variables needed to establish a more general causality between good environmental management and firm profits. The Nikkei survey gives scores from 0 to 1000. In our sample, which covers the years 1999-2003, the maximum score attained is 826, the lowest 78 and the average around 465.

The fact that the Nikkei survey is questionnaire based creates a potential self selection bias in our sample[74]. Who is to say how truthful the respondents were. What if worse performers over-emphasise their achievements? This would obscure any relationship between environmental performance and profitability, and represents a potentially serious flaw in the dataset. Where possible the Nikkei survey was compared with the Innovest Ecovalue21 index, which is non-questionnaire based. As figure (4.1) on the next page shows, the correlations between the Nikkei and the Innovest scores are good.

The dataset has been constructed so that all firms experiencing mergers or significant acquisitions in the period have been excluded[75]. In addition to this,

[74] In 2003 the response rate for manufacturers was 38%. Matthew Kiernan, president of Innovest, pointed to this as an immediate worry when looking at some early regression results produced for this thesis. Perhaps not too surprisingly, Horowitz and Manski (1998) show that the seriousness of this problem is directly proportional to amount of non response.
[75] This is surprisingly often not done in the literature.

to reduce any outlier effects, values of the dependent variable outside +/- 3 standard deviations from the mean have been left out of the regressions.

(Figure 4.1) *Correlations between Nikkei and Innovest scores*

4.2 The dependent variables and their relationship with the environmental indicator

We have chosen one financial performance measure Tobin's Q[76] and two operating performance measures, ROA and ROE, to serve as our dependent variables. Following Guenster *et al* (2005), employing both market-based (Tobin's Q) and accounting-based (ROA and ROE) measures was done to ensure reliable and consistent results, as both have their specific strengths and weaknesses.

The rationale for including a stock market based variable is straight forward. In popular writing, newspapers and business literature, intangible reputation effects, as discussed in chapter 3, are often mentioned as reasons for investing in environmental performance. This sort of impact is captured by Tobin's Q.

[76] See figure below for how Tobin's Q is measured. This is not analysts' Tobin's Q which is proven by Bond and Cummins (2001) to outperform conventional Q. (See Bond and Cummins 2001 for details). For this thesis a less complex Q was chosen due to data availability concerns.

With perfect information one would expect the stock value of a firm to react instantly to any change in information which is judged to influence future profitability[77]. In other words, the stock market based variables should capture benefits from an increase in environmental performance which would only be seen in accounting based variables in the longer run, possibly outside of the *t* dimension available to this thesis.

It is important to bear in mind however that stock market variables do not capture actual increases in profits caused by environmental performance, but rather the market's belief about future profitability increments. Increases in Tobin's Q do not directly feed into bottom line improvements.

A more subtle point in terms of a relationship between Tobin's Q and the environmental indicator is made by Koehler (2004). Looking at US evidence, she notes that so long as green investing is still quite marginal in terms of trading volumes, green investors might be expected to be price takers, and as such have little influence on Tobin's Q[78].

It follows from the discussion above that stock market based variables alone are not enough to uncover any firm causal dynamics between long run profits and environmental performance. The choice of the two operating performance measures reflects the aim to find broad measures which addresses profitability

[77] Some authors, notably Guenster *et al* (2005) report that also the stock market might update environmental information with a time lag. They work with monthly, not yearly data however. In any case, as opposed to the operating performance measures, there is no reason to expect a different effect of present relative to past values of environmental performance on financial performance.

[78] Although it is possible that green investors are not price takers in special, green segments of the market.

and efficiency (Guenster *et al* 2005). Russo and Fouts (1997) focus on the relation between corporate environmental performance and firm operating performance, and use ROA as the dependent variable. Hart and Ahuja (1996) also look at ROE[79]. Table 4.2 shows the three dependent variables and how they are defined.

(Table 4.2) *The dependent variables*

Tobin's Q:	$\frac{\text{Market value of assets}}{\text{Net replacement costs of assets}} = \frac{\text{Total assets - market capitalisation - shareholder's equity}}{\text{net property+investments+current assets}}$		
ROA:	$\frac{\text{net income after tax}}{\text{total assets}}$	**ROE:**	$\frac{\text{net income after tax}}{\text{shareholder's equity}}$

Due to the annual nature of accounting one might expect a potential relationship between the environmental indicator and ROE and ROA to be seen in the lagged, not current values (Guenster *et al* 2005)[80]. In the analysis that follows the environmental indicator both at *t* and lagged at *t*-1 will be used as control variables in the regressions run on accounting based operating performance indicators[81].The *T=5* data does allow the inclusion of a further *t-2* environmental indicator but it was thought that this would 'kill' the time dimension of the panel[82]. The ROA and ROE variables are in percentages when used in the regressions in the next chapter.

4.3 Additonal independent variables

Guenster *et al* (2005) note that regression analysis exploring the relationship

[79] It is important to note that the main difference between ROE and ROA is due to financial leverage. Assets = liabilities + shareholders' equity. A company with no debt will have ROA equal to ROE.

[80]As mentioned Hart and Ahuja (1996) found that decreases in firm pollution predates increases in operating performance.

[81] As opposed to Tobin's Q, it is important to include both – since as discussed in model 3, a negative initial effect when only costs accrue, and a more positive later effect, might be expected.

[82] Whilst *T-5* the panel is also unbalanced, with some variables missing for certain years.

between environmental management and financial or operating performance accounts for potentially confusing influences from the environmental indicator on the dependent variable. The dynamics seem likely to be multifaceted, and any potential causal effect of environmental performance on profits is likely to be affecting various firms and industries in different ways. From chapter 3 it is clear that reasonable control variables in this setting might include institutional responsiveness or managerial quality. While it under some assumptions will be possible to control for these, the lack of directly available controls is but one reminder that our regressions might suffer from serious, but indeterminate, biases. The controls chosen for the subsequent analysis stick closely to the more recent specifications used in the literature.

In the Tobin's Q regressions we include, following Guenster *et al* (2005), King and Lenox (2002), and Konar and Cohen (2001) R&D intensity[83] as a control variable, since this is found to be relatively closely related to the variable of interest, the environmental indicator (See figure 4.1). It is also thought to be affecting the reputation strategic effects we were exploring in the last chapter. Furthermore, R&D intensity might be a very crude indicator of institutional learning and responsiveness.

(Figure 4.1) *Correlation between the environmental indicator and R&D intensity*

	Nikkeiscore	R&D intensity
Nikkeiscore	1	
R&D intensity	0.3362	1

[83] Measured, following Dowell *et al* (2000) and King and Lenox (2002) as R&D expenditure scaled by book value of total assets.

Hirsch (1991) showed that recent sales growth is positively related to company profits, and Guenster *et al* (2005) include two-year sales growth as a further control variable. Here, year by year sales growth is included as a control variable. This is more practical due to our limited T[84].

To condition on differences in firm size, following Guenster *et al* (2005), book value of total assets is used. Finally, age of assets was included in the regressions[85]. The regression equation for the Tobin's Q regressions is hence as below.

$$\text{Tobin's Q}_{it} = \alpha \text{Tobin's Q}_{i,t-1} + \beta_1 \log(\text{Nikkeiscore}_{it}) + \beta_2 \log(\text{R\&D Intensity})_{it} + \beta_3 \text{Sales growth}_{it} + \beta_4 \text{Total assets}_{it} + \beta_5 \text{Age of assets}_{it} + \eta_i + u_{it}$$

The inclusion of a lagged dependent variable and the two error terms η_i and u_{it} will be discussed in more detail in the sections 4.5 and 4.6. The use of a semi-log form reflects that it seems plausible that the magnitude of both potential gains and costs of environmental performance becomes smaller as a firm moves closer to 'maximum environmental efficiency'[86].

In the regressions on the operating performance estimators controls include the before mentioned Nikkeiscore at *t-1*, total assets and age of assets, as well as a new measure of risk and managerial flexibility, debt to equity ratio (DER). The set of control variables here is similar to that of Waddock and

[84] We have sales data from 1998 to 2003.

[85] Year dummies to take account of methodological changes in the indicator might also at a first glance seem like a possible additional control. However these were found to be consistently insignificant in all regressions. Following Guenster *et al* (2005) and Konar and Cohen (2001), company age (and company age squared) was (were) initially included in the regressions but was (were) found to be insignificant and, somewhat surprisingly perhaps, unrelated to environmental performance.

[86] A semi-log specification is one of the specifications reported by for example Guenster *et al* (2005).

Graves (1997) and Guenster *et al* (2005). The specification for the ROA (ROE) regression equations is presented below. [87]

$$\text{ROA}_{it} = \alpha \text{ROA}_{i,t-1} + \beta_1 \log(\text{Nikkeiscore}_{it}) + \beta_2 \log(\text{Nikkeiscore}_{i,t-1}) + \beta_3 \text{DER}_{it} + \beta_4 \text{Total assets}_{it} + \beta_5 \text{Age of assets}_{it} + \eta_i + u_{it}$$

Apart from the Nikkei score, all the raw data come from the Toyokeizai database. The dataset was constructed by Take Kikuchi of Jesus College, Oxford, as part of his MSc Thesis in Environmental Change and Management submitted in 2005.

4.4 Arriving at the appropriate model

Endogeneity is a fundamental problem in most applied econometrics work. It often arises due to omitted control variables resulting in $E\left[y_{it}u_{it}\right] \neq 0$ or $E\left[x_{it}u_{it}\right] \neq 0$. In other words it is the correlation between the dependent and observed independent variables and the error term, caused by any omitted variable, which creates the bias. Since in this analysis the coefficient on the environmental indicator is of primary interest, it is the case where endogeneity leads to $E\left[x_{it}u_{it}\right] \neq 0$ which should be our main concern. The econometric literature offers various ways around this problem. IV estimation, where an instrument that is correlated with the variable of interest, but uncorrelated with the error term, is used instead of the variable of interest, is the most obvious solution. In practice this can be problematic due to limited potential for finding valid instruments[88]. No suitable and available

[87] R&D intensity was not included here due to the dataset only containing 3 years of R&D intensity data. Removing R&D intensity from the regressions seemed to impact little on the other point estimates.

[88] Weak instruments are not a good option since they introduce an indeterminate bias of their own (Blundell *et al* 2000)

instrumental variable could be found for this thesis[89]. A slightly different form of endogeneity bias that is often encountered in panel data analysis is due to unobserved individual specific fixed effects. Such endogeneity can be controlled for and is discussed in more detail in section 4.5. Final solutions to the endogeneity problem are the difference and system GMM (dGMM and sGMM) methods outlined in section 4.6. These methods, developed amongst others by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) have become increasingly popular in panel data estimations in recent years and utilize moment conditions on past levels and first differences of the control variables in order to overcome the endogeneity bias. The fact that the fixed effects can be identified in the regressions, also allow for investigations into the fixed effects as such. This enables us in chapter 5 to test for any relationship between the fixed effects and the environmental indicator, and thus assess whether there is a link between good management, unobserved and assumed fixed in the short run (Wooldridge 2002) and environmental performance.

4.5 Individual effects

Individual specific variables that do not change over time are referred to as individual or fixed effects and are, as already mentioned, often thought to include unobserved managerial ability in firm level micro econometric analysis (Wooldridge 2002). Since the data we are dealing with is reasonably short spanning, with T=4, interpreting managerial ability as approximately

[89] An effort was made to gather data on the age of companies' CEOs from the expectation that this might be related to environmental performance, whether this might have proven a good instrument could not be established due to it quickly becoming clear that such data gathering was beyond the scope of this thesis.

fixed seems a reasonably appropriate assumption. The individual effects are the η_i in the model below:

$$y_{it} = \beta x_{it} + \eta_i + v_{it}$$

The existence of fixed effects presents some problems with regards to the consistency of the pooled OLS estimator, $\hat{\beta}_{OLS}$, unless $E\left[x_{it}\eta_i\right] = 0$ and $Var[\eta_i] = 0$[90]. If this does not hold, then $\hat{\beta}_{OLS}$ will be inconsistent due to the serial autocorrelation of the error term, $u_{it} = \eta_i + v_{it}$, caused by the time-invariant component η_i. However, in a panel setting, some simple transformations can rectify this, but at a cost.

One way to eliminate the endogeneity bias produced by the time invariant elements of the error term is to do a within transformation, which under the classical panel data assumptions[91], is consistent even when $E\left[x_{it}\eta_i\right] \neq 0$ or $Var(\eta_i) \neq 0$. The transformation consists of subtracting the empirical mean from both sides of the equation, thereby eliminating the time invariant η_i. This produces the fixed effects/within groups estimator, $\hat{\beta}_{WG}$. Under classical assumptions $\hat{\beta}_{WG}$ is consistent both when $E\left(x_{it}\eta_i\right) \neq 0$ and $E\left(x_{it}\eta_i\right) = 0$. The pooled $\hat{\beta}_{OLS}$ is however more efficient so long as $E\left(x_{it}\eta_i\right) = 0$. In applied settings it is also of interest to note that the within transformation eliminates

[90] So long as the other 'classical assumptions' hold. In addition to strict exogeneity ($E(x_{it}v_{is}) = 0$) for all $s \neq t$ these are: (1) expected value error components is 0 ($E(\eta_i) = E(v_{it}) = E(\eta_i v_{it})$), (2) shocks are serially uncorrelated $E(v_{it}v_{is}) = 0$ for all $s \neq t$, and (3) the variance of the error terms is homoskedastic, $E(\eta_i^2) = \sigma_\eta^2, E(v_{it}^2) = \sigma_v^2$.

all potential control variables that are fixed across time periods, and that unless $E(\Delta x_{it}\Delta u_{it}) = 0$ holds, $\hat{\beta}_{WG}$ is inconsistent. It is hence clear that both $\hat{\beta}_{WG}$ and $\hat{\beta}_{OLS}$ might be expected to be biased in empirical work, $\hat{\beta}_{WG}$ due to measurement error, as it is only identified by the time dimension, $\hat{\beta}_{OLS}$ due to the endogeneity bias.

4.5 Dynamic linear GMM models

Motivated by the inconsistency of the $\hat{\beta}_{WG}$ and $\hat{\beta}_{OLS}$ in many settings, Arellano and Bond (1991) with dGMM and Arellano and Bover (1995) with level GMM (lGMM) introduced further advances in terms of addressing panel data endogeneity problems.

Dynamic models with lagged dependent variables allow for serial correlation of unknown form (Arellano 2003). Even though the coefficient on the lagged dependent variable is of no direct interest in our analysis, allowing for dynamics of the underlying processes 'may be crucial for recovering estimates of other parameters' (Bond 2002: 1). In our context it might seem reasonable to investigate a dynamic specification since current profitability might be expected to at least partially depend on past outcomes[92]. A generic dynamic model representation is shown below.

$$y_{it} = \alpha y_{i,t-1} + \beta x_{it} + \eta_i + u_{it}$$

The dGMM method, which treats the model as a system of equations with one for each time period, takes first differences to remove any time invariant fixed

[92] Consumers might for example be affected by switching costs.

effects. Lagged levels are then used as instruments for current first differences, under the assumption that lagged levels are uncorrelated with the error term of the transformed model in first differences. The subsequent moment restrictions, $E(x_{i,t-s}\Delta u_{it}) = 0$, are valid for *s>2* if the error term is MA(0). These impose less strict assumptions on the model than the strict exogeneity assumption of the classic models in section 4.4[93]. Bond (2002) notes that strict exogeneity is often not a natural restriction in the context of economic models since it rules out any feedback from current or past shocks on current values of a variable, which often seems appropriate for outcomes of variables like investments or Tobin's Q (Bond 2002). A problem with the dGMM estimator, however, is that lagged levels might be poor instruments for first differences. This is especially the case where variables are close to a random walk.

Arellano and Bover (1995) show how under slightly different assumptions, suitable lagged first differences will be available as instruments for the original equation in levels. This case occurs when we have $E(x_{it}\eta_i) \neq 0$, but when $E(\Delta x_{it}\eta_i) = 0$. The first differences of the control variables are uncorrelated with the individual effects. The moment conditions $E(\eta_i + u_{it})\Delta x_{i,t-s}) = 0$ are then valid for *s*=1[94] when the error term follows an

[93] These moment restrictions are valid provided $E(x_{i1}u_{it}) = 0 \forall t = 2,...,T$. See Bond *et al* (2003) for details.

[94] Arellano and Bover (1995) show how an initial condition of $E(\eta_i \Delta y_{i2}) = 0$ is required for consistency. This condition is satisfied by mean stationarity in the y_{it} process (Baltagi 2001; Blundell *et al* 2000). However, if the conditional process on y_{it} has been generated for many periods before the panel in question, any effect of the initial conditions will be negligible, and

MA(0) process. These two approaches lead Blundell and Bond (1998) to suggest a *system* GMM estimator which incorporates the optimal combination of the dGMM and the lGMM (Blundell *et al* 2000). The available moment conditions will vary in this estimation depending on whether the control variables are thought to be endogenous, predetermined or exogenous[95]. It is important to note that, whereas for the dGMM estimator a known weight matrix is available which will make a one-step and two-step estimator asymptotically equivalent, this is not so for the sGMM estimator. This means that the gain in efficiency from using an optimal two-step estimator is likely to be greater in this context (Bond 2002). The two-step estimator has been shown to deliver less reliable inference than the one-step version in finite settings however (Blundell and Bond 2000), and this has meant that applied work has often used the one-step estimator (Bond 2002). Windmeijer (2000) proposes a finite sample correction method for the two-step estimator and these corrected two-step errors can be computed in STATA. In this thesis diffferent representations will include both dGMM and onestep and twostep sGMM, and as shall be outlined in section 4.8, diagnostics will be used as far as possible to ascertain which is the more appropriate estimator.

4.7 More on the direction of the biases

As mentioned before, generally both the WG and OLS methods will tend to produce biased estimates. For dynamic representations this bias is systemic: $y_{i,t-1}$ will be correlated with the error term even after the within

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$E(\Delta x_{it}\eta_i) = 0$ only is needed for $E(\Delta y_{it}\eta_i) = 0$ (Baltagi 2001; Blundell, Bond and Windmeijer 2000). See Arellano and Bover (1995) for more details.

[95] These assumptions can be tested using Dif-Sar tests (Bond 2002). See section 4.8.

transformation, since $y_{i,t-1}$ is correlated with the transformed error term (Baltagi 2001). These methods are hence fundamentally unsuitable for dynamic estimation. Generally, at least in large samples, the WG estimate will tend to be biased downwards, and the OLS upwards (Bond 2002). Bond (2002) further notes that the fact that these two estimators tend to be biased in opposite directions is useful as they indicate an upper and lower limit for a candidate efficient GMM estimator. In the cases where a supposedly asymptotically efficient GMM estimator does not return an estimate within the WG-OLS band we might suspect either inconsistency or severe finite sample bias (Bond 2002).

Blundell and Bond (1998) consider the properties of the GMM estimators in dynamic models with weakly exogenous regressors. Since this is perhaps the most common case in empirical applications, they note that their Monte Carlo simulations will have important implications for applied work. They also compare the various GMM results with the OLS and WG estimators in dynamic representations. Blundell and Bond (2000) conclude that the dGMM is biased and has low precision when the individual series are highly autoregressive. They also conclude that this bias will be in the direction of the WG estimator. Blundell *et al* (2000) prove how the moment conditions on the lGMM estimator remain informative even as the series becomes very autoregressive. Estimating different autoregressive parameters in persistent series Blundell and Bond (2000) find that the sGMM estimator greatly improves precision. Bond (2002) hence advocates that care should be taken to examine the time series properties of any series in order to qualify the

precision of the dGMM estimator. In this thesis this was very crudely examined by estimating a simple dynamic representation,

$$y_{it} = \beta + \alpha y_{i,t-1} + e_{it}$$

to look at the coefficients returned by the WG and OLS regressions for the dependent variables and the Nikkeiscore. It was hoped that due to the biases discussed above we thus had a measure of an upper and lower band in autoregression. The figure below summarises the results.

(Figure 4.2) *Simple dynamic representation to examine persistence in some variables*

Regression	All data							
	Tobin's Q		Nikkei		ROA		ROE	
Dep. Var	OLS	WG	OLS	WG	OLS	WG	OLS	WG
y_t-1	0.615***	0.118***	0.974***	0.436***	0.288***	-0.030***	0.132***	-0.230***

Note:* significant at 10%; ** significant at 5%; *** significant at 1%. OLS is the pooled OLS estimator, WG the within groups estimator

There is evidence that especially the Nikkeiscore, and to a lesser extent Tobin's Q[96] are potentially highly autoregressive. There is reason to believe that the dGMM estimators of the coefficients on the environmental indicator will suffer from considerable bias in the regressions that follow, and should be treated with caution.

4.8 Which to trust? Some tests and diagnostics to decide on specification issues

A test which further examines the significance of the fixed effects, and so the need for the within transformation, is easily available in STATA. The Hausman test tests whether there is a systematic difference between the more

[96] This variable is often found to be strongly persistent (Bond 2002). In fact the reason why the coefficients are not higher her might be due to the effect of the technology bubble in 2000. If regressions are run for only the later years of the panel the OLS coefficient is >0.77.

often consistent WG estimator, and the more efficient but less often consistent OLS estimator. The Hausman test is reported in the regressions that follow.

As the discussion above has shown, in simulations at least, the sGMM estimator is the estimator of choice. In applied work there is potential for over-identification, and the utilisation of invalid instruments and moment constraints with 'large *n* small *T*' panels and sGMM, since the number of moment constraints increases rapidly with *n* (Bowsher 2002). Traditionally the GMM test of over-identifying restrictions, hereafter the Sargan test, has been used in dynamic panel data analysis to test for over-identification (Bowsher 2002). This test, which has χ^2 distribution asymptotically[97], and degrees of freedom equal to the number of over-identifying restrictions, has however been found to have low power when based on the full Arellano-Bond (1991) instrument set, especially when *T* becomes larger relative to a set *n* (Bowsher 2002). Furthermore, as pointed out by Anderson and Sørensen (1996) in the context of a stochastic volatility model, when too many moment constraints are included the p-values of the Sargan test get inflated, again making its power poor. This is important in applied settings as it is directly affected by the number of control variables, and lagged instruments, used. Of course, the applied econometrician can mitigate this to an extent by restricting the number of lags used when constructing the instruments. Such restrictions are easily achieved in STATA, where lag lengths can be controlled, and has been restricted as far as possible in the regressions presented here. Bowsher

[97] The test is based on the minimised two-step estimator and has asymptotic χ^2 distribution regardless of heteroskedasticity. The test also holds for the one-step estimate, since the over-identifying restrictions are the same in both cases (Bond 2002).

(2002) shows how such restrictions, in a dynamic AR(1) model, do reduce the tendency of the Sargan test to under-reject.

Another possible test of over-identification is the difference-Sargan test (Dif-Sar). Dif-Sar is useful in many contexts[98], and can be used here to supplement the Sargan test of over-identification. The actual test statistic becomes, when testing the appropriateness of sGMM over dGMM, $(S_s - S_d) \sim \chi^2_{dof_s - dof_d}$, where S_s and S_d are the Sargan test statistics under sGMM and dGMM respectively. The Dif-Sar tests whether the difference between a representation requiring weaker assumptions and one requiring stronger assumptions is significant. In other words, the Dif-Sar test specifically tests the validity of the extra instruments used in the sGMM estimation as compared to the dGMM estimation. Both the Sargan test and the Dif-Sar test have as null hypothesis that the extra instruments are valid. Sargan and Dif-Sar test statistics will generally be reported in the regressions that follow.

Finally, tests for serial autocorrelation are reported for all regressions. Since these models by construction are AR (1), the tests for second order autocorrelation in the v_{it} disturbances are also of interest (Bond 2002). The transformed Δv_{it} should have significant negative first order correlation (but no second order) for the assumption that the v_{it} are serially uncorrelated to be valid (Bond 2002).

[98] As noted by Bond (2002) it can be used to test the relatively weak assumption of endogeneity against pre-determinedness of a regressor, since the former moment conditions would necessarily be a strict subset of the latter. This has been done where appropriate (and possible) in this thesis to arrive at the correct specifications.

4.9 A further stability indicator: The Fama-Macbeth regression approach

Primarily because this is the method used by Guenster *et al* (2005) but also because it might further support the stability of any findings from other regressions, Fama-Macbeth (1973) (FM) regressions are also reported in chapter 5. The FM cross-sectional regression approach essentially consists of two steps. In the first step, for each time period, cross-sectional regressions are used to obtain estimates of the parameters of interest. In the second step, time series for these estimates are used to produce final parameter values and standard errors. Skoulakis (2005) notes that apart from Cochrane (2001) who proves that FM is essentially the same as OLS so long as the explanatory variables do not vary with time, the FM approach, whilst widely used in finance, is largely ignored in the econometrics literature. He goes on to provide a thorough analysis of the behaviour of the FM estimator relative to the OLS estimator in different settings. He concludes that if T is small, t-statistics can be rather misleading and that the FM estimator is primarily a large T estimator. In the regression analysis presented in the next chapter, results are reported for a traditional FM and a weighted FM which takes variances in year by year sample size into account[99]. Due to the relatively short T of the dataset, and the fact that the FM estimators do not control for any fixed effects, these should be expected to be biased. Since the estimators

[99] These programmes were written by Professor Mitchell Petersen (2005) of Kellogg School of Management.

have been used in the literature[100] it seems relevant still to report them and get a sense of the direction of the biases.

4.10 Identifying and testing the fixed effects

In a recent paper looking at the determinants of exports of manufacturing goods from Sub-Saharan Africa Rankin *et al* (2005) specifically analyses the fixed effects of their regressions. Here we propose to extract the fixed effects from the error term produced in the sGMM to specifically test for any relationship between these and the environmental indicator. While not part of a causal analysis, this is interesting as it allows us to examine a potential link between environmental performance and managerial ability, if this is thought to be a significant part of the unobserved fixed effects. In this way it directly approaches the institutional aspects discussed in chapter 3. In the next chapter pooled OLS is run on the identified fixed effects to see the extents to which the environmental indicator really is a proxy for these. Regressions are also run on the full models with the fixed effects as additional controls

The next chapter reports the results from the different estimators outlined above and discusses their appropriateness.

[100] The small '*T*' issue does not apply to for example Guenster *et al* (2005) who works with 7 years of monthly data.

Chapter 5

Results

This chapter presents various regression results making use of the estimators discussed in chapter 4. In section 5.1 results are presented for the OLS, WG, dGMM and sGMM estimators, and also for comparison, FM and wFM. These are results from regressions run on the whole sample. *Ex ante* the primary estimator is the sGMM estimator. Theoretically, this is the estimator that best controls for the various forms of endogeneity potentially affecting the sample. As discussed in chapter 4, a reasonable sGMM specification should return estimates of the lagged dependent variable within the WG-OLS band. Negative first order autocorrelation of the residuals, and no over-identification are other requirements for good specification. We will use the regression results for the whole dataset, presented in section 5.1, to assess the apparent biases on the different estimators and then report a more parsimonious set of estimators in the subsequent analysis.

In sections 5.2, 5.3 and 5.4 regression results for different sub-samples of the data, divided by environmental performance, environmental footprint and consumer exposure, are reported. Ideally, following the conclusions from chapter 3, regressions should be run sectorally[101], to ensure a sample which is exposed as homogeneously as possible to any causal dynamics. This was

[101] Another possibility not explored in the last chapter would be to control directly for sectors. This is not possible for the dGMM and WG estimators due to the transformation. It was judged that, due to the additional insights on the biases provided by the WG and dGMM estimates, as well as the much discussed theoretical argument against looking for overall effects, dividing the sample into sub-samples was appropriate for this study.

however not possible due to the limits it put on sample size. Depending on the sub-samples, regressions on Tobin's Q, operating performance or both will be reported. Before concluding the empirical analysis in section 5.6, in section 5.5 this chapter reports results from regressions directly analysing the relationship between the fixed effects, containing time invariant elements linked to managerial quality, and the environmental indicator. In the result tables, the point estimates and standard errors of the lagged dependent variable and the environmental indicator(s) will be reported.

5.1 All data

The results for the regressions run on the entire dataset are presented in tables 5.1[102] to 5.3. For dGMM and sGMM, regressions with instruments taken at *t-3* are also reported. *Ex ante* the expectation is that, following the exposition in chapter 3, a strong general result is unlikely to exist. Clearer results are hoped to emerge from the sub-sample analysis.

Table 5.1 presents the results for Tobin's Q. Some results are rather striking. In terms of the biases, both the two-step and one-step *t-2* sGMM return estimates for $\alpha y_{i,t-1}$ well within the WG-OLS band, and these are significant at the 1% level. Moreover the *t-2* dGMM, as expected, returns much lower, unsignificant estimates, outside the band. This might be due to some degree of weak instrument bias following the persistence in the Tobin's Q and Nikkeiscore series. The FM and wFM estimators appear to be biased

[102] Large tables can be found from page 91.

upwards[103]. Both the Dif-Sar and Sargan tests reject the validity of the extra sGMM instruments. The *t-3* sGMM does not rectify this: the Dif-Sar and Sargan tests again reject the validity of the sGMM instruments, and this time the estimates fall outside of the WG-OLS band[104]. The sGMM, but not the dGMM regressions return the expected negative first order correlation. The existence of fixed effects is confirmed by the Hausman test.

Turning to the estimator of interest, the environmental indicator, the situation is somewhat confusing. The OLS and, interestingly, the FM and wFM estimators, return positive and significant estimates at around 0.200[105]. The other significant estimate, however, is the *t-3* dGMM which returns a highly negative coefficient[106], and overall the point estimates vary substantially. This, together with the evidence suggesting that the sGMM regressions are over-identified, seems to imply that a strong conclusion of the relationship cannot be drawn from the dataset as a whole.

Table 5.2 shows the results for ROA. The FM and wFM estimates again appear to be more upward biased than the OLS estimator. The *t-2* dGMM and sGMM return estimates within the WG-OLS band. The Hausman test indicates the existence of fixed effects. The *t-2* dGMM coefficient on the

[103] This is not too surprising since they do not control for fixed effects.
[104] It is worth noting that R&D intensity has been taken out of the *t-3* regressions since it only spans 3 years and hence would kill the t-dimension entirely. The estimates are hence not directly comparable.
[105] A point increase in the log of the Nikkeiscore is roughly equivalent to going from the bottom of the nikkeiscore (around 300) to the top (around 800). When reading the coefficients in what follows it is important to have this in mind and also the diminishing returns represented by the semi-log function, ln(700)-ln(600)<ln(500)-ln(400).
[106] When we consider the definition of Tobin's Q the point estimates on the dGMM estimators seem unreasonably large.

lagged dependent variable here appears more in line with the sGMM results[107]. Furthermore, the *t-2* sGMM still seems over-identified, as does the *t-3*. The *t-3* one-step sGMM estimate also falls outside of the WG-OLS band[108] and generally the *t-3* regressions return insignificant estimates. The *t-2* GMM estimates all return the expected negative first order autocorrelation, and no second order. The estimates on the Nikkeiscore and Nikkeiscore at *t-1* show broadly negative point estimates[109], which is as expected due to the direct costs of increasing environmental performance. The results for ROE are broadly similar to the results for ROA[110] (see table 5.3).

Due to the apparent biases of the dGMM estimators reflecting the persistence identified in the last chapter these are not reported in the following tables. The *t-3* sGMM is only reported when adding it removes apparent over-identification in the sGMM or it returns a significant estimate. Whilst the focus will be on the sGMM estimates, the OLS, WG, FM and wFM estimates are still kept for reasons of comparison.

5.2 Environmental performance: Leaders and Laggards

The motivation to divide the sample into leaders and laggards, apart from the

[107] This might reflect the fact the operating performance measures are less autoregressive. It is worth noting that the 1-step sGMM estimator here appears to be potentially slightly negatively biased, returning estimates below the dGMM.
[108] Since R&D intensity is not part of the independent variables in either regression here the estimates are directly comparable.
[109] This was highlighted in model 3 of chapter 3 which showed how environmental improvements often involve trading current costs for future benefits. To the extent that a positive effect exists, it seems we need a longer t-dimension than the one available here to explore this. Again note the apparent downward bias on the dGMM estimators.
[110] The main difference being that the Sargan test here accepts the *t-3* instruments, as opposed to the Dif-Sar which still rejects. Especially the one-step *t-3* coefficients seem improbably large however. The standard errors are large too.

need to achieve more homogenous sub-samples[111], is based on the findings of Guenster *et al* (2005) who report an asymmetrical relationship between environmental performance and Tobin's Q[112]. Constructing dummies based on whether firms' eco-efficiency ratings are high or low, they find that whereas their high eco-efficiency dummy fails to provide evidence that high eco-efficiency companies have higher Tobin's Qs, low eco-efficiency is significantly associated with lower Qs. This sort of relationship says little about causality, but could be seen to strengthen the hypothesis of an association between environmental performance and institutional advantages or good management. The table below shows mean Tobin's Q for the dataset as a whole, and firms whose Nikkeiscore is either below or above the sample average.

(Table 5.4) *Mean and SD of Tobin's Q for all data, leaders and laggards*[†]

Variable	**Tobin's Q**	
	Mean	SD
All data	1.119923	0.718488
Leaders	1.13115	0.7000228
Laggards	1.085936	0.7711587

[†]Leaders defined as strictly above mean of sample nikkeiscore, laggards as strictly below mean of sample nikkeiscore. Leaders and laggards could also have been defined as above and below sector sample means. This produces a slightly different sample (As it turns out yielding very similar empirical results). The nikkeiscores are constructed to be comparable across samples however, and this part of the analysis seeks to catch 'best (worst) practice' firms regardless of sector.

The table indicates that a similar situation as the one described by Guenster *et al* (2005) can be found in our dataset. Higher environmental performance firms seem to have somewhat higher Qs and lower environmental performance

[111] And the potential for rational differentiation as mentioned in chapter 3.
[112] Recall too Klassen and McLaughlin (1996) who found that stock price changes are more responsive to negative than positive news about a firm's environmental performance.

firms somewhat lower than the sample average. All scores are however well within one standard deviation of one another, so this is at best only indicative of a relationship.

What drives these differences is important however. Although the sample as a whole is large and diverse, it is possible that it reflects external factors giving for example some sectors both lower Tobin's Qs and lower environmental performance, without this saying anything of the causality between the one and the other. As of December 2003, the number of ISO 14001-certified plants in Japan was 13,416, surpassing second-placed UK's 5,460 (ISO 2004). The number of companies publishing environmental or CSR reports also increased from 169 in 1997 to 743 in 2003 (Japanese Ministry of the Environment, 2004). The data we analyse therefore consists of relatively clean companies operating in a relatively advanced environmental management environment. This means that the laggards we identify might not be laggards in a global context. It also means that the firms that are found to be laggards should have had the opportunity to improve their environmental performance had they wished to.

There is not enough variation amongst firms over time to create dummy variables for leaders and laggards and use them as controls in our regressions. Nevertheless, tables 5.5 and 5.6 show that for Tobin's Q there is a clear difference in the estimated coefficients on the Nikkeiscore depending on whether the regressions are run on a leaders or laggards sub-sample. For the leaders sub-sample the point estimates on the Nikkeiscore are positive, and

with the exception of the one-step *t-2* sGMM and the WG estimates, positive and significant[113]. The sGMM estimators also return weakly negative first order autocorrelation and for the *t-3* sGMM no second order autocorrelation[114]. The over-identification tests imply that the additional instruments are invalid however.

While not mentioned before, regressing y_{it}, where y_{it} represents the last observation in the time series, on $\Delta y_{i,t-1}$ and all further relevant lags offers an alternative way to explore the validity of the sGMM instruments[115]. This was done for the leaders sub-sample and the lagged instruments were found to be significant and valid. The fact that the sGMM estimator also returns a negative first order, and no second order autocorrelation, provides further evidence that it is reasonably well specified. All in all there is quite good evidence here that for the leaders sub-group, the effect of an increase in environmental performance on Tobin's Q is positive.

For the laggards sub-sample on the other hand the situation is less clear. Here most point estimates on the Nikkeiscore are negative[116] and the *t-3* one-step sGMM estimate negative and significant at the 10% level[117]. There is evidence of over-identification in all sGMM estimations. However, when the

[113] It is worth noting how much higher the two-step sGMM estimate is compared to the OLS, WG and one-step estimate. All the estimates share the same sign however.
[114] The m2 test is not available for the *t-2* sGMM due to the slightly different set of control variables.
[115] This regression will be referred to as '$y_{it} - \Delta y_{i,t-1}$' in what follows.
[116] Or weakly positive. The most positive point estimate is that of the *t-2* two-step sGMM. This estimation seems badly specified. It is potentially over-identified, outside the WG-OLS band and does not return negative first order autocorrelation.
[117] Remember that this uses slightly different controls.

‘ $y_{it} - \Delta y_{i,t-1}$ ’ regression discussed in the last section is run, the instruments are again found to be valid. Another point to note is that the sGMM estimations do not return a negative first order autocorrelation. It seems that all models are mis-specified to some degree in these regressions. However it is warranted to say that compared with the positive effects found in the leaders regressions, a neutral to negative picture emerges for the laggards. Whilst this does not explain Guenster *et al*’s (2005) finding that lower eco-efficiency is related to lower Tobin’s Q it is an interesting result. What we see is that for leaders, increasing environmental performance increases Tobin’s Q, but that this is not the case for laggards. This is theoretically hard to explain, as one might expect laggards to have more latent gains to make than leaders. One hypothesis might be that markets are more aware and trusting of environmental information coming from leaders[118], or that environmental performance information is more readily available for high performance than low performance firms. Another hypothesis might be that the markets expect there to be less gains from improving environmental management for firms that are historically low achievers, possibly because they do not expect the firms to have the institutional framework needed to exploit environmental profit opportunities[119]. The results above could be indicative of such effects, but while this might merit more investigation, it is clear that no grand conclusions can be drawn here. The finding is puzzling more than it is enlightening.

[118] Recall extension to model 1.

[119] These are obviously mere guesses. It seems to make some intuitive sense however that one might expect more gains from firms with a proven ‘environmental track record’. This also fits into last chapter’s discussions on cognitive institutions and Bleischwitz’s (2003) path dependency argument.

For ROA and ROE the results are presented in tables 5.7 to 5.10. The leaders' estimates here are more diverse but if we focus on the sGMM estimates these show negative effects of both Nikkeiscore at *t* and *t-1* on ROA and ROE, but with the estimates of Nikkeiscore at *t* on ROA being the only significant ones[120]. The coefficients on y_{it} all fall within the WG-OLS band and the m1 and m2 tests seem reasonable. Again, however, there is evidence of over-specification, but the '$y_{it} - \Delta y_{i,t-1}$' regression accepts the instruments. Interestingly the coefficients on the lagged Nikkeiscore are much smaller than the present, indicating a diminishing magnitude effect and rendering some support to the trade-off between current costs and future gains hypothesis.

For laggards the situations is roughly similar, but the point estimates here are of a much larger magnitude[121]. For ROA for example, the two-step sGMM Nikkeiscore at *t* estimate is -9.802*, indicating that an increase in the log of the Nikkeiscore of one point lowers ROA by 9.8%. For the laggards the similar coefficient is -15.384***. This corresponds well to the findings on Tobin's Q and it might be that the potential to cost-effectively improve environmental performance is lower for laggards than leaders. Perhaps initial investments include more large scale changes such as the introduction of new managerial structures or changes in machinery, which once in place enables the firm to better take advantage of other environmental opportunities. Again this is an interesting finding but based on the evidence it is more suggestive

[120] Note however the large standard errors of these regressions. These seem large for most regressions run on the operating performance measures in this analysis.
[121] Note also that the *t-2* sGMM instrument set is accepted for laggards, but that the two-step estimator for ROA, and both one-step and two-step for ROE, fail to return a negative first order autocorrelation. These estimates should hence be treated with a degree of caution.

than conclusive about such effects being part of a wider picture. Finally, seen in conjunction with the Tobin's Q results, indicating that markets view the environmental potential of leaders more positively than laggards, the findings might also reflect a degree of *ex ante* firm level differentiation on environmental quality. Firms better able to exploit green profit opportunities will invest, and become our leaders, while firms less capable become our laggards.

5.3 'Environmental impact'

This sub-sample contains sectors which were judged to have an environmentally intensive production. It includes chemicals, automotives, oil and rubber, steel, machinery and other manufacturing. This is where the clearest evidence of productive efficiency gains similar to those indicated in model 3 were hoped to be found[122]. Due to the efficiency gains rationale for analysing this sub-sample, only ROA and ROE results are discussed in the following. It is on operating performance such an effect would be directly felt.

Tables 5.11 and 5.12 report the results for ROA and ROE respectively. The results are somewhat encouraging. Whilst the sGMM instruments are still rejected[123], the required autocorrelation structure is returned for ROA and the one-step estimates for $y_{i,t-1}$ are within the WG-OLS band for both ROA and ROE. Whilst the point estimates vary a lot, there is some evidence in this sample of a positive relationship between Nikkeiscore at *t-1* and profits. For

[122] Model 3.2 also showed that the extra costs following increasing green performance are likely to be easier recaptured in the market when firms environmental impacts are larger.
[123] Although they remain valid in the '$y_{it} - \Delta y_{i,t-1}$' regressions.

ROA the one-step sGMM returns the weakly significant coefficient 4.213*. For ROE positive point estimates are returned for all estimates apart from the WG estimate. While the estimates vary, and significance is limited, we can say that from the evidence here it seems that for the high 'environmental impact' sub-sample, effects similar to those modelled in model 3 do exist. Increases in environmental performance might, with a lag, lead to higher profits.

5.4 'Consumer exposure'

Due to gaps in the dataset, only *t-2* GMM analysis is available for this sub-sample. Three industrial sectors make up the sample: foods, electronic equipment and automotives. These are the sectors where it was thought consumer pressures might be relatively more important. While it is clear that these divisions are very crude, and that other industries, such as the retail part of oil and rubber might also have a good claim to be part of the sample, it was thought that on a sectoral level the above three represented a bottom line of what should be included. The rationale for constructing a 'consumer exposure' sub-sample reflects the logic of models 1 and 2 which looked at the potential of consumers to affect a firms' environmental management outcome, linked to the much cited reputation driver of environmental performance. Since reputation is captured directly by Tobin's Q through increased intangible firm value only the potential link between Tobin's Q and the environmental indicator is discussed here. Table 5.13 summarises the results. We see that all the sGMM estimators are within the required range and that all the returned coefficients for the Nikkeiscore are positive. The one-step *t-2*

sGMM Nikkeiscore coefficient is also significant at the 10% level. While seemingly over-identified[124] this estimator returns a weakly negative first order autocorrelation. There is some evidence here to support the reputation rationale for investing in environmental performance. In consumer exposed sectors at least, it seems that the market reacts positively to increases in environmental performance.

5.5 Identifying the fixed effects: Environmental performance as a proxy for management quality?

This section attempts to explicitly investigate the firm specific institutional factors discussed in chapter 3. As argued in chapter 4, in a short *t* sample it might be plausible to assume these as approximately fixed and part of the η_i in the regression models. Table 5.14 shows the results for regressions run on estimated two-step sGMM fixed effects[125] from the Tobin's Q, ROA and ROE models, with Nikkeiscore at *t,* R&D intensity, total asset value and age of assets as control variables.

(Table 5.14) *Fixed effects*

Nikkeiscore in logs

Regression	Tobin's Q	ROA	ROE
Nikkeiscore	0.184**	2.855**	5.621***
(Adjusted) R^2	0.041	0.08	0.064

*** is significant at the 1% level, ** at the 5% level. All estimations based on robust standard errors.

[124] Again the '$y_{it} - \Delta y_{i,t-1}$' regressions report the relevant lagged levels as significant.

[125] The control variables in the regression used to obtain the fixed effects vary slightly from the normal set of controls, due to some of these being used in the later regressions run specifically on the fixed effects. Nikkeiscore, R&D intensity and age of assets are hence not part of the controls, and sales is replacing total asset value as a proxy for size. Fixed effects were also identified for models with slightly different sets of controls and the positive relationship still seemed to hold.

The latter three controls were included as they have been shown to be related to the Nikkeiscore in order to avoid simultaneity bias. R&D intensity and age of assets might also themselves in some ways be related to the fixed effects[126]. The results are both clear and significant. There is a strong positive relationship between environmental performance and fixed effects in these estimations. To the extent that these fixed effects include management quality or institutional responsiveness this hence goes quite far in terms of ascertaining that environmental performance might be a management quality proxy as argued by Guenster *et al* (2005), Innovest and others. The result might also be seen to support the claims made by Bleischwitz (2003), Blank and Daniel (2002) and others that good environmental management does reflect the ability of a firm to rise above unknown challenges. While this, due to the lack of any direct causality, might matter relatively little for a manager trying to increase profits, it is clearly of interest to an investor, so long as the fixed effects, whatever they are, are related to firm profitability. It is worth noting the low R^2 scores however, indicating that the controls used here explain relatively little of the overall variation in fixed effects.

Furthermore, before drawing any conclusion about good environmental performance as a proxy for good management we need to check whether there is a positive relationship between the fixed effects and the profitability estimators. Consequently, it might be appropriate to run a regression similar to the models discussed earlier in this chapter, but this time controlling for the fixed effects directly. Before running such a regression it is sensible to

[126] Whilst not reported in the table above the regressions show that age of assets is strongly and significantly negatively related to the fixed effects in this sample.

evaluate a bit further what the fixed effects are likely to be capturing. In a *T*=5 sample, which firm specific variables are likely to stay reasonably fixed? Should we *a priori* expect the fixed effects to capture good management, and hence expect increases in these effects to also increase profitability? What if one postulates that physical assets might be relatively fixed over a short time period? To the extent that older physical assets feed back into lower profitability a negative relationship might be expected. However, as already noted in a footnote, age of assets was shown to be negatively correlated with the FEs in these regressions, and so a positive relation between the FEs and profitability remains our *ex ante* expectation.

Table 5.17 shows[127] the result of normal OLS regressions run on the models for Tobin's Q, ROA and ROE.

(Table 5.15) *Fixed effects and firm profitability*

Regression	Tobin's Q	ROA	ROE
FE	0.673***	1.337***	0.785**
w1	0.879	0.058	0.779

*** is significant at the 1% level, all estimations based on robust standard errors. w1 is the Wooldridge test of serial autocorrelation.

As this table shows there is a significant and positive relationship between the fixed effects and the various performance measures. Whilst not reported above, the estimates on the environmental indicator are significant and around unity or weakly negative in the above regressions. This offers some further

[127] The results are based on pooled OLS regressions run on the performance indicators with FE as additional controls relative to earlier models.

support for our previous hypothesis that due to heterogeneity amongst sectors it would be unlikely to find an unambiguous link in the general sample.

5.6 Concluding the empirical analysis

This chapter has presented various panel data regression results from regressions run on Tobin's Q, ROA and ROE attempting to explore a link between these variables and environmental performance. It was hoped that by using modern panel data techniques, explicitly controlling for any fixed effects and instrumenting to mitigate other sources of endogeneity, the analysis would add to the existing literature by looking more directly at any causal relationship. In addition to this, we sought to establish, empirically, a link between environmental performance and managerial ability, as represented by the fixed effects.

The results were interesting. In the causal analysis no clear cut conclusions could be drawn from the regressions run on the entire sample. This was not too surprising. Following the theoretical discussions and models in chapter 3 we had established that the various effects potentially linking environmental performance and profitability are likely to be heterogeneously felt across sectors. For the regressions run on ROA and ROE another potentially constraining factor was the short time dimension of our sample, meaning that any positive effects of increased environmental performance might not have enough time to 'make itself felt'. We saw evidence of point estimates that diminished with time.

When the sample was broken into smaller sub-samples according to environmental leader- or 'laggardship', environmental impact and consumer exposure, a richer set of results emerged. Firstly, mirroring earlier findings by Guenster *et al* (2005) it seemed that environmental laggards have lower Tobin's Qs than environmental leaders. Moreover, in regressions run on leaders sub-sample the Tobin's Q regressions returned significant positive estimates: environmental performance seemed to be positively related to financial performance. No such clear picture emerged for laggards. Interesting too was to note, from the ROA and ROE sGMM regressions, that the magnitude of the instantaneous negative effect on operating performance for leaders appear to be about half that of laggards. This fact, combined with the above point that the market takes a more positive view of environmental investments made by leaders than by laggards, might imply that what we observe is 'rational' environmental quality product differentiation by firms, due to some having much higher costs of instigating performance enhancing measures than others.

For the environmental impact sub-sample it was hoped that we would see a less ambiguous link between the accounting based measures and gains following increased environmental performance. The link was hoped to be clearer here since the potential for eco-efficiency savings, as modelled in chapter 3, was expected to be more important[128]. This was the only sample analysed for this thesis where the *t-1* estimates on the Nikkeiscore were

[128] Model 2 also implied that the scope for consumer fall-outs due to environmental mismanagement might be lower here.

unambiguously positive[129] and so the eco-efficiency hypothesis came out strengthened. In this sub-sample the time dimension appeared sufficient to capture evidence of a lagged positive relationship between environmental and operating performance.

For the consumer exposure sub-sample too the results were interesting. This sub-sample sought to look more directly at the reputation rationale for going green. Here a range of positive, and for the one-step sGMM estimator, positive and significant, coefficients were returned. The fact that these estimates are returned in what is judged to be a more consumer exposed sub-sample seems to imply that here consumers might affect the environmental management outcome by 'creating' green profit opportunities. All in all the results from these two sub-samples seemed to complement and support some of the predictions of models 1, 2 and 3.

Finally the most definite findings of this empirical analysis came from the regressions conducted on the samples' fixed effects. The literature has presented good theoretical reasons why environmental performance might reflect some degree of firm specific institutional qualities, discussed in various detail in chapter 3. The literature has not however let the supposed existence of fixed effects be reflected by the choice of regression techniques used, let alone by attempts to identify the fixed effects and specifically establish a relation. This chapter did just that and, while noting the low R^2 scores, found the link to be positive and highly significant. It also found the fixed effects to

[129]Excluding the WG estimate for ROE. The ROA one-step sGMM was positive and weakly significant.

be positively and significantly linked to all performance measures. Whilst this says nothing about any causality between environmental performance and profitability it sheds some more light on a much discussed and interesting link, and provides a further rationale for why regressions techniques controlling for any fixed effects are appropriate in any attempt of causal analysis. In the absence of this, environmental performance might also proxy good management in the regression analysis – and so the direct effects of environmental performance per se are not captured.

Overall we can say that the empirical chapters have added some new evidence to the theories discussed in the previous chapters. However, mis-specification seemed to be part of the story in most regressions, and coefficients on the environmental estimators often varied strongly. Consequently, too strong overall conclusions cannot be drawn from this analysis. The results are indicative of many interesting relationships, but by no means conclusive.

The next chapter brings together and concludes the analysis of this thesis and presents some very broad policy recommendations.

Chapter 6

Conclusion

This thesis explored the much-debated link between good environmental management and corporate profitability. Although this was fundamentally an empirical project, the empirics built on a reasonably thorough theoretical discussion.[130] The following summarises the insights gained from the theoretical and empirical analysis, and presents some general policy implications of this study within the wider context of contemporary applied environmental economics.

6.1 Theoretical insights

Any investigation of environmental management would be significantly incomplete without consideration of the broader CSR literature, since environmental management in many ways are driven by the same strategic arguments as CSR more generally. The CSR literature indicates that increasingly, corporate success in modern society is enhanced by 'enlightened profit maximisation' (Jensen 2001). This includes exploring latent green profit opportunities. Therefore, a link between good environmental management and good cognitive corporate institutions could be expected — environmental performance might be a proxy for a firm's ability to meet more general new strategic challenges. The asset management firm Innovest's work in this area, also points in the proxy direction.

[130] This follows Vogel's (2004) call for empirical work based on testable theoretical relationships.

We examined two key rationales for the view that improved environmental performance leads to improved profitability — reputation and eco-efficiency. Three simple theoretical models were constructed to examine some important aspects of these rationales. Models 1 and 2 applied simple game theory to illustrate some of the issues involved in any reputation argument for increasing environmental performance. They indicate that the existence of green profit opportunities depends crucially on assumptions about environmental information asymmetries between firms' and consumers, the ability of consumers to credibly coordinate their actions to achieve a Pareto superior outcome and the actual environmental impact of a firm's production. This was taken to imply that any effects of environmental performance on overall profits was likely to be felt heterogeneously across firms, and supported empirical findings by Salo (2005). It also indicated that in any empirical analysis, care should be taken to divide the data into sensible sub-samples reflecting this heterogeneity. Model 3, the eco-efficiency model, yielded some interesting, if rather obvious, results. An intertemporal version of the model showed how environmental investment decisions might often trade current costs against future benefits and therefore that, *ceteris paribus,* a firms' investment in environmental performance might be related to the management's overall view of future earnings. We were again pointed in the direction of the 'environmental performance as a proxy' story.

6.2 Empirical results

The theorised link between environmental performance and managerial abilities or institutional quality had important implications for the empirical

analysis. It suggested that pooled OLS regressions would be biased due the correlation with the unobserved variables. We therefore decided to also run regressions controlling for these unobservables, which we assumed fixed in the short run. Later, the techniques used to control for the fixed effects bias allowed us to test for a link between environmental management and managerial ability directly.

Dynamic GMM methods have been developed to produce less biased estimators in this context. A dynamic model specification also allows the researcher to model serial autocorrelation of an unknown form, which can be useful, even when the parameter estimate on the lagged dependent variable is not of primary interest to a study. The dGMM and sGMM methods offer a way to control for other forms of endogeneity than that caused by the fixed effects, and so might further improve an attempt to do causal analysis[131]. The empirical chapters discussed the dGMM and sGMM methods in some detail, and also provided some useful tests and diagnostics which could be used to evaluate whether a given estimator seems reasonable or not.

The regression results presented in chapter 5 used models based on the above techniques[132]. Regression equations had been constructed for stock market and accounting based measures of corporate profitability. These different

[131] Recent critique by Koehler (2004) of the existing literature seemed to imply that to worry about endogeneity was appropriate. We feel that we have shown here, both theoretically and empirically, that there is a case for sGMM analysis to be applied in this context. It would be interesting to see the results of such methods used on other, more comprehensive datasets, for example using the Innovest Ecovalue21 indicator.

[132] And also for comparison, the FM and wFM techniques used by Guenster *et al* (2005). In our regressions these seem to have bad small sample qualities, which complements Skoulakis (2005) simulations. They also showed evidence of an upward bias.

measures are useful in various ways and both were employed here in order to achieve a more comprehensive analysis. With respect to control variables, this thesis 'played safe' and employed sets similar to the most recent (and advanced) literature.

The regression results were interesting. As the theoretical chapter had indicated, there was scant evidence of an overall effect affecting the sample as a whole. However, the sub-samples confirmed some expected findings, and also yielded some new insights. Similar to Guenster *et al* (2005) and Klassen and McLaughlin (1996) we found that any relationship between good environmental management and profits is asymmetrical, and affects leaders and laggards in different ways. In this sample, leaders seem more able to reap the benefits of good environmental management, and this is appreciated by the market.

By dividing the data into sectors deemed to be especially exposed to consumer pressures, or to have a particularly high environmental impact of production, we approached the reputation and eco-efficiency rationale directly. For the consumer exposure group, evidence of a positive link between the environmental performance indicator and Tobin's Q was found. For the environmental impact group there seemed to be a positive relationship between the accounting based measures and lagged environmental performance. All in all it was felt that the reputation and eco-efficiency rationales came out strengthened in this analysis.

Finally evaluating the fixed effects, the results showed a significant relationship between environmental performance and the estimated fixed effects of regressions run on all three performance indicators[133]. These fixed effects were also found to be positively correlated with firm profitability. To the extent that the fixed effects represent firm specific factors capturing the quality of management and institutions this supports the claim that environmental performance might be a proxy for deeper variables related to how well a firm is run. The fact that such a link seemed to exist also seemed to *ex post* strengthen the case for the use of the modern panel techniques in the causal regression analysis.

Overall this thesis has gone some way in ascertaining both a causal link between good environmental management and profitability, and also the proxy story, with a link between environmental performance and managerial quality. It has however also theoretically argued, and offered empirical evidence to support this, that such a link, rather than being general, and affecting all firms, is likely to be sensitive and specific to different production and strategic contexts.

Does being green increase profits?

Based on the evidence here, in some circumstances, the answer is yes.

[133] A low R^2 was however reported in all estimations.

6.3 Policy implications

This thesis has shown that one cannot automatically assume business to be taking strides towards a more environmentally 'conscious capitalism'. Environmental microeconomics cannot be fully understood outside the context of the tragedy of the commons and diverging social and private costs. The overarching goal of environmental microeconomic policy is to make firms pay the full social cost of their actions. This goal is generally best achieved through taxation or regulation[134]. When Friedman argues that the social responsibility of business is to maximise shareholder value, he is right, in the simple world of no externalities of production. However in a more realistic case the invisible hand might need some help, as markets are not efficient (Heal 2005).

Corporate, managerial decisions do exert externalities on the environment (Tirole 2001). Freeman and Liedka (1991) argue that a conversation about what a 'commons-sensitive' vision of capitalism might look like is a pre-condition for linking corporations and the 'good society'. As argued by Ruff (1970), however, there is no inherent link between 'greedy capitalism' and pollution[135]. In a market where all externalities are internalised, one might expect the capitalist to also be a conservationist.

As the models in chapter 3 showed, it is often the behaviour of customers

[134] Regulation or taxes would change the firms' benefits and costs of environmental investments and so could indeed induce various socially preferred outcomes. The risk of the government getting its regulation or taxation scheme wrong, is always considerable.

[135] And experience from the USSR, China and Eastern Europe provide ample evidence that non-market economies do not fare very well in terms of protecting the environment.

which eventually decide what is 'good for business' in terms of 'amounts of CSR'. It seems likely that both coordination problems and asymmetric information play an important role in determining the CSR outcome. This suggests that in order to utilise capitalism's powerful dynamism to set the world on track towards a more sustainable future, there might be a case for proactive government involvement to mitigate these coordination and asymmetric information problems, provided the transaction costs from doing so do not outweigh the social benefits. All in all it seems that a sensible combination of regulation and information, for example aimed at highlighting the full social costs of production, ensuring the quality of environmental reports, or standardising eco-labels, might be beneficial[136]. Since whether or not a firm exploits a profitable green opportunity might come down to a lack of appropriate physical and cognitive institutions, information and support directed at firms might also be relevant. In a recent paper, Heal (2005) offers a fresh view of CSR which he sees as having evolved as a response to market failures, 'a Coasian solution to the problems associated with social costs' (Heal 2005 : 1)[137]. Efficient Coasian outcomes are often blocked by high

[136] This same conclusion is reached by Cason and Gangadharan (2004) who in a pioneering behavioural experiment conclude that 'when it is difficult to determine the environmental quality of goods in a market, consumers may hesitate to pay higher prices for products that might be environmentally superior. In this scenario of asymmetric information, our laboratory results suggest that government regulators or non-governmental organizations can improve environmental performance by providing the option of certified green labelling' (Cason and Gangadharan 2002 : 129)

[136] Coasian since, to quote Heal (2005 : 7): 'in cases where costs are externalized, corporations bargain with society about who will ultimately bear these costs. The corporation is not – currently – legally bound to bear them but society could change this if it wished, and indeed could go further and impose penalties for the past externalization of costs. The result is an implicit contract: society accepts the legal status quo provided that the corporation does not exploit it to society's disadvantage.' Interestingly the *McKinsey Quarterly* for January 2006 report that global CEOs think the public will expect corporations to take a significant role in handling increasing socio-political pressures.

transaction costs. Also from this point of view, government intervention to improve transparency seems important.

To the extent that economics is a theory of scarcity, the free market economy cannot be expected to do much to solve environmental challenges until these challenges are firmly incorporated in the market. In a less complex world what is needed might be the enclosure of the commons. The merits of the privatisation of all environmental assets obviously provide enough material for a thesis in its own right.[138] It suffices to conclude here that to the extent that we are moving towards a more 'environmentally conscious' future, and this is reflected by increasing demands made by society on business, it is reasonable to assume that the returns to being green tomorrow might be higher than today[139]. Governments have an important supporting role to play as a provider of the information, regulation and incentives needed to create a society more geared at exploiting, and increasingly enhancing, green profit opportunities.

[138] Or rather several books in economics and political philosophy.

[139] That this is happening is argued by Esty (2005) who declares that 'the long term trend, in any country, is to implement the polluter pays principle and thus internalize externalities consistent with allocative efficiency and demands of justice' (Esty 2004 : 139) This view is shared by business too. As James E. Rogers CEO of Cinergy Corporation puts it in an interview with BusinessWeek: 'Forget the science debate. The regulations will change someday. And if we're not ready, we're in trouble.' (BusinessWeek 2005)

Additional tables

Table 5.1 - Tobin's Q and environmental performance

Environmental indicator in logs

Dep Variable	Tobin's Q									
Estimation	All data									
	OLS	WG	dGMM t-2	dGMM t-3	sGMM(1step) t-2	sGMM(2step) t-2	sGMM(1step)† t-3	sGMM(2step) t-3	FM	wFM
y_t-1	0.434***	0.082***	0.050	-0.242	0.304***	0.300***	0.577***	0.541***	0.575*	0.582*
	(.053)	(.068)	(.118)	(.257)	(.064)	(.120)	(.095)	(.135)	(.167)	(.167)
Nikkeiscore	**0.222*** **	**0.189**	**-2.062**	**-5.984*** **	**-1.010**	0.282	**0.092**	**0.393**	0.166**	0.169**
	(.066)	**(.193)**	**(2.036)**	(2.019)	(.645)	(.881)	**(.480)**	**(.610)**	(.029)	(.029)
Observations	637	637	295	708	637	637	1248	1248	637	637
m1	0.078	0.002	0.333	0.696	0.042	0.038	0.010	0.006		
m2	-	-	-	0.565	-	-	0.101	0.145		
Hausman	0.000	0.000								
Sar			0.135	0.764	0.000	0.000	0.000	0.000		
Dif-Sar					0.000	0.000	0.000	0.000		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar.†sGMM and dGMM with t-3 instruments do not use R&D intensity as control variable.

Table 5.2 - Return on assets and environmental performance

Environmental indicator in logs

Dep Variable	ROA									
Estimation	All data									
	OLS	WG	dGMM t-2	dGMM t-3	sGMM(1step) t-2	sGMM(2step) t-2	sGMM(1step) t-3	sGMM(2step) t-3	FM	wFM
y_t-1	0.211***	-0.023	0.094***	-0.694	0.086***	0.111	-0.065	0.039	0.318**	0.324**
	(.075)	(.035)	-15.647	(.174)	(.031)	(.116)	(.141)	(0.495)	(.078)	(.078)
Nikkeiscore	**0.395**	**-3.992*** **	**(12.098)**	**-19.699**	**-8.028**	**-3.680**	**-4.092**	**-5.369**	-0.002	0.065
	(1.239)	**(1.605)**	(12.099)	**(16.041)**	**(6.489)**	**(6.485)**	**(9.263)**	**(7.002)**	**(.660)**	**(0.666)**
Nikkeiscore_t-1	**-0.164**	**-1.657**	**-19.323*** **	**-20.005** **	**0.544**	**-1.877**	**-5.199**	**0.582**	**0.029**	**0.046**
	(1.285)	(1.572)	**(6.280)**	(8.841)	(4.789)	**(5.380)**	(7.094)	(5.932)	(.459)	(.442)
Observations	1046	1046	605	605	1046	1046	1046	1046	1046	1046
m1	0.000	0.001	0.001	0.510	0.000	0.001	0.128	0.001		
m2	0.773	0.187	0.321	0.936	0.455	0.572	0.198	0.247		
Hausman		0.000								
Sar			0.086	0.045	0.002	0.002	0.002	0.002		
Dif-Sar					0.000	0.000	0.000	0.000		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar

Table 5.3 - Return on equity and environmental performance

Environmental indicator in logs

Dep Variable	ROE									
Estimation	All data									
	OLS	WG	dGMM t-2	dGMM t-3	sGMM(1step) t-2	sGMM(2step) t-2	sGMM(1step) t-3	sGMM(2step) t-3	FM	wFM
y_t-1	0.118**	-0.163***	-0.056	-0.083	-0.079*	0.078	0.084	-0.069	0.139	0.140
	(.051)	(.044)	(.045)	(.085)	(.045)	(.277)	(.052)	(.057)	(.079)	(.077)
Nikkeiscore	**-2.428**	**-9.169****	**-82.076***	**-76.110**	**-6.931**	**-1.838**	**53.759**	**-2.201**	**-1.355**	**-1.503**
	(2.820)	**(4.119)**	**(42.470)**	**(77.536)**	**(22.760)**	**(304.325)**	**(57.825)**	**(26.112)**	**(2.192)**	**(2.157)**
Nikkeiscore_t-1	**3.365**	**-3.302**	**-78.076***	**-42.243**	**-11.402**	**-16.650**	**-77.355**	**-35.353**	**-3.302**	**3.407**
	(3.107)	(3.963)	(42.470)	(42.521)	(16.800)	(49.797)	(49.436)	(20.793)	3.966	(2.879)
Observations	1043	1043	603	601	1043	1043	1043	1043	1043	1043
m1	0.003	0.244	0.417	0.976	0.253	0.523	0.068	0.040		
m2	0.387	0.044	0.918	0.222	0.266	0.445	0.230	0.123		
Hausman		0.000								
Sar			0.102	0.621	0.010	0.010	0.366	0.366		
Dif-Sar					0.005	0.005	0.001	0.001		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar

Table 5.5 - Tobin's Q and environmental performance

Environmental indicator in logs

Dep Variable	Tobin's Q						
Estimation	Leaders						
	OLS	WG	sGMM(1step) t-2	sGMM(2step) t-2	sGMM(1step)† t-3	FM	wFM
y_t-1	**0.502*** **	**0.141***	**0.285*** **	**0.312*** **	**0.579*** **	**0.641** **	**0.643** **
	(.046)	(.080)	(.079)	(.108)	(.078)	(.140)	(.142)
Nikkeiscore	**0.283*** **	**0.102**	0.182	**1.475** **	**1.489** **	**0.212** **	**0.214** **
	(.109)	(.221)	(.785)	(.648)	(.684)	(.040)	(.040)
Observations	443	443	442	442	875	442	442
m1	0.077	0.008	0.097	0.087	0.015		
m2	-	-	-	-	0.220		
Hausman		0.000					
Sar			0.000	0.000	0.000		
Dif-Sar			0.000	0.000	0.000		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar. †sGMM with t-3 instruments do not use R&D intensity as control variable.

Table 5.6 - Tobin's Q and environmental performance

Environmental indicator in logs

Dep Variable	Tobin's Q						
Estimation	Laggards						
	OLS	WG	sGMM(1step)	sGMM(2step)	GMM(1step)	FM	wFM
			t-2	t-2	t-3†		
y_t-1	**0.337*** **	**0.086*** **	0.324***	**0.348*** **	**0.397*** **	**0.502**	**0.510***
	-0.071	(.023)	(.064)	(.075)	(.089)	(.178)	(.176)
Nikkeiscore	**-0.074**	**-1.873** **	**-0.175**	**0.486**	-1.564*	**0.032**	**0.030**
	(.274)	(.848)	(.659)	(1.452)	(.915)	(.068)	(.067)
Observations	195	195	195	195	470	195	195
m1	0.738	0.098	0.525	0.514	0.291		
m2	-	-	-	-	0.276		
Hausman		0.000					
Sar			0.029	0.029	0.002		
Dif-Sar			0.000	0.000	0.000		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar. †sGMM with t-3 instruments do not use R&D intensity as control variable.

Table 5.7 - Return on assets and environmental performance

Environmental indicator in logs

Dep Variable	ROA					
Estimation	Leaders					
	OLS	WG	sGMM(1step) t-2	sGMM(2step) t-2	FM	wFM
y_t-1	**0.405*** **	**-0.053**	**0.177*** **	**0.165**	**0.442*** **	**0.433*** **
	(.062)	(.046)	(.061)	(.114)	(.059)	(.061)
Nikkeiscore	**-0.766**	**-0.110**	**-10.593***	**-9.802***	**0.283**	**0.520**
	(1.676)	(1.594)	(6.100)	(5.788)	(1.606)	(1.683)
Nikkeiscore_t-2	**0.481**	**-0.936**	**-0.766**	**-0.859**	**-0.103**	**-0.148**
	(1.470)	(1.784)	(4.122)	(3.383)	(.688)	(.069)
Observations	698	698	698	698	698	698
m1	0.000	0.000	0.002	0.002		
m2	0.116	0.472	0.895	0.895		
Hausman		0.000				
Sar			0.016	0.016		
Dif-Sar			0.250	0.250		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar.

Table 5.8 - Return on equity and environmental performance

Environmental indicator in logs

Dep Variable	ROE					
Estimation	Leaders					
	OLS	WG	sGMM(1step)	sGMM(2step)	FM	wFM
			t-2	t-2		
y_t-1	**0.190****	**-0.073***	**-0.002**	**0.016**	**0.287***	**0.275***
	(.098)	(.037)	(.086)	(.606)	(.095)	(.097)
Nikkeiscore	**4.051**	**5.102**	**-14.533**	**-19.604**	**2.215**	**2.536**
	(5.026)	(3.990)	(20.785)	(152.433)	(2.532)	(2.631)
Nikkeiscore_t-1	**-0.870**	**-0.709**	**-8.047**	**-5.592)**	**0.390**	**0.468**
	(4.193)	(4.968)	(12.360)	(40.294)	(1.936)	(1.916)
Observations	694	694	694	694	694	694
m1	0.000	0.000	0.007	0.335		
m2	0.347	0.817	0.235	0.671		
Hausman		0.000				
Sar			0.008	0.004		
Dif-Sar			0.000	0.000		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar.

Table 5.9 - Return on assets and environmental performance

Environmental indicator in logs

Dep Variable	ROA					
Estimation	Laggards					
	RE	WG	sGMM(1step)	sGMM(2step)	FM	wFM
y_t-1	**0.150****	**0.017**	**0.054*****	**0.051****	**0.384***	**0.414***
	(.062)	(.028)	(.018)	(.020)	(.153)	(.158)
Nikkeiscore	**0.609**	**-15.027*****	**-17.807****	**-15.384*****	**-1.672**	**-1.861**
	(3.230)	(5.043)	(7.941)	(5.497)	(2.932)	(2.868)
Nikkeiscore_t-1	**-0.595**	**-5.027***	**-0.95**	**-0.926**	**-0.253**	**-0.238**
	(2.478)	(2.627)	(6.459)	(10.299)	(0.853)	(.828)
Observations	347	347	347	347	347	347
m1	0.061	0.009	0.061	0.124		
m2	0.591	0.219	0.567	0.496		
Hausman		0.000				
Sargan			0.166	0.166		
Dif-Sar			0.250	0.250		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar.

Table 5.10 - Return on equity and environmental performance

Environmental indicator in logs

Dep Variable	ROE					
Estimation	Laggards					
	RE	WG	sGMM(1step)	sGMM(2step)	FM	wFM
			t-2	t-2		
y_t-1	**0.116**	-0.470***	**-0.113**	**-0.092**	0.194	**0.218**
	(.062)	(.119)	(.073)	(.407)	(.130)	(.133)
Nikkeiscore	**-3.160**	**-51.742*** **	**-78.118*** **	**-38.180**	-5.962	**-5.631**
	(8.241)	(13.146)	(24.319)	(228.940)	(12.034)	(11.656)
Nikkeiscore_t-1	**2.834**	**-2.113**	**-9.759**	**-11.726**	-1.167	**-1.021**
	(7.140)	(7.504)	(22.932)	(115.948)	(4.925)	(4.753)
Observations	348	347	348	348	348	348
m1	0.069	0.214	0.460	0.745		
m2	0.405	0.091	0.365	0.879		
Hausman		0.000				
Sargan			0.310	0.350		
Dif-Sar			0.750	0.750		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar.

Table 5.11 -Return on assets and environmental performance

Environmental vairable in logs

Dep Variable	ROA					
Estimation	Environmental impact					
	OLS	WG	sGMM(1step)	sGMM(2step)	FM	wFM
			t-2	t-2		
y_t-1	**0.166*** **	**-0.005**	**0.083** **	**0.065**	**0.325** **	**0.324** **
	(.063)	(.027)	(.037)	(.106)	(.075)	(.073)
Nikkeiscore	**0.754**	**-1.509**	**-8.703** **	**-10.642**	**1.357**	**1.366**
	(1.084)	(1.490)	(4.394)	(7.150)	(.653)	(.628)
Nikkeiscore_t-1	**0.797**	**0.405**	**4.213***	**2.846**	**0.119**	**0.237**
	(1.094)	(1.387)	(2.627)	(1.959)	(.961)	(.952)
Observations	727	727	727	727	727	727
m1	0.001	0.002	0.000	0.014		
m2	0.238	0.123	0.160	0.202		
Hausman		0.000				
Sar			0.004	0.004		
Dif-Sar			0.000	0.000		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar.

Table 5.12 - Return on equity and environmental performance

Environmental variable in logs

Dep Variable	ROE					
Estimation	Environmental impact					
	OLS	WG	sGMM(1step)	sGMM(2step)	FM	wFM
			t-2	t-2		
y_t-1	**0.083***	**-0.184*****	**-0.083**	**-0.001**	**0.049**	**0.045**
	(.046)	(.070)	(.074)	(.977)	(.053)	(.052)
Nikkeiscore	**-0.202**	**-2.329**	**-15.688**	**-27.134**	**3.586**	**3.602**
	(2.781)	(4.356)	(15.685)	(206.179)	(3.443)	(3.305)
Nikkeiscore_t-1	**3.744**	**-0.135**	**7.278**	**9.522**	**2.027**	**2.377**
	(3.060)	(3.674)	(7.212)	(7.873)	(4.966)	(4.420)
Observations	724	724	724	724	724	724
m1	0.080	0.830	0.872	0.876		
m2	0.322	0.077	0.162	0.199		
Hausman		0.000				
Sar			0.001	0.001		
Dif-Sar			0.000	0.000		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar.

Table 5.13 - Tobin's Q and environmental performance

All controls treated as endogenous, all variables in logs

Dep Variable	Tobin's Q					
Estimation	Consumer exposure					
	OLS	WG	sGMM(1step)	sGMM(2step)	FM	wFM
			t-2	t-2		
y_t-1	**0.362*** **	**0.100***	**0.258*** **	**0.321** **	**0.583**	**0.586**
	(.084)	(.053)	(.088)	(.136)	(.248)	(.247)
Nikkeiscore	**0.246** **	**0.044**	**0.815***	**0.575**	**0.181**	**0.184**
	(.099)	(.340)	(.499)	(.461)	(.217)	(.217)
Observations	262	262	263	263	263	263
m1	0.090	0.012	0.082	0.066		
m2	-	-	-	-		
Hausman		0.000				
Sar			0.009	0.009		
Dif-Sar			0.000	0.000		

Note: Asymptotic standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1% level. OLS is the pooled OLS estimator, WG the within groups estimator, both robust. Windmeijer (2000) finite sample corrections are implemented for sGMM. m1 and m2 are Arrelano-Bond (1991) tests (where available) for first- and second order autocorrelation, asymptotically N(0,1). Hausman is Hausman test for random effects, H_0: variation not systematic. P-values are reported. Also for Sar and Dif-Sar.

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