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THE EFFECTS OF ENVIRONMENTAL REGULATION ON STOCK MARKETS: EVIDENCE FROM THE UNITED STATES AND CHINA

Master graduation thesis by
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Dedicated to Alessandra,

together in the past, now, and forever.

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This thesis further develops and extends the work underlying two working papers, by Dr. Ramiah, myself and Prof. Moosa (Ramiah, Pichelli and Moosa, 2012a and 2012b), whose content is fully included in this thesis. Particularly, chapters 2, 3 and 4 of this thesis are to be considered expressing the opinion of these three authors, even when not referenced.

I thank Prof. Moosa and Dr. Ramiah who have worked closely with me in this project.

Ramiah, Pichelli and Moosa (2012b) has been accepted for presentation at the 2013 Midwest Finance Association conference in Chicago, 13-16 March 2013.

I wish that our work will attain several further satisfying achievements.

Abstract

Since his election in November 2008, President of USA Barack Obama has been associated with environmental regulation as he repeatedly advocated the implementation of green policies. This has given birth to a heated debate on the economic and financial effects of regulation in general and environmental regulation in particular.

On the other shore of Pacific Ocean, since the late 1970s China has opened up its economy to the outside world and moved gradually away from a system of command economy to state capitalism. The "produce now, clean up later" growth model, which has been adopted since then, encourages rapid growth while overlooking the environmental consequences of such a policy. However, the alarming situation has put pressure on the Chinese government to seriously consider and legislate laws pertaining to environmental regulation.

The objectives of this study are several, concerning either United States or China. It examines:

a. the effect of green policy announcements in the US on the stock market as well as the international effect;
b. the effect of election of President Obama in 2008 on the US stock market as well as on the international markets;
c. the effect of Chinese environmental regulation announcements on corporate performance in the Chinese stock market.

This study aims to find out if environmental regulation affects the stock market by changing the level and structure of abnormal returns, as well as different sectors' systematic risk.

The results show that the announcement of US green policies has a major effect on stock markets as reflected in stock returns. Further, they show the presence of an "Obama effect".

About China, the evidence indicate the general neutrality of announcements of environmental regulation. This may be explained in terms of the lack of enforcement of this regulation.

Abstract – Italiano

Fin dalla sua elezione nel 2008, il presidente degli Stati Uniti d'America Barack Obama è stato associato all'introduzione di norme a favore dell'ambiente, poiché in precedenza aveva ripetutamente auspicato politiche più forti per la protezione ambientale. Ciò ha causato la nascita di un acceso dibattito circa gli effetti economici e finanziari della regolamentazione in generale e, nella fattispecie, di quella ambientale.

Dall'altra parte del Pacifico invece, la Cina ha continuato la sua transizione da un sistema di gestione centralizzata dell'economia ad un sistema capitalistico, iniziata a partire dagli anni '70. Il modello di crescita del "*produciamo oggi, ripuliamo domani*", adottato fin qui, stimola una rapida crescita senza preoccuparsi delle conseguenze in termini di impatto ambientale. Conseguentemente, l'allarmante situazione ambientale ha recentemente spinto il governo cinese a considerare la necessità di emanare norme ambientali più stringenti.

Gli obiettivi di questo studio sono molteplici e riguardano sia gli Stati Uniti che la Cina:

a. l'effetto degli annunci di politica ambientale negli Stati Uniti sui mercati azionari nazionali (US) e internazionali;
b. l'effetto dell'elezione del presidente Obama del 2008 sui mercati azionari nazionali (US) e internazionali;
c. l'effetto degli annunci di politica ambientale cinese sulle performance finanziarie dei titoli azionari sul mercato borsistico cinese.

Questo studio punta ad analizzare se le norme ambientali si ripercuotono sui mercati azionari attraverso un cambiamento del livello e della struttura degli extra-rendimenti e del rischio sistematico in diversi settori.

I risultati mostrano che le notizie riguardanti l'introduzione di politiche ambientali negli Stati Uniti presentano un effetto significativo sui mercati azionari, come mostrato dai rendimenti dei titoli azionari, insieme ad un "effetto Obama" occorso nel momento della sua elezione.

Per quanto riguarda la Cina, i risultati mostrano una generale neutralità del mercato agli annunci di politiche ambientali e viene ipotizzato che la ben nota mancanza di applicazione di tali leggi costituisca una possibile spiegazione.

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Introduction

"Few of us would want to live in a society without rules that keep our air and water clean; that give consumers the confidence to do everything from investing in financial markets to buying groceries. And the fact is, when standards like these have been proposed in the past, opponents have often warned that they would be an assault on business and free enterprise. We can look at the history in this country. Early drug companies argued the bill creating the FDA would "practically destroy the sale of … remedies in the United States." That didn't happen. Auto executives predicted that having to install seatbelts would bring the downfall of their industry. It didn't happen. The President of the American Bar Association denounced child labor laws as "a communistic effort to nationalize children." That's a quote. None of these things came to pass. In fact, companies adapt and standards often spark competition and innovation."

President Obama,
speech to the U.S. Chamber of Commerce,
February 7, 2010

Since his election in November 2008, President Obama has been associated with environmental regulation as he repeatedly advocated the implementation of green policies. This association has provided a lot of ammunition for Republican leaders to criticize him ever since he was elected as well as a topic that has been recurring in the Republican primaries in the run-up to the 2012 presidential election. He is associated with at least four green policy initiatives:

a. the *New Energy for America* plan as stated in his electoral program;
b. the announcement in November 2008 of the introduction of a cap and trade system on pollution emissions;
c. the clean energy funds announced in February 2009;
d. his proposal of new offshore drilling leases, following Gulf of Mexico oil spill disaster.

In the United States, a heated debate has been raging on the economic and financial effects of regulation in general and environmental regulation in particular. For example, the Republican critics of President Obama argue that regulation is hampering the recovery of the US economy, suggesting that "scrapping the rules" is what is needed for the economy to "spring to life" (The Economist, 2011a). In contrast with this opinion, Treasury Secretary Tim Geithner rejected the Republican view, refusing to accept the argument that "there's good evidence in support of the proposition that it's regulatory burden or uncertainty that's causing the economy to grow more slowly than any of us would like" (Eberly, 2011). Tea-Partiers, on the other hand, yearn for a president who would "chop away job-strangling regulation" (The Economist, 2011b).

On the other shore of Pacific Ocean, since the late 1970s China has opened up its economy to the outside world and moved gradually away from a system of command economy to state capitalism. The "produce now, clean up later" growth model, which has been adopted since then, encourages rapid growth while overlooking the environmental consequences of such a policy. Measures have been taken to boost the privatization of agriculture, the urbanization of rural population, the massive development of small-scale rural industries, and the ability to attract foreign direct investments. While the economic benefits of the policy shift have been enormous in terms of the reduction of poverty and the rise of China to the status of an economic super power, the environment has suffered equally massively as water pollution, air pollution and soil degradation, which started to pose serious threat to ecosystems and human health: "the scope and scale of China's miraculous economic growth are matched only by the nation's massive resource destruction and environmental degradation in the last two decades" (Qi, 2008). The seriousness of the situation and the role that can be played by environmental regulation in decelerating the pace of environmental damage have been revealed by studies of the effect of pollution on human health (Tanaka, 2010). The alarming health situation has put pressure on the Chinese government to consider seriously and legislate laws pertaining to environmental regulation. Mishra and Smyth (2012) refer to some evidence indicating that the Chinese government is "reconsidering the costs of unfettered emphasis on economic growth", arguing that "environmental protection is a cornerstone of China's commitment to more balanced economic growth". However, the question remains as to the economic and financial consequences of environmental regulation, particularly (in the case of China) the effects on growth and foreign direct investments flows. The proposition that environmental regulation seems to be a double-edged sword creates a policy dilemma.

The objectives of this study are several, concerning either United States or China. It examines:

d. the effect of green policy announcements in the US on the stock market as well as the international effect.
e. the effect of election of President Obama in 2004 on the US stock market as well as on the international markets.
f. the effect of Chinese environmental regulation announcements on corporate performance in the Chinese stock market, when performance is proxied by stock returns. The analysis tries to determine: (i) if in general environmental regulation has a negative impact on corporate performance; and (ii) if the effect of environmental regulation differs across sectors, in the sense that the effect is more pronounced on heavy polluters while environmentally-friendly industries may actually benefit from the regulation. The answer to the second question gives an indication as to the effectiveness of the underlying regulatory measure.

> While studies of environmental regulation in China are plentiful, no study deals with the effect on the stock market or corporate performance as proxied by stock returns (Ramiah, Pichelli and Moosa, 2012b). However, if environmental regulation affects growth, productivity, FDI, costs and revenues, it must also affect corporate performance. If also corporate performance is proxied by stock market returns, the announcement of new regulatory measures should affect stock returns.

This study aims to find out if environmental regulation affects the stock market by changing the level and structure of abnormal returns, as well as different sectors' systematic risk.

Chapter 1

Literature review

Chapter 1.1
Environmental regulation literature

The body of literature addressing environmental regulation is wide and it has been growing as environmental awareness and regulation itself affirm their importance in the worldwide sustainable development debate. However, it is noticeable that, even if it addresses to world-spanning discussion topics, most of literature in this field comes from United States. Consequently, it often analyzes general problems starting from data and evidence from Unites States. However, given the overwhelming presence of studies from the US in the literature, the importance and innovative content of US regulations and the importance of the US as contribution to world total pollution, this literature body assumes a manifest preeminence and proposes itself as a starting point to any other locally-focused further study.

In order to make the literature review in this thesis easy to handle with, it has been organized by topics, as below:

a. Brief introduction to different environmental debate’s aspects;
b. Environmental regulation and financial performance in stock markets;
c. Environmental regulation and labor demand;
d. Environmental regulation and productivity;
e. Environmental regulation and business locations decisions;
f. Environmental regulation and competitiveness.

1.1.1 Brief introduction to different environmental debate's aspects (Eberly, 2011)

Eberly (2011) addresses the question of whether regulatory uncertainty is a major impediment to job growth. According to him, two commonly repeated misconceptions are that uncertainty created by proposed regulations is holding back business investment and hiring and that the overall burden of existing regulations is so high that firms have reduced their hiring. If regulatory uncertainty was a major impediment to hiring right now, he argues that we would expect to see indications of this in one or more of the following: business profits; trends in the workforce, capacity utilization, and business investment; differences between industries undergoing significant regulatory changes and those that are not; differences between the United States and other countries that are not undergoing the same changes; or surveys of business owners and economists. As discussed below, Eberly (2011) posits that none of these data support the claim that regulatory uncertainty is holding back hiring.

1.1.1a Business profits

If regulation was a significant drag on business today, Eberly (2011) observes that we would expect to see profits constrained after recent regulatory reforms were passed into law. However, he reports that corporate profits as a share of gross domestic income have about recovered their pre-recession peak, and earnings per share in industries most affected by recent regulatory changes, such as energy and healthcare, have among the highest earnings per share of those in the S&P 500. Thus he remarks that this growth is inconsistent with a corporate sector held back by regulation.

1.1.1b Trends in workforce, capacity utilization, and business investment

If regulatory uncertainty was the primary problem facing businesses, Eberly (2011) argues that firms would prefer to use their existing capacity and current workers as much as possible, while avoiding building additional capacity until they are more certain about the contours of future regulation.

He further posits that if demand was strong but businesses were concerned about future regulations, they would increase the hours of the workers they already employ rather than hiring additional workers. After Eberly's (2011) research there is no evidence of this in the data: he reports that the average work week for private employees has been roughly flat for the past year. Similarly, he suggests that if demand were strong, firms could easily expand using existing capacity without taking on the cost and risk of added capacity. However, he reports that the share of total potential industrial output in use remains 3% below its long-run average. According to his reasoning, low capacity utilization is inconsistent with concerns about future regulatory risk, but aligns with weak demand holding back current production. At the same time, business investment has led economic growth over the last few years. Since the end of the first quarter of 2009, he reports that real investment in equipment and software has grown by 26%, that is about five times as fast as the economy as a whole. However, Eberly (2011) concludes that businesses would not increase investment if they thought that future regulation posed a threat to their ability to operate profitably.

1.1.1c Financial indicators

If regulatory uncertainty were having a significant impact on business performance, Eberly (2011) argues that we would expect this to be reflected in capital markets. However, he observes that financial indicators do not provide any evidence in favor of this hypothesis. As shown in Figure 1 (Eberly, 2011), corporate bond yields are low across a range of industries, thus he suggests that firms in industries facing greater regulatory risk, such as insurance and energy, are not being priced out of the market.

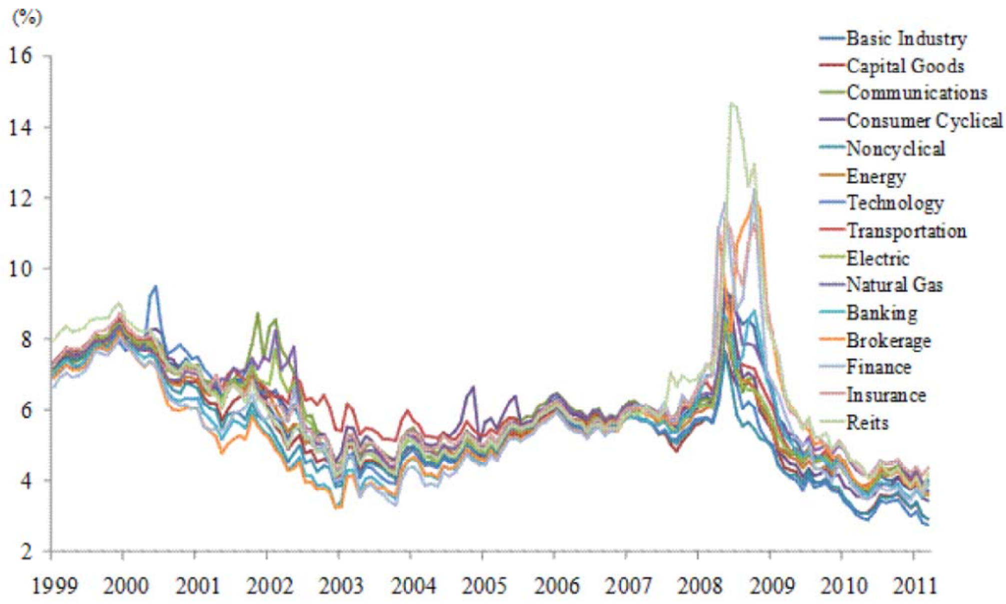


Figure 1: bond yields for selected industries

Source: Barclays investment grade corporate sub-indices, measured as yield to worst at the end of the month (Eberly , 2011)

One commonly cited measure of uncertainty is the Chicago Board Options Exchange Market Volatility Index (known as the VIX), which measures the implied volatility of S&P 500 index options. Eberly (2011) analyses the relation between VIX (for the US) and VDAX, the equivalent index for German stock market. He observes that the correlation between these two indicators suggests that uncertainty in both countries primarily reflects global financial and economic conditions, rather than conditions specific to the United States, such as regulatory changes.

1.1.1d Business owners and economists' opinion

Eberly (2011) reports that in recent surveys, business owners and economists do not list regulation as the main problem facing their business, nor do they blame regulation for job cuts.

1.1.2 Environmental regulation and financial performance in stock markets (Klassen and McLaughlin, 1996; Hart and Ahuja, 1996; Cohen and Fenn, 1997; Feldman, Soyka and Ameer, 1997; Dowell, Hart and Yeung, 2000; Dasgupta and Laplante, 2001; Dasgupta et al., 2004)

1.1.2.1 Klassen and McLaughlin (1996)

Klassen and McLaughlin (1996) posit that environmental management has the potential to play a pivotal role in the financial performance of the firm. They propose a theoretical model that links strong environmental management to improved perceived future financial performance, as measured by stock market performance. In their paper, the linkage to firm performance is tested empirically using financial event methodology and archival data of firm-level environmental and financial performance. Significant positive returns were measured for strong environmental management as indicated by environmental performance awards, and significant negative returns were measured for weak environmental management as indicated by environmental crises.

Environmental management encompasses all efforts to minimize the negative environmental impact of the firm's products throughout their life cycle (Klassen and McLaughlin,1996). Environmental performance measures how successful a firm is in reducing and minimizing its impact on the environment, often relative to some industry average or peer group (e.g., Investor Responsibility Research Center 1992). Many managers, however, view environmental management as compliance with environmental regulations, involving tradeoffs between environmental and economic performance (Walley 1994). Externalities, such as the costs of polluted air, are transferred back to the firm to achieve environmental improvement, thus raising operating costs and hurting profitability (Bragdon and Marlin 1972). However, some evidence links strong environmental performance to lower manufacturing costs, often by eliminating waste (Allen 1992, Schmidheiny 1992).

Klassen and McLaughlin (1996) report that earlier research on the linkage between firm-level social responsibility, of which impact on the natural environment is one dimension, and financial performance is mixed, although generally positively correlated (Arlow and Gannon 1982, Capon et al. 1990).

However, they observe that the direction of causality between higher profits permitting better social responsibility in the future, or strong social responsibility resulting in higher future profits, has been debated (McGuire et al. 1988). Klassen and McLaughlin (1996) provides a more general theoretical model linking environmental management within the firm to financial performance; several pathways are proposed that link investments in environmentally compatible products, processes, and management systems to greater corporate profits, either through market (revenue) gains or cost savings. In Klassen and McLaughlin (1996) the overall linkage is empirically tested using financial event methodology and archival data of firm-level environmental performance.

1.1.2.1a Linkage of social responsibility to firm performance – Previous literature review

The strategy literature highlights social responsibility, including environmental management, as an important corporate duty (e.g., Arlow and Gannon 1982). McGuire et al. (1988) provide a brief summary of three theoretical arguments for a relationship between social responsibility and financial performance which includes environmental performance:

a. management must effect a tradeoff between environmental and economic performance, and those firms that improve their environmental performance are at an economic disadvantage;
b. explicit costs of environmental management are minimal and generate other management benefits, such as higher morale or increased productivity;
c. although the costs of improving environmental performance can be significant, other costs are reduced or revenues are increased.

Klassen and McLaughlin (1996) report that researchers have used different measures for social responsibility, environmental performance, and financial performance. Survey-based perceptual measures, including environmental reputation, are often used to assess social responsibility (Alexander and Buchholz 1978). Based on a meta-analysis of previous financial research, Capon et al. (1990) have found a positive correlation between positive social performance and firm performance, although a number of individual studies indicate negative or no correlation (see Arlow and Gannon 1982 for another review). McGuire et al. (1988) found a greater positive correlation between social responsibility and historical, instead of future, economic performance.

Specific to environmental performance, poor external ratings of pollution performance had a significant negative impact on a firm's stock price, suggesting that the market's expectation of future profitability was altered (Shane and Spicer 1983). In a similar study, the disclosure of high expected future pollution abatement expenditures caused a negative market reaction, while low expected future expenditures had little effect (Stevens 1984).

1.1.2.1b Klassen and McLaughlin's environmental management model

Klassen and McLaughlin (1996) posit that corporate strategy determines the environmental orientation of the firm, as showed in Figure 2.

Environmental management, in turn, is one significant component of functional strategies, particularly operations. As one integrative element of corporate strategy, environmental management affects environmental performance, some of which becomes public knowledge-observed and evaluated directly by the marketplace. Further, Klassen and McLaughlin think that environmental management affects both structural and infrastructural components as it involves choices of product and process technology and underlying management systems (Figure 3).

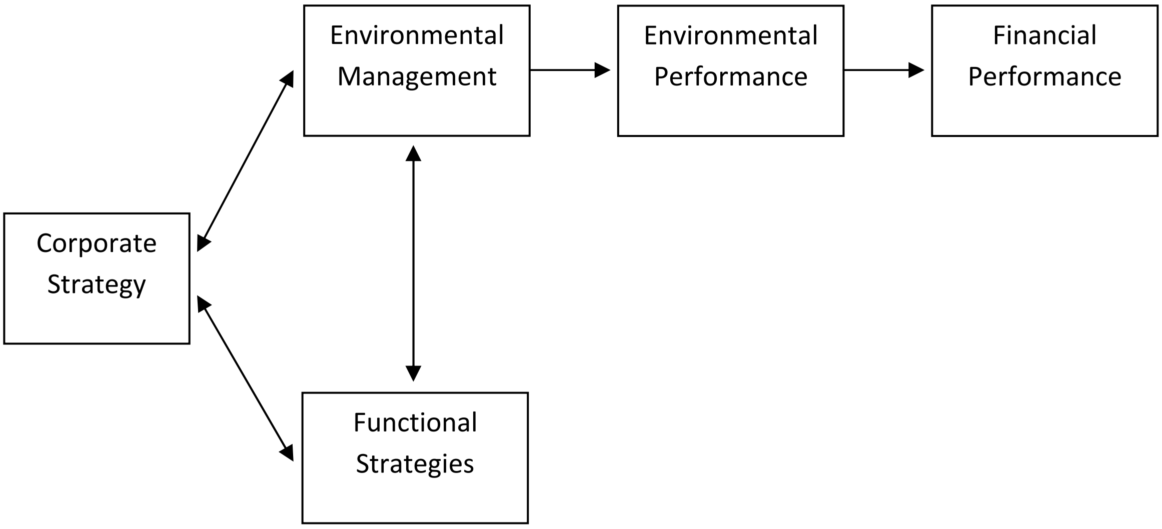


Figure 2: Model of the Linkage between Strategy, Environmental Management, and Firm Performance (Klassen and McLaughlin, 1996)

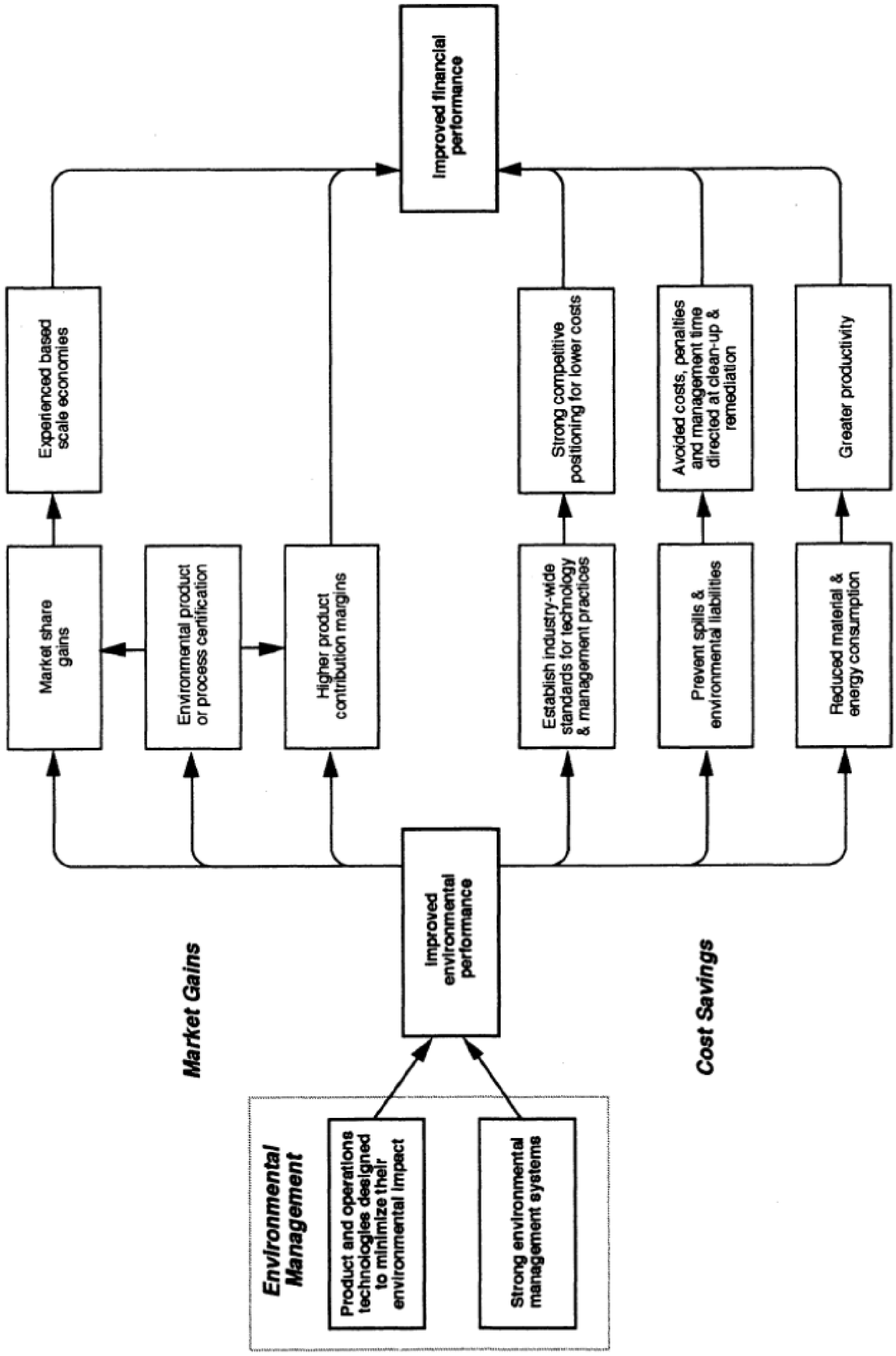


Figure 3 – Linkage of environmental management to firm profitability (Klassen and McLaughlin, 1996)

Total quality management in operations management provides a striking parallel with environmental management (Klassen and McLaughlin 1993). The Klassen and McLaughlin's model parallels several linkages between quality management and firm performance (Garvin 1984). However, although effective quality management has been linked to higher profits (Capon et al. 1990), similar evidence has been lacking for environmental management. The financial performance of the firm is affected by strong environmental performance through both market (revenue) and cost pathways. On the revenue side, customers are showing preferences for environmentally oriented companies (e.g., Rosewicz 1990). On the cost side, firms that invest heavily in environmental management systems and safeguards can potentially avoid future environmental spills, crises, and liabilities. Costs resulting from materials waste and inefficient processes also are minimized (Schmidheiny 1992). Because environmental requirements are often based on best available technology, an industry leader could gain competitive advantage by establishing the industry standard and creating a potential barrier to entry (Barrett 1992, Chynoweth and Kirschner 1993).

Klassen and McLaughlin (1996) investigates empirically the proposition – naturally following from their model - that strong environmental performance positively affects the financial performance of the firm, and conversely, weak environmental performance has a negative effect.

Klassen and McLaughlin (1996) observe that the relative importance of the cost pathways (Figure 3) can be expected to vary to some extent by the level of interaction between the firm and the natural environment (pollution intensity). Thus the financial markets may be expected to react differently to industries that historically are viewed as environmentally "clean" or "dirty." They provide the example that indications of improved environmental performance for firms in dirty industries, such as petroleum, may be treated with skepticism, leading the financial markets initially to reward strong environmental performance only in clean industries. On the other hand, because environmental compliance costs are much larger for environmentally dirty industries, greater cost savings could accrue to the firm from resource conservation, crisis prevention and the establishment of new competitive barriers (industry-wide technology standards). Therefore they argue that the high level of environmental impact in dirty industries might lead to a stronger association between strong environmental performance and financial performance. Klassen and McLaughlin (1996) also test whether environmental management is becoming an increasingly important dimension of firm management and operations strategy, through the fact that strong environmental performance is increasingly valued by financial markets.

Klassen and McLaughlin (1996) study environmental events because they are a public signal of a firm's cumulative performance and positioning for future performance, and the event (firm and date) is an operational variable. Admittedly, any award or crisis is a single discrete event, whereas environmental performance is the outcome of a longer term pattern of decisions by management.

Klassen and McLaughlin (1996) empirical evidence supports the overall linkage hypothesized by their model. They document significant positive abnormal stock returns following positive environmental events, highlighting the perceived value of strong environmental performance. Klassen and McLaughlin report that the marketplace rewarded firms that received awards for investing in areas such as new or redesigned products and processes that minimized their adverse environmental impact, improved their environmental safety systems, and developed strong management programs. They further observe that analysis of firm-level emission and compliance ratios indicated that cost pathways related to the reduction of hazardous emissions were particularly important. Their additional analysis on a subsample of manufacturing firms using other objective measures of environmental performance gave some evidence that financial markets incorporate the cumulative effect of environmental performance into their evaluation of the firm.

Klassen and McLaughlin (1996) further observe that first-time awards to firms in historically dirtier manufacturing industries had lower returns, possibly because the evaluation of performance was greeted with skepticism. Significant negative returns were documented for environmental crises, adding further empirical support for a causal link between environmental and perceived future financial performance.

1.1.2.2 Hart and Ahuja (1996)

Hart and Ahuja (1996) examine the relationship between emissions reduction and firm performance in S&P500 firms using two databases (environmental performance and emissions reduction measures) derived from the Investor Responsibility Research Center' s (lRRC) Corporate Environmental Profile.

Hart and Ahuja's (1996) results suggest that it does pay to be green. Efforts to reduce emissions through pollution prevention appear to drop to the bottom line within one to two years after initiation, according to Hart and Ahuja (1996). They observe that operating performance (ROS, ROA) is significantly benefited in the following year, whereas it takes about two years before financial performance (ROE) is affected. These are general findings based on a sample drawn from a broad range of industries; they find that the results are even more significant for particular industries where emissions and effluents are especially salient. They provide some arguments about longer lag between emissions reduction and impact on ROE; at least two factors could explain this result:

a. ROE reflects not only operating efficiency, but also the capital structure of the firm. The impact of emissions reduction on ROE thus works through its effect on ROS and ROA with capital structure as a confounding factor. Hence a relationship that is less immediate than that between emissions reduction and ROS/ROA is not particularly surprising for Hart and Ahuja (1996).
b. The environmental profile of a company is known to have an effect on its liability exposure, reputation and market value (Barth and McNichols, 1993; White, 1995). Poor environmental performance may thus affect the firm's cost of capital. According to Hart and Ahuja (1996) this 'cost of capital' effect is likely to affect the ROE with a longer lag than the direct effect through ROS and ROA as it requires that the market becomes aware of the firm's environmental performance and reflects this in the cost of capital and that the firm raises capital at this new cost level.

1.1.2.3 Cohen and Fenn (1997)

Also Cohen and Fenn's (1997) study reports on a data set detailing the environmental performance of the Standard and Poor's 500 companies. They construct two industry-balanced portfolios and compare both accounting and market returns of the "high polluter" to the "low polluter" portfolio. They also examine the stock market reaction to new information on the environmental performance of individual firms, and provide a preliminary analysis of which comes first - good financial performance or good environmental performance.

Cohen and Fenn (1997) address the question of whether a company that strives to attain good environmental performance gains advantages over competitors, or if environmental performance is just an extra cost for these firms. They observe that answers to these questions have important implications for the role that corporations can be expected to play in promoting pollution reduction efforts and the use of cleaner technologies, and that, historically, investments by corporations in environmental protection measures have tended to be viewed as a drag on financial performance. In recent years, this premise has come under increasing attack, however, not only by environmental advocates, but also by important business and academic leaders and investors. The notion that environmental performance is an important component of competitive advantage has found acceptance by a growing number of corporate leaders over the last several years (See Porter (1995) and a critique by Palmer, Oates and Portney, 1995).

Although they admit there are many ways in which one could compare environmental and financial performance, their paper is concerned with whether or not "green investing" provides a positive financial return relative to a more neutral investing strategy. Cohen and Fenn (1997) define green investing to be investing in companies that are the environmental leaders in their respective industries. This would allow for investing in oil and chemical companies and firms in other heavy polluter industries.

Cohen and Fenn (1997) construct two "portfolios" consisting of the "low pollution" and "high pollution" firms in their respective industries. A dummy variable was constructed equal to 0 if that firm's environmental measure was below the median for its industry group, and 1 if its measure was higher than the median. Cohen and Fenn's (1997) main finding is that the "low pollution" portfolio does as well as - and often better than - the "high pollution" group. They say it is important to state at the outset, however, that any relationship that is found does not necessarily imply the direction of causation. For example, a finding that good environmental performance is correlated with high earnings does not necessarily mean that firms who improve their environmental performance will also improve their earnings. They suggest that it is possible that causation runs the other way - that firms are good environmental citizens because they are strong financially and are able to afford to be good citizens. Put differently, high polluter firms might simply be those who cannot afford to comply. On the other hand, Cohen and Fenn (1997) suggest that the fact that greener firms are doing as well or better than their more polluting counterparts may be due to the fact that firms with more efficient manufacturing processes also pollute less.

Based on Cohen and Fenn's (1997) finding, one could construct a well-balanced portfolio that tracked the S&P500 index and included only the environmental leaders in each industry category. Such a portfolio would be expected to meet or exceed the market returns of the S&P500.

1.1.2.4 Feldman, Soyka and Ameer (1997)

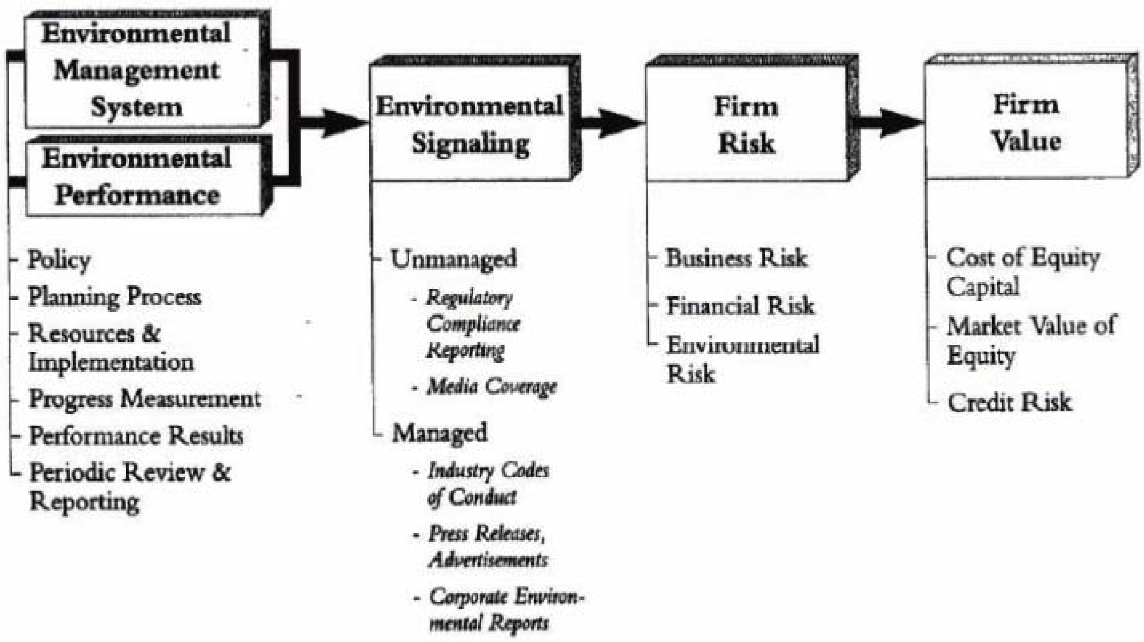
Also Feldman, Soyka and Ameer (1997) address the question of whether improving a firm's environmental management system and environmental performance results in a higher stock price. Their results suggest that adopting a more environmentally proactive posture has, in addition to any direct environmental and cost reduction benefits, a significant and favorable impact on the firm's perceived riskiness to investors and, accordingly, its cost of equity capital and value in the marketplace. Their results strongly suggest that firm's that improve both their environmental management system and environmental performance can increase their stock price by as much as 5%.

Perhaps more interesting and innovative, Feldman, Soyka and Ameer (1997) propose a conceptual model to describe how improving environmental management impacts indirectly the firm value, in order to suggest a possible argument to theoretically support their findings.

Feldman, Soyka and Ameer's (1997) model links the evaluation of corporate environmental management systems and environmental performance to the market value of publicly traded corporations. The model has five components and it is represented in figure 4:

a. Corporate environmental management systems;
b. Environmental performance;
c. Environmental signaling;
d. Firm risk, including environmental risk;
e. Firm value, including shareholder wealth gains (or losses) ranking from changes in environmental risk.

Figure 4 Schematic representation of Feldman, Soyka and Ameer's (1997) model



The Feldman, Soyka and Ameer's model framework indicates that, in order to obtain the benefits of greater shareholder wealth gains, the firm must improve its environmental management system and/or performance. Improvements are then made public through a series of targeted environmental communications to all stakeholders, but specifically to the financial community. This information becomes the basis for the financial community to assess the extent to which the firm's environmental risk profile has improved. If the assessment is positive, the firm will experience a lower cost of capital because it has become less risky overall. Because a lower cost of capital means that investors are willing to pay more for the firm's future cash flows, its stock price will rise, and shareholder wealth will increase. How much the firm's stock price actually rises will depend on the size of the investment necessary to improve the firm's perceived environmental risk and the magnitude of the resulting risk reduction. Shareholders also benefit when the firm's environmental performance continues to improve over time because of the upgrades to its environmental management system. Once this outcome is clearly signaled to the investment community, another increase in share price should result because there is clear evidence that the firm's environmental risk (i.e., the probability of one or more adverse outcomes) has been further reduced.

1.1.2.5 Dowell, Hart and Yeung (2000)

Dowell et al. (2000) identify the following benefits of environmental regulation:

a. the cost savings associated with lower environmental standards may be exaggerated and may not even exist;
b. when firms make new investments they may find it more costly not to adhere to higher environmental standards;
c. firms can reduce pollution by making changes in the production process rather than by incurring direct costs;
d. some fringe benefits may be associated with adhering to high environmental standards such as heightened employee morale and hence productivity.

For all of these arguments, Dowell et al. (2000) suggest that "the relationship between corporate environmental standards and firm value is an empirical question".

Dowell et al. (2000) also show that firms with strong environmental management practices produce higher stock returns than firms with poor

practices, after an environmental disaster. They interpret these results to mean that "investors expect that firms incur trivial costs for environmental cleanup and that these costs are lower for firms with better environmental records". Dowell et al. (2000) also observe that a recognition of environmental performance has a positive reputational effect that boosts firm value. They also point out that the positive reputational effect may include not just investors' impression of a firm's environmental performance but also investors' impression of a firm's management ability.
Dowell et al. (2000) analyze the global environmental standards of a sample of U.S. multinational corporations and find that those adopting higher environmental standards have much higher market values as measured by Tobin's q (market value over replacement costs of tangible assets). A policy implication of their findings is that developing countries that use lax environmental regulation to attract foreign direct investment may end up attracting poor-quality firms.

1.1.2.6 Dasgupta and Laplante (2001), and Dasgupta et al. (2004)

It is generally said that firms in developing countries do not have incentives to invest in pollution control effort because of weak implementation of environmental regulation: compliance costs exceed expected benefits. (D. O'Connor, 1995) However, this argument assumes that the environmental regulator is the only agent that can penalize firms lacking pollution control effort (see Afsah S., B. Laplante, and D. Wheeler, 1996; Blackman A. and G. J. Bannister, 1998; Pargal S. and D. Wheeler, 1996).
Dasgupta and Laplante (2001) criticize the argument remarking that it ignores that capital markets may react negatively to the announcement of adverse environmental incidents (such as violation of permits, spills, court actions, complaints) or positively to the announcement of superior environmental performance. They observe that, when accounting solely for regulators' fines and penalties and ignoring the costs that may be imposed by communities and markets, the expected costs associated with poor environmental performance may be significantly underestimated. Hence, the

inability of formal institutions, especially in developing countries, to provide incentives for pollution control effort via the traditional channel of fines and penalties may not be as serious an impediment to pollution control as generally argued. Thus, they argue that communities and capital markets, if properly informed, may in specific circumstances provide the appropriate reputational and financial incentives.

Dasgupta and Laplante (2001) suggest that the impact of firm-specific environmental news on market value may work its way through various channels: a high level of pollution intensity may signal to investors the inefficiency of a firm's production process; it may invite stricter scrutiny by environmental groups and/or facility neighbors; or it may result in the loss of reputation, goodwill, and the like. On the other hand, they suggest that the announcement of a good environmental performance or of the investment in cleaner technologies may have the opposite effect: lesser scrutiny by regulators and communities including the financial community, and greater access to international markets, among other things (see Michael E. Porter and C.Van der Linde, 1995; S. Konar and M.A. Cohen, 1997). Dasgupta and Laplante (2001) assess whether or not capital markets in Argentina, Chile, Mexico, and the Philippines react to the announcement of firm-specific environmental news. Dasgupta and Laplante show that capital markets react negatively to citizens' complaints targeted at specific firms, while they react positively to the announcement of rewards and explicit recognition of superior environmental performance. They suggest a policy implication from the current analysis: environmental regulators in developing countries may explicitly connect those market forces by introducing structured programs of information release on firms' environmental performance and empower communities and stakeholders through environmental education programs.

Dasgupta and Laplante (2001) conclude that despite a generally acknowledged poor enforcement of environmental regulations, capital markets in Argentina, Chile, Mexico and the Philippines appear to react to the announcement of specific positive and negative environmental events. While fines and penalties used by the environmental agencies of these countries may have fallen short of creating incentives for pollution control, they observe that capital markets have penalized firms which are the objects of citizens' complaints and rewarded firms which have obtained the explicit recognition of superior environmental performance. In another paper, J. Foulon, P. Lanoie and B. Laplante (1999) have shown that public disclosure may indeed complement a strong enforcement of environmental regulation.

In another different paper Dasgupta et al. (2004) analyze the public disclosure program that the government of Korea has actively implemented to inform citizens of the fact that some large companies in Korea are not complying with Korean environmental laws and regulations. Perhaps contrary to expectations that capital markets in developing countries may not reach to such news, Dasgupta et al. (2004) find that investors on the Korean Stock Exchange do in fact strongly react to the disclosure of such news. The average reduction in market value was estimated to be much higher than the estimated changes in market value for similar events in Canada and the United States, and of a similar magnitude as observed changes in other developing countries (Argentina, Chile, Mexico and Philippines). They further show that the larger the extent of coverage by newspapers, the larger the reduction in market value, reaching above 35% for those events covered by 5 or more newspapers.

1.1.3 Environmental regulations and labor demand (Berman and Bui, 2001a; Morgenstein et al., 2002; Cole and Elliott, 2007; Shapiro and Irons, 2011)

1.1.3.1 Berman and Bui (2001a)

Berman and Bui (2001a) report that after the come into force of the 1997 national ambient air quality standards, the main perceived cost of regulation is the loss of employment, an issue that was often present in policy debates on environmental regulation in US. Fears of an inter-regional 'race to the bottom' in setting lax environmental regulations to avoid local job loss was one reason for the establishment of the US Environmental Protection Agency (EPA).

Berman and Bui (2001a) observe that estimating the effects of environmental regulation is difficult for a number of reasons. Some studies have estimated the effects of regulation by regressing outcomes on measured abatement activity (see for example, Gray and Shadbegian,1993). According to Berman and Bui this approach is confounded by selection bias and measurement error: plants that can abate at low cost are likely to have the smallest employment effects and are most likely to abate voluntarily — without the impetus of regulation. They think that this selection effect will bias estimates of the effects of induced abatement on employment, making abatement appear less costly than it actually is. Further, Berman and Bui (2001a) posit that measurement error in abatement costs is likely to bias estimated effects toward zero because of attenuation bias. Their solution to these estimation problems is to gather detailed micro data on local air pollution regulations in a specific region of the country and to construct relevant treatment and comparison groups for each industry affected by the concerned local air quality regulations. By doing this, Berman and Bui construct comparison groups to represent the counterfactual in which treated plants are not subject to local air pollution regulation.

Berman and Bui's (2001a) innovation is in directly estimating the effects of local air pollution regulations using a quantitative approach that includes comparison plants in the same precisely defined industry.

Berman and Bui (2001a) exploit three dimensions of variation — across regions, industries, and time — to estimate the effects of local air quality

regulation on labor demand, constructing a sample including both plants in the South Coast (California) subject to changes in local regulation and plants in the same industries in other regions of the US (the comparison plants).
They find that while regulations do impose large costs they have a limited effect on employment. The employment effects of both compliance and increased stringency are fairly precisely estimated zeros, even when exit and dissuaded entry effects are included. They report point estimates of the cumulative effect of 12 years of air quality regulation from 1979–1991 vary according to the comparison regions used, from 2600 to 5400 jobs created, with standard errors about the size of the estimates. Point estimates based on the quintennial Census (which allow for entry and exit of plants, long term response and include 1992 regulations as well) vary more with comparison groups, from 9600 jobs lost to 12 300 jobs gained. Berman and Bui (2001a) observe that these are very small effects in a region with 14 million residents and about 1 million manufacturing jobs. The large negative employment effects alluded to in the public debate (Goodstein, 1996) can clearly be ruled out, in Berman and Bui's opinion.

They argue that small employment effects are probably due to the combination of three factors:

a. regulations apply disproportionately to capital-intensive plants with relatively little employment;
b. these plants sell to local markets where competitors are subject to the same regulations, so that regulations do not decrease sales very much;
c. abatement inputs complement employment.

However, the strict and sometimes innovative approach to environmental regulation in the South Coast has been copied by other regions in their attempts to comply with the national ambient air quality standards. (Berman and Bui (2001a).

1.1.3.2 Morgenstein et al. (2002)

Morgenstein et al. (2002) observe that most previous attempts to measure net employment effects have depended on aggregate industry data or anecdotal evidence. In their opinion, such approaches make it difficult to separate the effect of environmental regulation from other differences that exist across industries and changes that occur over time. Morgenstein et al. (2002) use detailed Census data, with a six-year panel of data on plant-level prices, inputs (including labor), outputs, and environmental expenditures, to estimate the structure of production and its dependence on environmental expenditures. Their approach differs from previous empirical work in this area by coupling a structural model of production, estimated with detailed plant-level data, with an aggregate model of demand, estimated from industry-level time-series data. The detailed plant-level data allow us to control for many potential confounding variables, including any that are fixed either at a particular plant or in a particular year (using plant and time dummy variables).

Morgenstein et al. (2002) separately analyze four heavily polluting industries: pulp and paper, plastics, petroleum, and steel.

In plastics and petroleum, they find that increased regulation raises employment by a small but statistically significant amount: respectively 6.9 and 2.2 jobs per million dollars of regulatory expense. In pulp and paper and steel, the estimates are smaller and insignificantly different from zero; the average across all four industries has a 95% confidence interval of between 2.8 jobs lost and 5.9 jobs gained per million dollars of regulatory expense.

On the production side, Morgenstein et al. (2002) propose two arguments for increased employment:

a. environmental regulation raises production costs: as production costs rise, more input, including labor, are used to produce the same amount of output. They call it the cost effect;
b. environmental activities may be more labor intensive than conventional production. For example, cleaner operations may involve more inspection and maintenance activities, or reduced use of fuel and materials. In both examples, the amount of labor per dollar of output will rise. They call this effect as the factor-shift effect.

However, they observe that this second argument can go the other way: cleaner operations could involve automation and less employment (Porter and Van der Linde, 1995).

Morgenstein et al. (2002) conclude that, given the $4.9 billion increase in regulatory expense and 632,000 job decrease in manufacturing employment from 1984 to 1994, these estimates suggest that, at most, environmental regulation accounted for 2% of the observed decline in employment over this 10 year period.

1.1.3.3 Cole and Elliott (2007)

Cole and Elliott (2007) apply to the UK previous research methods about the job and environmental regulations relation, proving the first example of analysis for a country outside the US. They observe that environmental regulations in the UK, like those of most other developed economies, have become increasingly stringent since the British Clean Air Acts of the 1950s and 1960s. A clear benefit of these regulations has been a steady reduction in air and water pollution emissions. For example, over the period 1980 to 2003, UK emissions of sulphur dioxide, carbon monoxide and lead fell by 79%, 70% and 98%, respectively[1] However, such obvious environmental gains come at a cost. Cole and Elliott (2007) report that total environmental protection expenditure by UK industry in 2003 was £3.4 billion, equivalent to 0.6% of industry revenue and that the distribution of this expenditure is very uneven with the greatest burden falling on the traditional heavy industries such as Basic Metals, Chemicals and Chemical Products, and Pulp and Paper, industries that have also faced significant competitive pressures in recent years. The Confederation of British Industry (CBI), for example, has repeatedly expressed its concern regarding the impact of UK environmental regulations on employment and competitiveness. Indeed, the Director

[1] Convention on Long-Range Transboundary Air Pollution, EMEP data from http://webdab.emep.int .

General of the CBI, Sir Digby Jones, accused the UK government of "sacrificing UK jobs on the altar of green credentials"[2].

No previous study empirically examined the relationship between environmental regulations and employment for a country other than the US, previous Cole and Elliott (2007). Their study examines the impact of UK national environmental regulations on sectoral employment using a panel of data covering 27 industries and 5 years (the period 1999 to 2003), considering the possible endogeneity of environmental regulations with regard to employment levels. An extensive body of literature argues that the regulations faced by an industry are endogenously determined by self-interested regulators acting on behalf of special interest groups (Stigler 1971, Peltzman 1976, Grossman and Helpman 1994). Ray (1981a, 1981b) and Baldwin (1985) identify the industry characteristics that increase the effectiveness of a lobby, with several studies including Caves (1976), Magee *et al.* (1989) and Goldberg and Maggi (1999) identifying employment size as one such characteristic. Following this literature, Cole and Elliott (2007) assess whether the impact of environmental regulations on employment differs when such regulations are treated as endogenous. Cole and Elliott (2007) remark that, by focusing on industry-level employment within the UK, their analysis is unable to capture job reallocation within UK firms, within UK industries or across regional boundaries within the UK. Thus, their analysis may provide only a conservative estimate of the true adjustment costs that could potentially result from an increase in the stringency of UK environmental regulations. By focusing on the UK alone, Cole and Elliott estimate the costs that fall upon UK industries. They argue however that, since a decline in UK jobs may be associated with a concurrent increase in jobs elsewhere in the world, a cost to the UK is not necessarily translated into a global cost.

Cole and Elliott (2007) find regulation costs to be a statistically insignificant determinant of employment. Their statistically insignificant results raise the possibility that regulation costs generate competing effects on employment that cancel each other out. They argue that regulations could affect

[2] House of Commons Environmental Audit Committee, Pre-Budget 2004 and Budget 2005: Tax, Appraisal and the Environment. Seventh report of session 2004-05, London 13th April 2005

employment through the elasticity of output with respect to regulations and a potential substitution effect between abatement activity and labor. They say it is therefore possible that a negative output effect is present and abatement activity and labor are complements. Alternatively, they suggest that the output effect may be positive while abatement activity and labor may be substitutes. A final possibility is simply that regulation costs do not affect output positively or negatively, and abatement activity has no net impact on employment.

1.1.3.4 Shapiro and Irons (2011)

Shapiro and Irons (2011) provide a very recent and exceptionally exhaustive analysis of fears and opinions about job loss as a consequence of environmental regulations. This paper moves from the very recent American political debate. They state that a chief priority of the House Republican majority in Congress is to curtail government regulation activity. They observe that in the first months since the new Congress convened, the House has held dozens of hearings designed to arouse criticisms of regulations, introduced legislation that would dramatically alter the regulatory process by requiring congressional approval of all major regulations, and passed a spending bill that would slash the funding levels of regulatory agencies and restrict their ability to enact rules covering areas such as greenhouse gas emissions (Shapiro and Irons , 2011).

1.1.3.4a Regulation and the British Petroleum Deepwater Horizon oil spill

Shapiro and Irons (2011) remember the reader that the BP Deepwater Horizon spill was the worst accidental oil spill in U.S. history, in order to show that very often in academic literature the cost of disasters is not considered, thus underestimating the economic value of regulations. The initial oil rig explosion on April 20, 2010, killed 11 people and injured 17, and the Macondo well was not capped until July 15. Nearly five million barrels of oil spilled into the Gulf of Mexico, producing serious environmental and economic damage that continues to unfold. The disaster significantly disrupted the three pillars of the Gulf Coast's economy (fishing, tourism, and energy production) and the economic and cleanup costs will total in the tens of billions of dollars. The oil spill occurred in a regulatory context that was lax to the extreme. According to the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, the lack of concern by government officials over the safety of deepwater oil drilling meant that, "the only question had become not whether an accident would happen, but when. On April 20, 2010, that question was answered."[3]

In sum, the commission found that this enormous oil spill was avoidable, and the lack of regulatory oversight was critical to its occurrence. The accident "resulted from clear mistakes made in the first instance by BP, Halliburton, and Transocean, and by government officials who, relying too much on industry's assertions of the safety of their operations, failed to create and apply a program of regulatory oversight that would have properly minimized the risks of deepwater drilling." [4]

1.1.3.4b Cost-benefit analysis of regulation

Shapiro and Irons (2011) report that on March 1, the EPA released a comprehensive congressionally mandated study of the costs and benefits of the Clean Air Act Amendments of 1990. These wide-ranging amendments to the 1970 Clean Air Act (which had also been amended in 1977) established new programs to control acid rain and the depletion of the stratospheric ozone. The amendments also strengthened and tightened existing aspects of the act, refined permitting requirements, and reformed the hazardous air pollutant regulatory program. The study, which was reviewed extensively by a respected outside panel of experts (who characterized the study's cost-

[3] National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling*, Washington, D.C., January 11, 2011, p. 85

[4] National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling*, Washington, D.C., January 11, 2011, p. 127

benefit analysis as "state of the art"),[5] found the amendments to be enormously beneficial. The study's central cost-benefit estimate is that the Clean Air Act Amendments of 1990 had net benefits in 2010 of $1.2 trillion (expressed in 2006 dollars), with benefits exceeding costs by a ratio of 25-to-1. The central estimate found costs of $53 billion in 2010 and benefits of $1.3 trillion[6]

Shapiro and Irons (2011) report that other information in the study describes the estimated health benefits produced by the 1990 amendments. In 2010 alone, these include 160,000 lives saved (described by EPA as "reductions in premature mortality"), 13 million additional days of work (and productivity) because employees were healthier, and 3.2 million additional days of school attended because students were healthier (Table 1).

According to Shapiro and Irons (2011) the Office of Management and Budget and EPA information portray an unmistakable pattern: for decades the value of the benefits of regulations has consistently and significantly outweighed the costs. The Clean Air Act Amendments of 1990 offer a particularly dramatic example of enormous health benefits, direct aid to the economy through increased work days and productivity, and millions of lives saved.

[5] Advisory Council on Clean Air Compliance Analysis, "Review of the Final Integrated Report for the Second Section 812 Prospective Study of the Benefits and Costs of the Clean Air Act," Washington, D.C., December 16, 2010. http://yosemite.epa.gov/

[6] U.S. Environmental Protection Agency, Office of Air 21. and Radiation, "The Benefits and Costs of the Clean Air Act: 1990 to 2020," Final Report, Washington , D.C., EPA, March 2011, pp. 7-9

Table 1		
Clean Air Act Amendments of 1990 are providing enormous health benefits		
Health benefits	*2010*	*Cumulative through 2010*
Lives saved	160,00	1,826,000
Additional work days	13,000,000	137,000,000
Additional shool days	3,200,000	26,600,000
Heart attacks prevented	130,000	1,358,000
Fewer hospital admissions	86,000	841,000
Fewer cases of chronic bronchitis	54,000	575,000

SOURCE: Environmental Protection Agency (for 2010 data) and authors' analysis of EPA data (for cumulative through 2010).

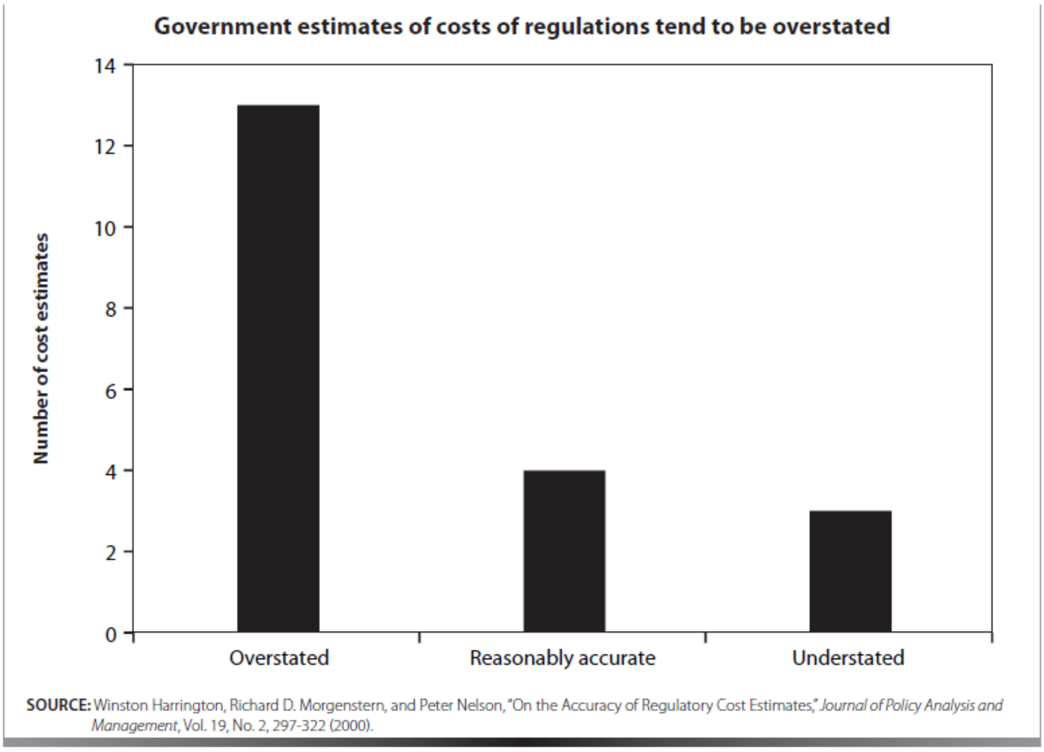
1.1.3.4c Are government studies biased?

Shapiro and Irons (2011) report that a relatively large number of studies have examined whether the predictive cost estimates used by government agencies when they are formulating their regulations tend to be overstated or understated. The general consensus might be surprising: government cost estimates tend to be too large.

Perhaps the most widely cited of these studies is Harrington, Morgenstern, and Nelson (2000). Their analysis compared the cost estimates for federal regulations before they were put in place (*ex ante* estimates) to cost estimates of how much these regulations cost once they were implemented *(ex post* estimates). The focus was on comparing *ex ante* cost estimates used by government agencies to *ex post* estimates usually prepared by an academic or independent analyst. A central finding of this study is that overall costs of particular regulations estimated by the federal government tend to be overstated. Of the 21 federal regulations examined, in 13 cases the *ex ant*e costs turned out to be too large (they were at least 25% larger than the *ex post* costs). In only three cases a federal agency understate costs (its cost estimates were at least 25% smaller than the *ex post* costs). In the remainder of cases, the *ex ante* cost estimates were deemed to be reasonably accurate (Figure 5) (Harrington, Morgenstern, and Nelson, 2000). In 2010, Harrington, Morgenstern, and Nelson, in an updated summary of their findings, discussed why government cost estimates tend to be too high (Harrington, Morgenstern, and Nelson, 2010). They concluded that:

a. Government cost estimates fail to account for technological adjustments;
b. Delays in devising and implementing rules lead to less costly adjustments;
c. Either because the extent of pollution reduction a rule can produce was initially overestimated, or because firms failed to comply, rules can be both less costly *and* less beneficial than expected;
d. *Ex ante* cost estimates are based on the proposed rule; adjustments made before the rule is finalized, often to respond to points made by the industries regulated, may reduce costs;
e. *Ex ante* cost estimates tend to rely on the use of current technology as well as information provided by the regulated industries themselves, both of which bias the estimates upward.

Figure 5



1.1.3.4d The track record of regulatory opponents

Shapiro and Irons (2011) report the table 2, which provides several other examples of how industry estimates of the costs of proposed regulations have proved to be greatly exaggerated. In the case of the regulation of benzene emissions, control costs were estimated at $350,000 per plant by the chemical industry, but soon thereafter the plants developed a new process in which more benign chemicals could be substituted for benzene, thereby reducing control costs to essentially zero. Table 2 includes some of the most prominent regulations put in place in recent decades. It focuses on the costs of the regulations, but the benefits from these regulations have proven significant. They include dramatic reductions in pollutants—and consequent improvements in health—from environmental regulations, and tens of thousands of lives saved from the air bag requirements. (National Highway Traffic Safety Administration, 2008)

Table 2

Industry estimates of compliance costs tend to be exaggerated

Regulation	*Ex ante* estimate by Industry	*Ex post* or revised *ex ante* estimate
Acid rain	$5.5 billion a year initially, $7.1 billion a year in 2000	$1.1 billion - $1.8 billion a year
Air bags	$800 per vehicle	$300 per vehicle
Benzene	$350,000 per plant	Approximately $0 per plant
Catalytic converters	$860 per vehicle	$288 per vehicle
CFCs-Auto air conditioners	$650-$1,200 per car	$40-$400 per car

SOURCE: Pew Environmental Group "Industry Opposition to Governement Regulation", October 2010 (for acid rain, air bags and catalytic converters);
Hart Hodges, "Falling Prices: Cost of Complyng With Enviromental Regulations Almost Always Less Than Advertised", Economic Policy Intitute, Novembre 1, 1998 (for benzene and CFCs-auto air conditioners)

1.1.4 Environmental regulations and productivity (Gray and Shadbegian, 1995; Berman and Bui, 2001b)

1.1.4.1 Gray and Shadbegian (1995)

Gray and Shadbegian (1995) think that, instead of relying exclusively on survey evidence, it may be possible to measure abatement costs indirectly, through their impact on productivity. Productivity is defined as output per unit of inputs, so pollution abatement spending should reduce productivity: increasing inputs without creating more output. Thus, they analyze plant-level productivity data for three industries (pulp and paper mills, oil refineries, steel mills), taken from the Longitudinal Research Database (LRD). They use information on pollution abatement expenditures, along with enforcement, compliance, and emissions data for the 1979-1990 period. They focus on total factor productivity (TFP), examining both productivity levels and growth rates for each plant, and their relationship to the regulatory measures.

Gray and Shadbegian (1995) find that plants which spend more on pollution abatement, one measure of regulatory impact, are significantly less productive. A plant with \$1 higher abatement costs tends to have the equivalent of \$1.74 lower productivity in paper, \$1.35 lower in oil, and \$3.28 lower in steel. They don't observe other regulatory measures (enforcement, compliance and emissions) to be significantly related to productivity, and their impacts vary across industries, though their signs tend to point in the same direction (more regulation is associated with lower productivity). In earlier work (Gray and Shadbegian, 1993), the same authors found larger productivity impacts of differences in abatement costs across plants, with \$1 of abatement costs reducing productivity by \$2.26 for paper, \$2.38 for oil, and \$4.19 for steel.

Gray and Shadbegian (1995) observe that if firms choose the best (profit-maximizing) combinations, regulations that constrain these choices will tend to force plants away from the optimum production decisions. Increases in regulation could also lead firms to become more uncertain about future regulatory demands. They argue this may lead firms to postpone investment (Viscusi 1983), the development of new products (Hoerger, Beamer and

Hanson 1983), or research on new production processes. Gray and Shadbegian also consider that similar effects could result if firms had a limited budget for research and development, and regulation required them to investigate cleaner technologies rather than more productive ones.

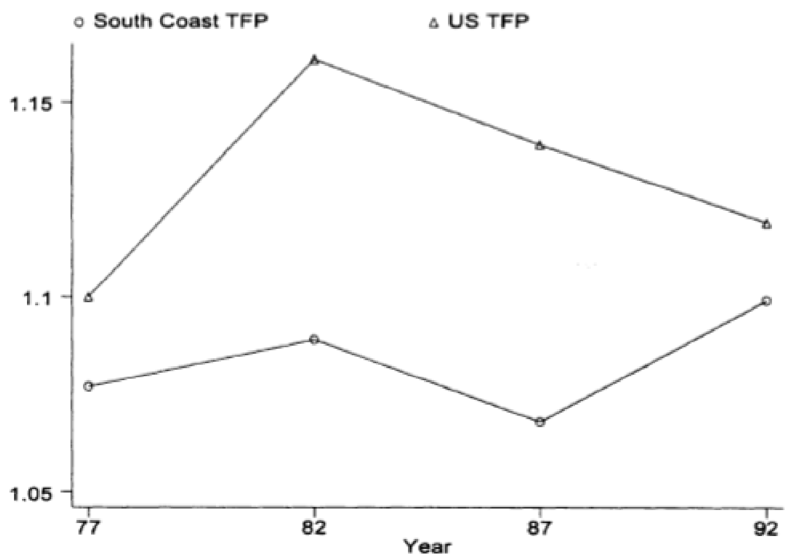
Gray and Shadbegian (1995) think that new plants generally face more stringent rules, and current regulations tend to be written for existing technologies, which further discourages the building of new plants or development of new technologies. They continue their negative critics to regulations adding that in addition to these constraints, most regulations force firms to use inputs directly for regulatory compliance: a scrubber on a smokestack, a water treatment plant, or clerks to fill out government forms. This constraints drive the prevailing view that plants facing more regulation should have lower productivity. The opposing view, that regulation can increase productivity, is necessarily based on the notion that firms were not really behaving optimally (in productivity terms) before the regulation was imposed (Gray and Shadbegian, 1995). One possibility is the presence of 'X-inefficiency' (Leibenstein, 1960), where workers and managers don't bother to work their hardest unless prodded by an outside stimulus such as regulation (see also Clark, 1980). In this context, new and cleaner equipment may also be more productive than the old equipment it replaces, although for this to represent a productivity gain from regulation it is necessary to assume that the plant would not have installed the new equipment without the regulatory pressures. Thus Gray and Shadbegian (1995) say that saving in costs, hence gain in productivity, often come from redesigning processes to eliminate waste and recycle production by-products (so-called 'closed loop' production methods).

1.1.4.2 Berman and Bui (2001b)

Berman and Bui (2001b) investigate the effect of a specific set of environmental regulations on productivity in the petroleum refining industry, one of the single most regulated industries in the United States. They examine the effects of regulation on productivity, allowing for the possibility that abatement expenditures do not accurately reflect the economic costs of regulation, either because of hidden costs or because abatement is productive. They measure total factor productivity using unique data on physical quantities from detailed products and material records in the Census of Manufactures. Thus, they compare the productivity of refineries in the South Coast Air Basin, which surrounds Los Angeles, to that of refineries in the rest of the United States, which are subject to much less extreme regulations. In particular, they focus on the set of regional environmental regulations in California enacted by the SCAQMD (South Coast Air Quality Management District), that affect petroleum refining activities.

Berman and Bui (2001b) find strong econometric evidence that South Coast regulations induced large investments in abatement capital. Surprisingly for them, they find no evidence that these regulations had more than a transitory effect on the productivity of South Coast refineries. According to their results, these refineries suffered a productivity decline in the 1980s but recovered to the national average by 1992, despite their heavy regulatory burden. In fact, the productivity of South Coast refineries rose sharply between 1987 and 1992, the period when the most stringent regulations came into effect, a period when productivity was falling for refineries elsewhere in the country. Berman and Bui (2001b) suggest that abatement associated with the SCAQMD regulations was productivity enhancing, so that the gross cost of pollution abatement overestimates the economic cost of regulation.

Figure 6 – South Coast and U.S. Total Factor Productivity



Source: Census of Manufacturers, Berman and Bui (2001b)

Following these findings, Berman and Bui (2001b) ask a question: if South Coast regulations induced abatement that increased productivity, why aren't the same technologies adopted elsewhere? Why haven't other plants adopted the new technology if it is truly more productive? One possible explanation they provide comes from the "real options" theory of investment under uncertainty (Dixit & Pindyck, 1994). Plants located outside the local regulatory region face considerable uncertainty both about the costs and efficacy of untested abatement technologies and about the requirements of future regulations. Under these conditions, a plant may optimally choose to defer even an investment with high expected returns if downside risk can be reduced by waiting to see how the technology works elsewhere, perhaps in the South Coast. Berman and Bui (2001b) state that the fact that abatement costs are sometimes productive should refocus the debate about costs and benefits of environmental regulation. Using PACE measures (Pollution Abatement Costs and Expenditures Survey), costs are commonly estimated at 1% to 2% of GDP. They observe that this may be a gross overestimate of true economic costs. The suggest that a more appropriate measure would be the cost net of increased production due to abatement activity.

1.1.5 Environmental regulations and business locations decisions (McConnell and Schwab, 1990; Henderson, 1996; Levinson, 1996)

1.1.5.1 McConnell and Schwab (1990)

In order to study the relation between environmental regulations, McConnell and Schwab (1990) choose to analyze in detail the motor vehicles industry situation.

McConnell and Schwab (1990) report that air pollution policy has moved steadily toward strict uniformity of regulations across regions. In particular, amendments to the Clean Air Act (CAA) and Environmental Protection Agency (EPA) rules in the 1970s and early 1980s have promoted a policy designed to reduce regional variation in air pollution controls required of industrial polluters. This policy was based on the premise that differences in environmental regulations would promote locational competition among regions. The fear was that polluting firms would migrate to clean areas where they would be subject to less stringent regulation. According to McConnell and Schwab (1990), the issue is of critical importance because environmental policy which is uniform across regions is likely to have a high social cost, compared with one that accounts for differences in abatement costs and benefits among regions (see Baumol and Oates, 1988). McConnell and Schwab (1990) use a conditional logit model to examine the impact of a variety of county characteristics on the locations of 50 new branch plants in the motor vehicle industry during 1973-82, a period when there was still substantial variation in environmental requirements between regions.

The evidence in McConnell and Schwab's (1990) results on whether regional differences in environmental regulation matter in this industry is somewhat mixed. Most of their results indicate that these regulations do not affect location decisions. The inclusion of a simple non-attainment county dummy variable consistently yields coefficients which have the wrong sign and are insignificant. However, they observe some evidence that firms may be deterred, at the margin, from locating in regions where the ozone problem is particularly severe. Their evidence for motor vehicle industry suggests that regional differences in environmental policy in the 1970s discouraged firms from choosing only the handful of most polluted large cities.

1.1.5.2 Levinson (1996)

Levinson (1996) explores exactly the same topic as McConnell and Schwab (1990), that is the effect of differences in the stringency of state environmental regulations on establishment location choice, by using establishment-level data from the Census of Manufactures and the Survey of Pollution Abatement Costs and Expenditures. Unlike previous work in this area, including McConnell and Schwab (1990) just reviewed, which has focused on particular industries or sets of plants and on one or two measures of environmental regulatory stringency, this study explores the relationship between site choice and environmental regulations using a broad range of industries and measures of stringency. Levinson (1996) uses a conditional logit model of plant location choice to show that interstate differences in environmental regulations do not systematically affect the location choices of most manufacturing plants.

Despite his effort in accuracy, Levinson (1996) finds little evidence that stringent state environmental regulations deter new plants from opening. Given the conclusion that regulations do not affect plant openings, Levinson tries to understand the reason behind it. He observes that it seems unlikely that environmental compliance costs are too small to weigh into location decisions, especially for the more pollution-intensive industries. On average, the industries studied in Levinson (1996) spent about 4% of their investment dollars on pollution abatement equipment. Some industries spent more than 5% and one (petroleum and coal) spent 16%. Levinson (1996) provide the alternative explanation that firms manufacturing products in a variety of jurisdictions find being most cost effective to operate according to the most stringent regulations, eliminating the necessity of designing a different production process for each location.

Although the several proxies for environmental standard stringency utilized by Levinson (1996) appear to have negative effects on the new plant births, their coefficients are significant only for the branch plants of very large firms. Trying to explain this result, Levinson (1996) suggests that two theories might explain why large firm branch plants are more sensitive to variations in local environmental stringency. Such firms may have economies of scale in conducting site searches and such plants may have less constraints than those of independent manufacturers. Levinson (1996) finds very few industries to have negative and significant coefficients for the environmental stringency variables and an offsetting few have positive and significant coefficients.

1.1.5.3 Henderson (1996)

Henderson (1996) investigates effects of air quality regulation of ground-level ozone in the United States for the period 1977-1987. He investigates how differential local implementation of air quality regulations affects local air quality and the allocation of economic resources. For example, to what extent polluting plants tend to move to localities where the application of regulations is weaker.

Henderson (1996) argues that for counties not in attainment with regulation values, new manufacturing firms to the county will be subject to more stringent regulations governing equipment specifications. Existing firms in nonattainment areas face stricter requirements to reduce source emissions and new firms may be required to purchase emission rights from existing firms (Atkinson and Tietenberg, 1987; Roumasset and Smith, 1990). All firms in non-attainment counties are more likely to be closely monitored and subject to greater enforcement efforts (Deily and Gray, 1991; Russell, 1990; Crandall, 1985; Tietenberg, 1985; Portney, 1990b). For ozone, in addition, auto related regulations may be tougher, requiring the state to set up auto emission inspection stations in various parts of the state. In summary, being out of attainment introduces a set of overall regulatory activities designed to reduce emissions, which are not faced to the same extent by counties in attainment.

Henderson (1996) finds that air quality improves for the majority of stations but also declines for some stations initially well below the critical reading. In addition, he finds that for the five high polluters the growth rate of number of plants is much higher in the attainment than non-attainment counties. In contrast, the average employment growth rates for all industries in the two sets of counties are the same for the whole period. Also the growth rates in overall number of manufacturing establishments for the two sets of counties are similar.

By examining the effects of attainment status on five control industries, who are not big volatile organic compound emitters (i.e. not big polluters), Henderson (1996) finds that in four of them, improved counties also have higher growth rates than nonattainment countries. He remarks that this evidence is very suggestive of the relocation hypothesis. He concludes that polluting industries tend to relocate over time to areas with a record of staying in attainment, presumably to reduce regulatory scrutiny.

1.1.6 Environmental regulations and competitiveness (Jaffe et al., 1995; Porter and Van der Linde, 1995; Nerth, 1998)

1.1.6.1 Jaffe et al. (1995)

Jaffe et al. (1995) report that since 1970 to 1990 the United States has spent more than $ 1 trillion to prevent or reduce environmental damages created by industrial and commercial activities. They also report that during the latter part of this period, the U.S. economy has moved from a position of approximate trade balance on a long-term basis to a position of chronic trade deficit. The coincidence of these two major trends has led many to suspect that environmental regulation may play a major causal role in impairing the "competitiveness" of U.S. firms (Krugman, 1994). Jaffe et al. (1995) observe that the conventional wisdom, at that time, was that environmental regulations impose significant costs, slow productivity growth, and thereby hinder the ability of U.S. firms to compete in international markets. This loss of competitiveness was believed to be reflected in declining exports, increasing imports, and a long-term movement of manufacturing capacity from the United States to other countries, particularly in "pollution-intensive" industries (see Pethig, 1975; Siebert, 1977; Yohe, 1979, and McGuire, 1982).

Jaffe et al. (1995) remark that under a more recent, revisionist view, environmental regulations were seen not only as benign in their impacts on international competitiveness, but actually as a net positive force driving private firms and the economy as a whole to become more competitive in international markets. (Porter, 1991; Stewart, 1993; Hopkins, 1992).

Jaffe et al. (1995) report that much of previous discussion revolved around the fear that environmental regulation may reduce net exports in the manufacturing sector, particularly in "pollution-intensive" goods, which could have several effects (Jaffe et al., 1995):

a. in the short run, a reduction in net exports in manufacturing will exacerbate the overall trade imbalance. Although the trade balance is likely to return in the long run, one of the mechanisms through which this happens is a decline in the value of the dollar. This means that imported goods become more expensive, thus reducing the standard of living for many people.

b. if those industries most affected by regulation employ less educated workers, then this portion of the labor force will be particularly hard hit, because those workers may have an especially hard time finding new jobs at comparable wages.
c. a diminishing US share of world capacity in petroleum-refining, steel, autos, and other industries could endanger economic security.
d. even in the absence of these income distribution or economic security concerns, the rearrangement of production from pollution-intensive to other industries creates a broader set of social costs, at least in the short run. Because the "short run" could last for years or even decades, these transition costs are also a legitimate policy concern.

Jaffe et al. (1995) report that the indicators of "competitiveness" used in previous literature can be classified into three broad categories:

a. The change in net exports of certain goods, the production of which is heavily regulated, and with comparisons between net exports of these goods and others produced under less regulated conditions. For example, stringent environmental regulation of the steel industry should, all else equal, cause the net exports of steel to fall relative to the net exports of goods the production of which is more lightly regulated. Thus, the magnitude and significance of an econometric parameter estimate that captures the effect of regulatory stringency in a regression explaining changes in net exports across industries could be taken as an indicator of the strength of the effects of regulation on competitiveness.
b. Test if the locus of production of pollution-intensive goods has shifted from countries with stringent regulations toward those with less. After all, Jaffe et al. (1995) observe that the policy concern about competitiveness is that the United States is losing world market share in regulated industries to countries with less stringent regulations. If this is so, then there should be a general decrease in the US share of world production of highly regulated goods and an increase in the world share of production of these goods by countries with relatively light regulation.
c. Study if regulation is reducing the attractiveness of the United States as a locus for investment. In this case there should be a relative increase in

investment by US firms overseas in highly regulated industries. Similarly, all else equal, new plants in these industries would be more likely to be located in jurisdictions with lax regulation.

Because the economic adjustment to regulation is highly complex, and because there are a multiplicity of issues wrapped up in the term "competitiveness," it is not possible to combine estimates of these different aspects of the process into a single, overall quantification of the effects of regulation on competitiveness (see Hopkins, 1992, and Portney, 1994). Jaffe et al. (1995) posit that the best that can be done is to assess somewhat qualitatively the magnitude of estimated effects, based on multiple indicators. Overall, Jaffe et al. (1995) find little evidence to support the hypothesis that environmental regulations had a large adverse effect on competitiveness, however that elusive term is defined. Although the long-run social costs of environmental regulation may be significant, including adverse effects on productivity, studies attempting to measure the effect of environmental regulation on net exports, overall trade flows, and plant-location decisions have produced estimates that are either small, statistically insignificant, or not robust to tests of model specification. (Jaffe et al., 1995).

Jaffe et al. (1995) provide possible explanation to their results:

a. Their data are limited in their ability to measure the relative stringency of environmental regulation, making it difficult to use such measures in regression analyses.
b. The cost of complying with federal environmental regulation is a relatively small fraction of total cost of production. According to EPA, that share for U.S. industry as a whole averages about two percent. Environmental regulatory intensity should not be expected to be a significant determinant of competitiveness in most industries. They argue that labor cost differentials, energy and raw materials cost differentials, infrastructure adequacy, and other factors would indeed overwhelm the environmental effect.
c. Although US environmental laws and regulations are generally the most stringent in the world, the difference between US requirements and those

in other western industrial democracies is not great, especially for air and water pollution control (see Kopp, Dewitt, and Portney, 1990a, and Barrett, 1992).

d. Even where there are substantial differences between environmental requirements in the United States and elsewhere, multinationals firms are reluctant to build less-than-state-of-the-art plants in foreign countries. Jaffe et al. (1995) observe that if such willingness existed before the accident at the Union Carbide plant in Bhopal, India, it does not now. Thus, even significant differences in regulatory stringency may not be exploited.

1.1.6.2 Porter and Van der Linde (1995)

Porter and Van der Linde (1995) provide one of the most referenced theoretical framework. Most of subsequent papers reference to it when reporting the theory that environmental regulations improve firms' competitiveness stimulating innovation and thus competitive advantages in the long term.

"The relationship between environmental goals and industrial competitiveness has normally been thought of as involving a tradeoff between social benefits and private costs. The issue was how to balance society's desire for environmental protection with the economic burden on industry. Framed this way, environmental improvement becomes a kind of arm-wrestling match. One side pushes for tougher standards; the other side tries to beat the standards back.

Our central message is that the environment-competitiveness debate has been framed incorrectly. The notion of an inevitable struggle between ecology and the economy grows out of a static view of environmental regulation, in which technology, products, processes and customer needs are all fixed. In this static world, where firms have already made their cost-minimizing choices, environmental regulation inevitably raises costs and will tend to reduce the market share of domestic companies on global markets.

However, the paradigm defining competitiveness has been shifting, particularly in the last 20 to 30 years, away from this static model. The new paradigm of international competitiveness is a dynamic one, based on innovation (Porter, 1990). Competitiveness at the industry level arises from superior productivity, either in terms of lower costs than rivals or the ability to offer products with superior value that justify a premium price. Detailed case studies of hundreds of industries, based in dozens of countries, reveal that internationally competitive companies are not those with the cheapest inputs or the largest scale, but those with the capacity to improve and innovate continually. Competitive advantage, then, rests not on static efficiency nor on optimizing within fixed constraints, but on the capacity for innovation and improvement that shift the constraints.

This paradigm of dynamic competitiveness raises an intriguing possibility: in this paper, we will argue that properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them. Such "innovation offsets," as we call them, can not only lower the net cost of meeting environmental regulations, but can even lead to absolute advantages over firms in foreign countries not subject to similar regulations. Innovation offsets will be common because reducing pollution is often coincident with improving the productivity with which resources are used.[…] By stimulating innovation, strict environmental regulations can actually enhance competitiveness.

There is a legitimate and continuing controversy over the social benefits of specific environmental standards, and there is a huge benefit-cost literature. Some believe that the risks of pollution have been overstated; others fear the reverse. Our focus here is not on the social benefits of environmental regulation, but on the private costs. Our argument is that whatever the level of social benefits, these costs are far higher than they need to be. The policy focus should, then, be on relaxing the tradeoff between competitiveness and the environment rather than accepting it as a given."

Toward a New Conception of the Environment-Competitiveness Relationship,
Michael E. Porter and Van der Linde, 1995

Porter and Van der Linde (1995) observe that is unlikely that firm always make optimal choices. Instead, they argue that the actual process of dynamic competition is characterized by changing technological opportunities coupled with highly incomplete information, organizational inertia and control problems reflecting the difficulty of aligning individual, group and corporate incentives. Thus, companies have numerous avenues for technological improvement, and limited attention.

Porter and Van der Linde (1995) observe that firms make choices based on how they perceive their competitive situation and the world around them. In such a world, regulation can be an important influence on the direction of innovation, either for better or for worse. Properly crafted environmental regulation can serve at least six purposes:

a. regulation signals companies about likely resource inefficiencies and potential technological improvements;
b. regulation focused on information gathering can achieve major benefits by raising corporate awareness. For example, Toxics Release Inventories, which are published annually, require more than 20,000 manufacturing plants to report their releases of some 320 toxic chemicals. Such information gathering often leads to environmental improvement without mandating pollution reductions, sometimes even at lower costs;
c. regulation reduces the uncertainty that investments to address the environment will be valuable.
d. regulation creates pressure that motivates innovation and progress. Economists are used to the argument that pressure for innovation can come from strong competitors, demanding customers or rising prices of raw materials; Porter and Van der Linde (1995) argue that properly crafted regulation can also provide such pressure;
e. regulation levels the transitional playing field. During the transition period to innovation-based solutions, regulation ensures that one company cannot opportunistically gain position by avoiding environmental investments;
f. regulation is needed in the case of incomplete offsets. Porter and Van der Linde (1995) admit that innovation cannot always completely offset the cost of compliance, especially in the short term before learning can reduce

the cost of innovation-based solutions. In such cases, regulation will be necessary to improve environmental quality.

Porter and Van der Linde (1995) divided innovation into product offsets and process offsets.

a. Product offsets occur when environmental regulation produces not just less pollution, but also creates better-performing or higher-quality products, safer products, lower product costs (perhaps from material substitution or less packaging), products with higher resale or scrap value (because of ease in recycling or disassembly) or lower costs of product disposal for users.
b. Process offsets occur when environmental regulation not only leads to reduced pollution, but also results in higher resource productivity such as higher process yields, less downtime through more careful monitoring and maintenance, materials savings (due to substitution, reuse or recycling of production inputs), better utilization of by-products, lower energy consumption during the production process, reduced material storage and handling costs, conversion of waste into valuable forms, reduced waste disposal costs or safer workplace conditions. These offsets are frequently related, so that achieving one can lead to the realization of several others (Porter and Van der Linde, 1995).

Porter and Van der Linde (1995) think that environmental standards should adhere to three principles:

a. they must create the maximum opportunity for innovation, leaving the approach to innovation to industry and not the standard-setting agency.
b. regulations should foster continuous improvement, rather than locking in any particular technology.
c. the regulatory process should leave as little room as possible for uncertainty at every stage.

Porter and Van der Linde (1995) conclude that, if evaluated by these principles, it is clear that US environmental regulations have often been crafted in a way that deters innovative solutions, or even renders them impossible.

1.1.6.3 Nerth (1998)

Nerth (1998) examines the conditions under which financial advantages may accrue to a firm that invests in pollution-reducing manufacturing technologies that produce salable product at the same time that they reduce pollution.

Nerth (1998) draws from the literature on first mover advantage and on sustainable advantage. The literature on first mover advantage, offers an established theoretical basis for proposing that a firm may realize a competitive advantage through early investments in the new pollution-reducing assets. Three concepts in the literature are key to understand how a first mover firm may benefit:

a. Learning effects (Spence, 1977; Porter, 1980; Lieberman, 1989). In its traditional form, learning effects are associated with economies of scale (Dixit, 1980; Ghemawat, 1984; Lieberman, 1989). As the firm gains experience with the new technology through additional volume throughput, it drives its cost per unit toward the new lower potential (Burgess, 1989). A follower firm that later adopts the new technology is at a disadvantage relative to a first mover firm so long as it remains behind the first mover on the learning curve, and possibly for longer. A non-first mover firm may not be able to purchase the knowledge that it needs in order to catch up to a first mover firm.
b. Time compression diseconomies (Dierickx and Cool, 1989). In addition to gaining through volume-related learning effects, the first mover firm may also gain simply due to the direct effects of time. The concept of time compression diseconomies recognizes that some tasks simply take time to accomplish, and that diseconomies to the firm result when it spends more manpower or money to accelerate their completion (Dierickx and Cool, 1989).
c. Asset mass efficiencies (Dierickx and Cool, 1989). Sometimes a firm must make a certain minimum investment in a technology in order to fully understand it and gain from it. When this critical asset mass is not achieved, the firm’s investments in the new technology will not pay off.

Nerth (1998) uses data from 50 producers of chemical bleached paper pulp in eight countries to test the relationship between investment timing, intensity and the interaction of timing and intensity on the one hand, and growth in the firm's profits from the mid-1980s to the early 1990s on the other hand.

Nerth (1998) finds that earlier investments in extended in pollution-reducing processing equipment are positively and significantly associated with net income growth. Interestingly, the effect of environmental regulations is non-significant. He finds no statistical significance for the parameter estimates for intensity of investments or for the interaction between timing and intensity. He suggests that the non-significance of the intensity and interaction parameter estimates rely to the concepts of asset mass efficiencies and time compression diseconomies. He argues that companies capabilities (the intensity variable) may be attempting to assimilate several pollution-reducing process technologies at the same time. Without sufficient time to absorb the new technologies, the firms face time diseconomies that leave them unable to realize the full benefits of their investments, at least in the short term.

Chapter 1.2
Environmental regulations literature: a Chinese focus

Recent years have seen a growing body of literature related to environmental regulations and their effects on economy, both macro-economically and micro-economically, with a special focus on China. Given that one of the objectives of this thesis is to study the effects of environmental regulation on China's financial market, I present hereafter a selection of paper detailed reviews. They are organized according following topics:

a. Introduction to current Chinese environmental situation (McElwee, 2008)
b. Brief example of health impact of environmental regulation (Tanaka, 2010)
c. Theory of environmental policy in China (Hills and Man, 1998; Shi and Zhang, 2006; Qi, 2008; Mol, 2009)
d. Researches about Pollution Haven Hypothesis (Dean, Lovely and Wang, 2009; Peng et al., 2011)
e. Analysis of impacts of environmental regulations on productivity and wages (Managi and Kaneko, 2005; Xu,2007; Mishra and Smyth, 2012)

1.2.1 Introduction to current Chinese environmental situation (McElwee, 2008; Managi and Kaneko, 2005)

1.2.1.1 McElwee (2008)

McElwee (2008) states that the consequences of 20 years of China's "produce now, clean up later" growth model fill today's headlines. According to him, Beijing's new skyscrapers are shrouded in smog and sit on a depleted aquifer and China's rivers—when they flow at all—run black and red, and thousands of acres of once productive farm land have turned into desert or been contaminated with hazardous wastes. All layers of Chinese society now realize that an environmental crisis exists. Private citizens, the press, and some segments of the PRC government are demanding that something be done.

According to McElwee (2008) researches penalties for non-compliance with some of China's environmental laws are so low that it is often cheaper not to comply and pay fines than to undertake the actions necessary to meet the statutory mandates. In other instances, companies have disregarded statutory requirements because the PRC government has not yet issued implementing regulations. McElwee observes that although China lacks environmental enforcement—not environmental laws—the PRC government apparently views the promulgation of more laws and regulations as a big part of the solution. The pace of legislative and regulatory activity in China's environmental arena has increased dramatically. Numerous agencies, in addition to the PRC State Environmental Protection Administration (SEPA), are churning out ever-stricter regulations and standards in the name of environmental improvement.

If one factor had to be identified as the cause of China's environmental crisis, it would be lax enforcement of the existing environmental laws—the practical manifestation of the "clean up later" policy, McElwee says. Over the past two years, central authorities have repudiated the “clean up later” model and demanded that government agencies at all levels get tough on polluters. Western companies that invest in China usually subscribe to corporate social responsibility principles that require them to comply with the environmental laws and regulations of the countries where they operate, regardless of whether those laws are enforced. Thus, improved enforcement should not significantly affect the China operations of most foreign-invested enterprises. Anecdotal evidence, in McElwee's words, suggests that foreign-invested enterprises are sometimes the first targets when local officials feel the need to show they are "getting tough" on polluters. In the last few years, McElwee reports that citizens have protested against pollution sources that acutely affect their health or livelihoods. He argues that these protests, some of which have taken the form of civil disobedience, are generally aimed at state-owned enterprises and reflect, at least in part, the public's frustration with its inability to achieve effective redress through formal channels. In fact, McElwee reports that citizens can employ several legal mechanisms to stop harmful pollutant discharges and obtain restitution for past harm. Though these mechanisms may be ineffective against politically powerful state-owned enterprises, he argues they may be effective against foreign-invested enterprises.

While many of the civil protests in China to date have involved existing polluting facilities, McElwee observes that some protests herald an incipient NIMBYist ("not in my backyard") attitude on the part of the Chinese public. For instance, in spring 2007, thousands of street demonstrators in Xiamen, Fujian, protested against plans by a private entity to build a new petrochemical plant in an industrial zone near the city center. Although the government strongly discourages such protests, McElwee reports that it has recently encouraged, through new SEPA regulations, greater public participation in the environmental impact assessment process, which is required before constructing projects in China. Consequently, when building a new facility or expanding an existing one, companies should engage and seek to address the concerns of neighbors, who are becoming newly emboldened and empowered stakeholders, in McElwee's opinion. He reports that like many other countries, China publicizes the names of entities that violate its environmental laws; generally, China's local environmental protection bureaus release the information. In 2007, the Institute of Public and Environmental Affairs (IPEA), a nongovernmental organization with ties to SEPA and other government organizations, published lists of companies that reportedly violated China's water pollution law. Although the number of

US companies on the list is small (less than 1 percent of the total) and the violations ascribed to them mainly involve temporary problems such as equipment malfunctions or other one-off events (not systematic flouting of China's environmental laws), McElwee reports that these companies, along with a handful of other multinational corporations, have been singled out by the domestic and foreign press.

McElwee thinks that these are interesting times in China's environmental development: New laws and regulations are being promulgated at a breakneck pace, new construction projects may face increased opposition from a newly empowered populace and foreign-invested enterprises operating in China have lost their "shining knight" status on the environmental front.

1.2.1.2 Managi and Kaneko, 2005

Managi and Kaneko (2005) observe that, as a result of China's extremely rapid economic growth, the scale and seriousness of its environmental problems are clearly evident. Consequently, a number of environmental problems, including growing energy consumption, heavy reliance on coal, and increasing air pollution, are threatening China's sustainable future (World Bank 2001). For example, the World Bank estimated that economic damage caused by pollution in China in 1997 costs around $54 billion annually, amounting to close to 8% of domestic GDP (World Bank, 1997). Similarly, Economy (2004) reported that in 2000, China had 16 of the 20 most polluted cities in the world, and Bolt et al. (2001) conclude that China's air pollution problem is the world's worst. By the end of the 20th century, the explosion in economic growth also made China the world's second largest carbon dioxide (CO2) emitter and energy consumer after the United States. In response, from the late 1970s, China began implementation of a number of environmental policies in relation to air and water pollution and solid waste disposal, and the number of these regulations has been steadily increasing (Sinkule and Ortolano, 1995). The State Environmental Protection Administration (SEPA) in China has also declared control of industrial pollution to be a top priority for Chinese regulators.

1.2.2 Brief example of health impact of environmental regulation (Tanaka, 2010)

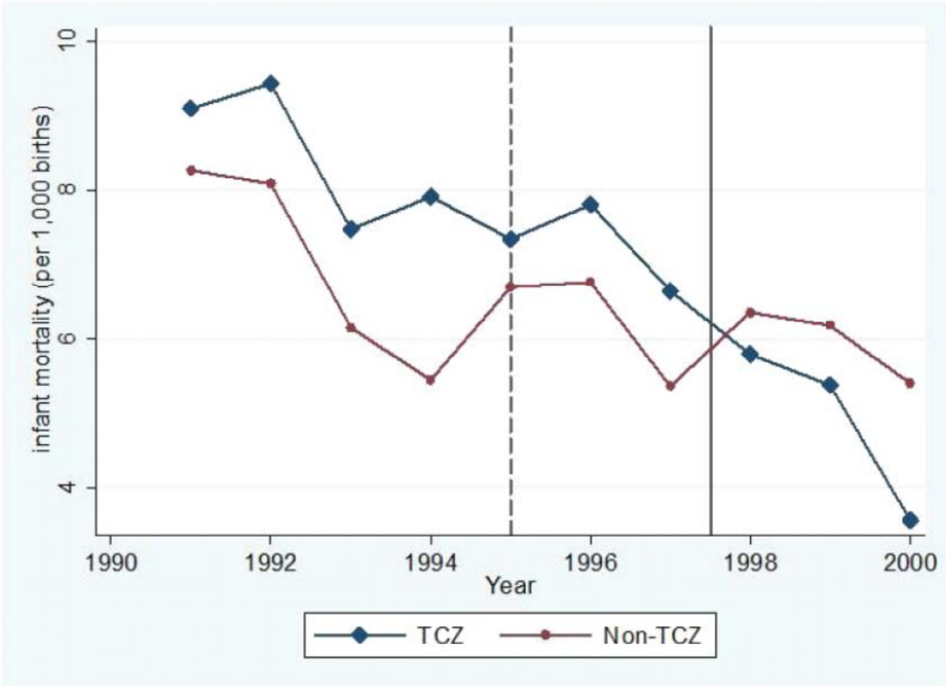
Tanaka (2010) quantifies the impact of air pollution and related regulations on infant mortality in China. To establish causality, he exploits plausibly exogenous variations in air quality generated by environmental regulations since 1995: these legislations imposed stringent regulations on pollutant emissions from power plants.

Tanaka's (2010) results suggest that regulations led to significant reductions in air pollution and infant mortality rate. He estimates that 25,400 fewer infants died per year than would have died in the absence of regulations, corresponding to about a 21 percent decline in infant mortality rate.

More importantly, Tanaka (2010) argues that the analysis highlights the important role of maternal exposure to pollution on fetal development. The instrumental variable estimates he uses indicate that a one percent reduction in total suspended particulates results in a 0.95 percent reduction in infant mortality rate, whereas a one percent reduction in sulfur dioxide results in a 0.82 percent reduction in infant mortality rate. The estimated impact of a unit change in tota suspended particulate is of similar magnitude to that found in the U.S., but the elasticity is substantially higher in China, highlighting the greater benefits associated with regulations when pollution is already quite high.

Thus, China being in the earlier phase of its environmental regulation development and its pollution being quite high, new environmental regulations should have a great effectiveness, meaning good results in population health following a relative small environmental effort.

Figure 7 – Trends in Infant Mortality Rate



Notes: This figure plots the general trend of infant mortality per 1,000 live births between the Two Control Zone (TCZ) and non-TCZ localities. The annual mean is calculated using the total population as the weight. The dotted vertical line indicates the timing of 1995 Air Pollution Prevention and Control Law (APPCL) amendment, and the solid vertical line indicates the timing of TCZ policy implementation in January 1998. Note that the 1995 APPCL was amended in August. Because each observation presents the annual average value, the dotted vertical line is located at 1995, while the solid vertical line is located between 1997 and 1998. This is to clarify the timing of the TCZ policy implementation.

1.2.3 Theory of environmental policy in China (Hills and Man,1998; Mol, 2009; Qi, 2008; Shi and Zhang, 2006)

1.2.3.1 Hills and Man (1998)

Hills and Man (1998) focus on the relationship between environmental regulators and industrial enterprises in China in an attempt to explain the "implementation gap" (the weak enforcement problem). They attribute the gap to "legislative shortcomings, poorly designed policy instruments, an unsupportive work environment for environmental regulators, and a pro-growth political and social environment". They further argue that "such relationships, which reflect a cultural predisposition to harmony and consensus building among key actors, play an important role in determining how environmental policies are implemented, and how stringently regulations are enforced at the local level".

1.2.3.2 Shi and Zhang (2006)

According to Shi and Zhang (2006), the "unimpressive" performance of China's early environmental regulation can be attributed to several factors:

a. China developed its environmental regulation in the 1970s, with little experience and virtually no institutional capacity;
b. China lacked a strong environmental state, with large and effective monitoring and enforcement capacity, to oversee the initial regime of industrial environmental pollution control;
c. the regime was mainly designed to target large state-owned enterprises within a centrally planned economy via direct command-and-control interventions;
d. industry experienced constant and rapid change in the 1990s, both in scale (quantitatively) and in structure (qualitatively).

Shi and Zhang (2006) observe that an increasing number of Chinese companies have started to pursue environmental performance beyond government regulations. According to their research, the growing number of ISO 14001 certified Chinese companies is an example. They also remark that, as of October 2005, the State Environmental Protection Administration

(SEPA) had designated 32 companies as 'Environmentally Friendly Enterprises', as they fulfill the criteria of the voluntary programme launched by SEPA. Moreover, civil society and environmental non-governmental organizations (NGOs) become increasingly active in putting pressures on polluting companies and lax governments.

Following Shi and Zhang's (2006) reasoning, these developments raise a number of questions: are we witnessing a major change in the roles of state and non-state actors in environmental policymaking and decision-making related to industrial environmental management, not unlike that which has been interpreted in Western countries under the label of environmental governance? What are the characteristics of and drivers behind these changes in what was until recently a state-monopolized environmental reform? How will these transitions influence and shape the future environmental performance of China's industrialization? Building upon results of earlier studies (Sinkule & Ortolano, 1995; World Bank, 1997, 2001; Jahiel, 1998; Ma & Ortolano, 2000; SEI & UNDP, 2002), Shi and Zhang (2006) further explore these questions by focusing on the transition of China's industrial environmental governance since 2002.

Industrial environmental management in many OECD countries has shifted during the last two decades and different authors have used different concepts to characterize these changes. Tietenberg (1998) and Khanna (2001) have emphasized the use of new market-based and voluntary instruments in addition to, and sometimes instead of, command and control regulation. Others have framed the changes in term of a transition from government to governance (e.g. Jordan et al., 2005), emphasizing the role of non-state actors in environmental politics. Shi and Zhang (2006) claim that similar tendencies can be witnessed also in China. They argue that although the state remains the primary player, now economic actors and civil society start to play significant and ever-increasing roles.

Shi and Zhang (2006) report that the founding of Friends of Nature in 1994 inaugurated a decade of vibrant growth of environmental NGOs in China, articulating and lobbying for environmental interests against specific political and economic decisions (Yang, 2005). Despite the strict oversight of NGOs by the Chinese government in terms of their activities and financial situation, SEPA as the central environmental watchdog, has sought strong collaborative relationships with environmental NGOs (Pan, 2005). The disclosure of the information on pollution emissions of enterprises remains strongly controlled, except for a few cases where provincial or municipal Environmental Protection Bureaus publicized blacklists of top polluters in their jurisdictions.

Shi and Zhang (2006) conclude that in the long term, greater openness and integration will be beneficial to the modernization of China's industrial environmental governance. However, they state that the question remains whether it will be enough to protect China's (and the global) environment; but there seems to be little alternative.

1.2.3.3 Qi (2008)

Also Qi (2008) posits that the scope and scale of China's miraculous economic growth are matched only by the nation's massive resource destruction and environmental degradation in the last two decades. He observes that china is facing unprecedented challenges in its efforts to protect the environment and natural resource base: the rapid deterioration of the nation's environmental quality and depletion of its natural resources are threatening the lives and health of the largest population in the world and the very potential for sustained growth of the economy. Qi (2008) reports that one out of every five cities in the country suffers from serious air pollution; two thirds of all cities experience shortage of drinking water; one third of the land area is affected by acid rain; one third of land suffers from soil erosion and desertification; more than 90% of natural grasslands are degraded and overall biodiversity is threatened. Based on newly developed Environmental Performance Index ranking of 133 nations, on 16 indicators of environmental quality and policy performance, China ranked 94th, below all the developed and most of the developing nations of the world. Qi also reports that not only is China the second largest green house gas emitter in the world after the United States, but projections are that due to a number of geographical, social, and climatic conditions, China will be particularly hit by climate change (Qi, 2008). Qi notices that these threats call for urgent action and effective environmental governance.

Qi (2008) provides a deep review of existing theoretical interpretations of Chinese environmental problems:

a. The development stage theory:
   It considers a close relationship between environmental quality and the level of economic development. When the state of economic development is low as in the pre-industrial period, environmental quality is high because pollution and other environmental damage are minimal due to low level of anthropogenic activities. As the economy develops, environmental damage increases as a result of increased human activities, low awareness of the consequence of environmental deterioration, and lack of regulation and intervention for protecting the environment. Thus at the middle level of economic development as seen in China now, environmental damage is high and environmental quality is low. However, as the economy further develop into even higher level, the environmental quality will increase due to better environmental management and to the fact that the business and society can afford spending on prevention and damage control of environmental problems. A widely cited empirical evidence for the development stage theory is the so-called environmental Kuznets Curve.

b. The development approach theory:
   The development approach theory attributes the environmental problems to the mode of economic development. Based on the production factors, one can identify different economic production types as labor intensive, capital intensive, technology intensive, or resource intensive (land, mineral, water etc.). Each type of production has a unique impact on the environment. China's industrialization is characterized by intensive resource use and labor input, and low resource use efficiency. Environmental degradation occurs when resource is overly extracted and utilized, and when much waste is produced from the production and

consumption. China became a big workshop that produces industrial products for the world. Industrial production, especially in the industry with high material and energy input, tends to be associated with environmental pollution. The model of industrialization and economic development that China has chosen or developed into has major environmental impacts.

c. Political system theory:
   Qi (2008) observes that associating the environmental problems with certain political systems is nothing new. In 1970s when the first World Conference on Human Environment took place in Stockholm, Sweden, the world was still divided between East and West, or the camps of socialism and capitalism. Qi argues that environmental pollution was earnestly considered by the socialist camp as a unique feature of capitalism, something that would never happen under the socialist system. Today, such a claim would not be considered serious, in Qi's opinion. Yet, he observes that some still think political system is a big explanatory variable. For example, that the state of democracy, or lack of it, is the cause of problems;

d. Environmental enforcement and compliance theory:
   According to Qi's researches, three factors are often cited, in a sequence, to interpret the causes of environmental problems in China. They are incomplete legal system, non-compliance and lax enforcement. For example, while explaining the grant scale of non-compliance, a phenomenon is often noted that compliance costs more than paying the penalty for violation of the law and regulations. Thus, a rational polluter must prefer paying the penalty to comply with the law.

e. Institutional capacity theory:
   The institutional capacity theory simply points to the fact that inadequate capacity in the government is an important factor for lack of effective enforcement. Inadequate capacity may mean:
   - lack of government agencies dedicated to environmental protection as in China prior to 1983;
   - the designated agencies does not have the authority and power needed for the job;
   - constraints from interagency interaction and trans-jurisdictional frictions;
   - understaffing;
   - insufficient resources and skills in the designated agencies.

1.2.3.4 Mol (2009)

Mol (2009) observes that while national systems of environmental governance in most OECD countries have shown a considerable degree of stability over the past two decades, in China environmental governance is in flux (Carter and Mol, 2007). Mol (2009) reports that between 1991 and 2007, the staff of state environmental authorities increased from 70 000 to well over 170 000 and governmental environmental investments increased from RMB 10 billion to RMB 340 billion (and from 0.6% of GDP to 1.36% of GDP). Equally astonishing, in author's opinion, is the – still ongoing – transformation in environmental governance institutions, the subject of the Mol's (2009) paper.
According to this study, transitions within the environmental state system are articulated around three main axes:

a. The content of environmental policy-making has been rapidly modernized and updated. New environmental laws, i.e. the 2002 Cleaner Production Promotion Law (Mol and Liu, 2005), the 2008 Environmental Information Disclosure Decree, and the 2009 Law on Promoting Circular Economy, and new environmental policy instruments, such as voluntary agreements (Elechhort and Bongardt, 2009) and emission trading (Tao and Mah, 2009), point at a harmonization of China's environmental policy with that of OECD countries. Regardless the strong international influence and cooperation, some typically Chinese environmental policies remain intact, such as the National Environmental Model City program (Economy, 2006)

b. Mol (2009) observes that decentralization and more flexibility in environmental policy-making and implementation are paralleled by moving away from a rigid, hierarchical, command-and-control system. Increasingly local and provincial Environmental Protection Bureaus and local governments are given – and taking – larger degrees of freedom in developing environmental priorities, strategies, financial models and institutional arrangements (Lo and Tang, 2006). This is motivated by past state failures in national environmental policy, but also part of a wider tendency of less centralized control, according to Mol (2009). The Quantitative Examination System for Comprehensive Urban Environmental Control and an emerging environmental auditing system are new developments in this regard (Mol and Carter, 2006; Gong, 2009; Gao, 2009). They ensure some form of national control, where environmental policy-making and implementation becomes decentralized;

c. A third major development is the strengthening of the rule of (environmental) law. According to Mol (2009), the system of environmental laws has led to the setting of environmental quality standards and emission discharge levels.

Mol (2009) observes that centrally planned economies did a poor job in setting the right price signals for a sustainable use of natural resources and a minimization of environmental pollution. With a turn to a social market economy this is changing. In China, environmental protection slowly becomes part of markets, prices and competition, in four ways:

a. Subsidies on natural resources (such as water and energy) are rapidly being abandoned, turning natural resource prices towards cost prices;

b. Economic incentives, fees and taxes are increasingly used, to influence (economic) decision-making of polluters. In particular, discharge fees (related to the amount of pollution, or the amount of pollution in excess of standards) are common;

c. Private companies are increasingly becoming involved in executing public tasks and services on the environment. Urban service provisioning in drinking and wastewater (Zhong, Mol and Fu, 2008), energy (Han, Mol and Lu, 2009), and solid waste management experiences all kinds of new public–private partnership models. Private national and international capital is included to remove financial shortages, poor service quality and inefficient operation;

d. In the wake of China's accession to the WTO, market demand increasingly triggers transparency, information disclosure (Liu and Ambumozhi, 2009) and greening of products and production processes.

Mol (2009) also observes that besides a direct involvement of citizens in the making and implementation of environmental policies, China is also providing more room for citizens to organize themselves, express their environmental concerns and set new public agendas for environmental reform (Tang and Zhan, 2008). Especially on a local level and around national prestige projects as the 2008 Beijing Olympics, Mol states that 'conventional' reflexes of suppressing environmental criticism are still frequently reported. However, compared with sensitive issues as Tibet, the Falun Gong and Taiwan, Mol argues that the environment seems to experience limited reporting restrictions (Mol, 2009). However, Mol concludes saying that many experiments prevail in some (usually the richer, eastern) provinces or metropolis and are absent in the peripheral and western ones.

1.2.4 Researches about Pollution Haven Hypothesis (Dean, Lovely and Wang, 2009; Peng et al., 2011)

1.2.4.1 Dean, Lovely and Wang (2009)

Dean, Lovely and Wang (2009) examine evidence from China in order to understand whether foreign investors may be attracted to weak environmental regulations. They start from the fact that at the center of the pollution haven debate is the claim that foreign investors from industrial countries are attracted to weak environment regulations in developing countries. Or rather if differences between countries' environmental regulations are turning poor countries into "pollution havens."

The main common argument is that stringent environmental standards in industrial countries lead to the relocation of dirty goods production away from high income countries toward developing countries, where standards are relatively weak (Dean 2001). Following Dean, Lovely and Wang's (2009) reasoning, a convincing test of the pollution-haven hypothesis (PHH) would surely examine foreign direct investment (FDI) outflows from industrial countries to all host countries. Instead of pursuing this objective, Dean, Lovely and Wang observe that previous researchers have searched for evidence of what Taylor (2004) calls a "pollution haven effect", the deterrence of exports or capital inflows by tighter environmental regulation. Dean, Lovely and Wang posit that the existence of a pollution haven effect is necessary, but not sufficient, for the PHH to hold. The say that while higher environmental costs must affect trade and investment flows for pollution havens to appear, these cost effects may be outweighed by other factors determining international flows. Studies focusing on the location of investment in the United States find evidence consistent with the PHH: Keller and Levinson (2002), List and Co (2000), and List et al. (2004) all find that regulatory costs deter investments in relatively stringent U.S. states.

Dean, Lovely and Wang (2009) test for evidence of pollution haven behavior by foreign investors in China, incorporating the methodological insights of these previous studies. Building upon Copeland and Taylor's (2003) firm production and abatement model, Dean, Lovely and Wang (2009) derive a model of FDI location choice in the presence of inter-provincial differences in environmental stringency, amended to include agglomeration and factor abundance. They use data on actual collected water pollution levies to construct a measure of provincial environmental stringency, drawing on annual Chinese environmental and economic censuses. This detailed information on the levy system allows the researchers to address endogeneity concerns directly.

Significant Chinese trade and investment liberalization in 1992 spurred vast FDI inflows from many source countries (Broadman and Sun,1997; Shuguang et al.,1998) and made China the single largest recipient of FDI flows to the developing world in 1995 (UNCTAD, 1996). According to Dean, Lovely and Wang (2009), the enormity and scope of FDI flows to China reduce the likelihood that environmental costs are the driving force behind them. However, the authors observe that environmental stringency varies dramatically across Chinese provinces. Thus, if reductions in compliance costs matter to investors, pollution haven behavior will be evident in their location choice across China.

Dean, Lovely and Wang's analysis addresses three important issues raised in the recent literature:

a. The impact of regulatory costs varies across industries by pollution intensity (Copeland and Taylor, 1994; Taylor, 2004);

b. Poor proxies for environmental stringency can lead to measurement error and endogeneity bias (Keller and Levinson, 2002). Using Chinese collected pollution levies and official water pollution-tax formula, Dean, Lovely and Wang are able to measure provincial environmental stringency and control for endogeneity arising from industrial concentration;

c. They further argue that omission of corruption and other location-specific attributes can lead to a spurious relationship between FDI and environmental stringency (Javorcik and Wei, 2004; Fredriksson et al., 2003; Keller and Levinson, 2002).

Dean, Lovely and Wang state that careful modeling of firm production and abatement decisions, inclusion of location fixed effects, and corrections for the effects of state ownership allow them to reduce the possibility of omitted variable bias.

1.2.4.1a FDI and environmental stringency in China

The distribution of foreign investment within China is highly uneven, as it is in most host countries (for evidence of FDI clustering, see Ondrich and Wasylenko, 1993; Head and Mayer, 2004).

Henley et al. (1999) report that 80% of cumulative FDI inflows is located in one of China's ten eastern provinces. This distribution clearly reflects the influence of special incentive programs (see Head and Ries, 1996) and the policy of gradual opening pursued before new guidelines were issued in 1992 (see Tseng and Zebregs, 2002; and Lardy, 1994).

However, as Huang (2003) notes, in comparison to other countries at similar stages of development, FDI inflows to China are remarkable for their wide distribution among industries and provinces (in the 1995 Industrial Census, no industry received more than 10% of total FDI. While interior regions received only 13% of cumulative FDI from 1992 to 1998, that exceeded all FDI inflows to India during the same period).

According to Henley et al. (1999), between 1985 and 1996, 66.4% of FDI into China came from ethnically Chinese sources: Hong Kong, Macao, and Taiwan. Much of this investment involved labor-intensive processing of imported inputs for re-export. The remaining 33.6% of FDI came from non-ethnically Chinese sources: mainly OECD countries, with the largest shares from the US (8%) and Japan (8%). Much of this investment was by transnational corporations to produce goods for the Chinese market. Dean, Lovely and Wang (2009) compiled data for a sample of equity joint-venture (EJV) investments undertaken during 1993–1996 using project descriptions available (EJVs are companies incorporated in China, in which foreign investors hold equity. See Fung 1997).

According to Dean, Lovely and Wang (2009),the water pollution levy system is the most fully developed mechanism in the Chinese pollution control regime.

Thus, they are able to combine the regulatory formula and data on total collected levies and wastewater to create a measure of de facto provincial stringency—the average collected levy per ton of wastewater.

1.2.4.1b Addressing environmental stringency and endogeneity

As said earlier, environmental stringency may itself be endogenous, thus blurring the relationship between stringency and FDI location choice. Dean, Lovely and Wang (2009) observe that one source of endogeneity might be two-way causality. Foreign investors might negotiate pollution levies with local authorities prior to choosing where to invest. This would imply that the levy itself is a function of the location choice of the firm. As the OECD (2005) states, there is evidence that local Environmental Protection Boards (EPBs) often negotiate the levels of fees with firms. In addition, EPBs are often impeded from fully enforcing environmental regulations, when local leaders believe the noncompliant enterprises are important for the local economy. However, the OECD study notes that negotiations between the EPBs and firms take place after the EPBs issue notices to collect discharge fees. Thus, such negotiations occur after location, production, and emissions decisions have been made by the firm and following an inspection by local authorities (Wang and Wheeler, 2005). In addition, Dean, Lovely and Wang (2009) report that recent evidence shows that state-owned enterprises (SOEs) have more bargaining power than other firms and that this has led to significantly lower environmental levies for SOEs relative to foreign-invested and Chinese private firms (Wang et al., 2003; Wang and Jin, 2006; Wang and Wheeler, 2005). This evidence suggests that two-way causality is unlikely to be a problem when it comes to a foreign investor's location choice.

But the influence of SOEs points to the importance of controlling for corruption and a second possible source of endogeneity—omitted variable bias. Fredriksson et al. (2003) and Javorcik and Wei (2004) argue that corruption may imply lower environmental charges, but may also imply a less attractive location in which to invest. Thus, Dean, Lovely and Wang (2009) argue that if corruption is omitted, low levies may not attract FDI even if the PHH is true. A similar bias may arise if income is omitted. Higher incomes may imply more stringent environmental regulations, but may also imply a larger local market and better infrastructure. If these variables are omitted, high levies might not deter FDI, even if PHH were true. Dean, Lovely and Wang (2009) proxy corruption using controls for state ownership.

1.2.4.1c No evidence of a pollution haven effect on average

Ignoring the variation in pollution intensity across industries, Dean, Lovely and Wang (2009) find no support for a pollution-haven effect in their sample. However, they find strong regional effects indicating that EJVs are much less likely to locate in the southwest and northwest and much more likely to locate in the coastal and northeast regions, relative to the central region. Inclusion of provincial fixed effects does not change the lack of support for a PH effect in the full sample. Investors are indeed attracted to cleaner provinces with higher incomes. Dean, Lovely and Wang (2009) find that the pollution levy is not a significant deterrent for firms in industries with low pollution intensity. On the other hand, investors in highly polluting industries are significantly less likely to choose a province with a high levy. This finding is consistent with haven-seeking behavior, but also supports the view that such behavior is conditioned by pollution intensity.

1.2.4.1d The source country of the investor matters

There is some evidence from firm surveys that non-ethnically Chinese investors transfer more advanced technology in their Chinese investments than do investors from ethnically Chinese countries (Brandt and Zhu, undated). Dean, Lovely and Wang's (2009) hypothesis is that the levy will have a stronger deterrent impact on ethnically Chinese firm location decisions than on non-ethnically Chinese firms, all else equal. They conclude that ethnically Chinese investors are deterred by more stringent pollution standards, but only when investing in pollution intensive activities. In contrast, non-ethnically Chinese investors do not engage in significant pollution-haven seeking behavior within China.

1.2.4.1e The investment decision is nested

Dean, Lovely and Wang (2009) estimate a nested logit specification. The investor is assumed to first choose the region in which to invest and then the province within that region. Thus, the nested logit analysis supports the conclusion that only ethnically Chinese investment in highly polluting industries is significantly deterred by stringent pollution regulation.

One explanation for Dean, Lovely and Wang's (2009) findings may be technology differences. Profit-maximizing behavior implies that PH behavior is conditioned by technology. As Bhagwati (2004) has argued, richer countries have higher environmental standards, which have induced innovation and production of environment-friendly technology (Lanjouwand Mody,1996), so that FDI from these countries often employs newer, cleaner technology even in locations where standards are relatively weak. In contrast, entrepreneurs in poorer countries with lower standards typically use older, less "green" technologies and may import them as second-hand machinery. If regulatory costs are non-negligible, they might affect decisions of investors from poorer rather than richer countries.

1.2.4.2 Peng et al. (2011)

Peng et al. (2011) employ impulse response function of VAR model and the estimation variance decomposition method to investigate the two-way dynamic relationship between environmental regulation and FDI during 1985 to 2009. They start from the observations that current Chinese researches mainly focus on discussing the times series models, cross section data models and panel data models, and the conclusions differ among these researches. For instance, Ying and Zhou (2006) claim that the relation between environmental regulation and FDI fits the "hypothesis of pollution haven" after analyzing the time series model (1985-2003) and panel data model (2000-2003). Yang (2003) employs a panel data model using the data from 1998 to 2001. Wu (2007) also employs a panel data model but uses the data of 30 provinces of mainland China in successive 7 years (1998-2004). Both of them find out that the environmental regulation indeed has a negative effect on FDI in some extent. Chen (2009) employs a province-level panel data of China from 1994 to 2006, and claims that the environmental regulation has significant restraining effect on FDI.

Peng et al. (2011) make some observation on previous literature: first, most approaches chose a single index to illustrate environmental regulation which causes deviations when analyzing the relationship between environmental regulation and FDI. Second, the economic theory models used by most researchers still need to be improved.

Although, it is difficult to construct a model containing all influencing factors when studying the relationship between environmental regulation and FDI. Peng et al. (2011) think that vector autoregressive model (VAR) presented by Sims (1980) provides a simple alternative method, as it can better be used to analyze the dynamic influence among the variables. Compared to simultaneous equations and CGE model estimation method, VAR model has the following advantages: all the variables in VAR model are treated as endogenous variables and they are placed into equations symmetrically. The variables are less constrained by the current theories; and the model can be used to analyze the long-term dynamic influence among variables. The model can avoid the problem of missing variables. Besides, Peng et al. (2011) adopt generalized impulse response function (GIRF) to achieve the object that better describes the economic meaning of VAR model results. Thus, Peng et al. (2011) employ the VAR model and use two kinds of Chinese environmental regulation indexes in 1985-2009 to investigate the two-way dynamic influence between environmental regulation and FDI.

According to Peng et al. (2011), the result of generalized impulse response shows, on the one hand, that environmental regulation is an important factor influencing FDI. On the other hand, they notice that FDI has positive effect to environmental regulation. The impact of environmental regulation exerting to FDI become less and less in long-term that verifies “hypothesis of pollution haven” (Peng et al. 2011). The positive impact response shows that the inflows of FDI would cause the deterioration of ecology and the subsequent interference of governments which gives pressure to the transformation of environmental regulation standard. Peng et al. (2011) observe that this feedback mechanism usually has certain lag effects, so the feedback effect of

FDI exerting to environmental regulation often appears after certain periods. The result of variance decomposition shows that FDI play an important role in the estimated variance of environmental regulation; this means it is necessary to pay attention and tale measures to promote the positive effects of FDI exerting to environmental regulation. On the other hand, the estimated variance contribution of environmental regulation exerting to FDI is relatively low. Peng et al. (2011) conclude that, considering some governments use none environmental regulation to attract FDI, which would cause a worse environmental condition, it is mandatory to pay enough attention to the importance of environmental regulation. To avoid the case of "regulation race to the last", it is necessary to reform the environmental management system and to build a effective one.

1.2.5 Analysis of impacts of environmental regulation on productivity and wages (Managi and Kaneko, 2005; Xu,2007; Mishra ans Smyth, 2012)

1.2.5.1 Managi and Kaneko (2005)

Managi and Kaneko (2005) measure and analyse the determinants of various components of total factor productivity within a joint-production model of market and environmental outputs in China from 1992 to 2003. Managi and Kaneko (2005) report that weak enforcement of environmental regulations has been recognized as a major problem in China. Growth of productivity plays an important role in GDP growth in China (Wang and Yao, 2003). In addition, the costs (and availability) of alternative production and pollution abatement technologies, which are important determinants of the environmental compliance cost, are also influenced by productivity (e.g., Jaffe, Newell and Stavins, 2003). Thus, it is important to understand the interaction between productivity change and environmental policies, which influence the compliance costs. In the long run, the most important single criterion on which to judge environmental policies might be the extent to which they spur new technology toward the efficient conservation of environmental quality (Kneese and Schultze, 1978; Robinson, 1995).

Managi and Kaneko (2005) observe that successful economic and environmental policies can contribute to technological or efficiency improvements by encouraging, rather than inhibiting, technological innovation. Although a large number of studies have been made on the constituents of technological change (Griliches 1994), little was known about the empirical evaluation of policies that encourage (or discourage) productivity progress and/or regress in China before Managi and Kaneko (2005). Managi and Kaneko's (2005) results for market output are consistent with the literature that there has been considerable total factor productivity growth in China (e.g., Jefferson *et al.*, 2000), while environmental managements in China have not effectively regulated wastewater, air and solid waste pollutants emissions over the same periods. Detecting the determinants of these factors, they found the "international spillover, *FDI*" instead of "domestic invention, *Patent*" is the major factor to increase the market productivity growth. While FDI helps economic development by encouraging market productivity improvements, it does not lead to a positive consequence for environmental technologies where FDI does have negative coefficients though they are not significant. Thus, Managi and Kaneko (2005) say that FDI may lead to more environmental damage since firms in advanced countries might avoid rigid environmental regulations.

Managi and Kaneko (2005) find the levy to have negative consequences to environmental productivities. They conclude that the levy system needs to be re-considered and by pointing out several problems of the current system in the following areas:

a. Enforcement of environmental laws is limited and policies and firms' environmental managements are insufficient. For example, the levy rate is less than the average cost of pollution abatement partially because the levy fees are not indexed for inflation, and, for state-owned enterprises, they can be included under costs and later compensated through price increase or tax deductions (Sinkule and Ortolano, 1995);

b. Smaller enterprises tend not to pay levy though they share significant rate of total industrial outputs;

c. The cost of installing pollution abatement facilities is usually not subject to financial assistance from the commercial banks.

1.2.5.2 Xu (2007)

Xu (2007) thinks that the enactment of environmental regulation will bring negative influence on productivity. He asks: if China strictly executes environmental regulations, how will their impact on productivity be? In his paper, Xu (2007) uses the data of 1990s to investigate it. Xu (2007) observes that the fact that the eastern coastal regions developed first resulted in unbalanced development in China, that is, there are gaps among provinces for technical efficiency and productivity. Therefore, he connects the analysis of impacts of environmental regulation on technical efficiency and productivity loss with China's regional economy.

The purpose of Xu (2007) is to analyze the impacts of strict environmental regulation on technical efficiency and productivity loss in 28 provinces and municipalities of China, especially to focus on the difference of impacts of environmental regulation in three regions. He tries to find which pollutant brings larger cost due to environmental regulation between wastewater and SO2. In addition, he also wants to know the movement of industrial pollutions due to unbalanced development among three regions. Xu (2007) follows radial efficiency measure (Fare et al., 1986) of Data Envelopment Analysis approach based on output distance function.

There are two main methods used in measuring the impacts of environmental regulation on technical efficiency and productivity. One is the radial efficiency measure which considers the increase of desirable outputs and pollutants. Another is the hyperbolic efficiency measure that allows for the improvement of production and the reduction of pollution simultaneously. China paid attention to economic development policy more than environmental policy in the 1990s. It is considered that China could not practically distinguish desirable outputs and pollutants and almost merely pursued the increase of desirable outputs and pollutants. As consequence, Xu (2007) uses the radial efficiency measure.

Xu (2007) estimates technical efficiencies for the disposability of pollutants and compares the level of technical efficiency change due to environmental regulation. In addition, he measures the productivity loss came from environmental regulation by technical efficiency change. The variables in his paper are desirable output, pollutants and inputs. The desirable output is real GDP of the manufacturing industry. Pollutants include industrial wastewater, SO2 and waste solids. Inputs are real capital stock and labor force of the manufacturing industry.

According to economic growth level, Xu (2007) classifies 29 provinces and municipalities into three regions. The most developed region is the East, followed by the Middle and the West. He focuses the research on three regions where technical efficiencies increased due to the enforcement of environmental regulation.

As for the impact of environmental regulation on productivity loss, three regions showed different results respectively. The rate of productivity loss from environmental regulation for the East is 7.08%, while the Middle is 2.22%, and the West is 3.05% when considering three pollutants including wastewater, SO2 and waste solids simultaneously. Xu (2007) observes from his results that the East paid the largest cost for controlling environmental pollutions. That is why back technology and pollutions were moved from the East to the Middle and the West from 1990s, he argues. Xu (2007) finds that all of three regions did not pay large cost for controlling SO2 under the assumption of strict enactment of environmental regulation. It implies that China can strength environmental regulation for SO2 without corresponding large cost increase in the current situation. However, the productivity losses from other pollutants are not low.

The output losses from regulation are not easily ignored, especially for the East, since they account for more than a half of growth rate of GDP when including three pollutants. With strengthening environmental regulation, Xu (2007) suggests that China has to change its old production pattern, which merely purses the increase of outputs but does not distinguish desirable output and pollutants, to sustainable production pattern which achieves the increase of desirable outputs and the reduction of pollutants simultaneously. In one word, resource-saving, energy-saving and the development of environmental technology are fundamental ways to decrease the impact of environmental regulation on productivity loss in China.

1.2.5.3 Mishra and Smyth (2012)

Mishra and Smyth (2012) address the following question: who bears the cost of pollution abatement and to what extent do firms pass the cost of pollution abatement back to labor in the form of lower wages? According to authors, this question is important to address in the Chinese context because China's strategy of growing rapidly through burning coal has been a major reason for the rapid growth in urban incomes. They observe that rapid industrial growth has literally lifted tens of millions of people out of poverty. If the Chinese Government is going to adopt a more balanced approach to economic growth, it is important to be aware of the potential costs to labor in terms of lower wages. A more balanced growth path has been lauded because of its positive effect on urban living standards and the health of the urban populace via reduced pollution levels (Li et al. 2004, World Bank 2007). However, Mishra and Smyth (2012) argue that to the extent that the costs of pollution abatement are passed on to workers in the form of lower wages, there is also a potential adverse effect on living standards. The effect on the hip pocket is also likely to influence the extent to which China's urban workers support a more balanced approach to economic growth. If the cost in terms of lower wages is too high, support for balanced growth policies are likely to wane.

A series of theoretical studies have examined the backward incidence of pollution control (Yohe 1979, Yu and Yu 1982, Forster 1984, Wang 1990). These studies suggest that expenditure on pollution abatement is a cost of production that shifts the supply curve to the left. Previous studies computed willingness to pay for clean air, based on wage differentials across cities (see e.g. Cropper and Arriaga-Salinas 1980). Another series examined whether there is a wage premium for working in pollution intensive industries (Cole et al. 2009). Others analyzed the extent to which firms shift the burden of mandated social security obligations, or payroll taxes, back on to workers in the form of lower wages (Holmund 1983, Gruber and Krueger 1991, Gruber 1994, 1997). Others again considered the effect of pollution abatement on labor productivity (see e.g. Christiansen and Haveman 1981). Few studies have directly examined the effect of pollution abatement on the demand for labor or wages. As Morgenstern et al. (2002) and Cole and Elliott (2007) noted, there are several ways through which the demand for labor could be influenced by the stringency of environmental regulations:

a. environmental regulations may increase production costs that, in turn, increase output prices, reduce final demand and hence the demand for labor;
b. alternatively as environmental regulations increase production costs, more inputs will be needed to produce the same amount of output, which will have a positive effect on the demand for labor;
c. the actual process of abating pollution and the post-abatement production equilibrium may be more or less labor intensive than the pre-

abatement production, which could result in a positive or negative effect on labour demand.

Mishra and Smyth (2012) examine the backward incidence of pollution abatement on wages, using a unique matched employer-employee dataset collected from Shanghai. Using the Mincer (1974) earnings function, Mishra and Smyth (2012) present four alternative specifications in which different combinations of the dummy variables for certification, occupation, ownership and position are included. Their results suggest that for those individuals surveyed, hourly wages were lower in firms which reported implementing measures to control pollution. Their results imply between a 13.8% and 18.8% reduction in the average hourly wage for those individuals in firms which reported implementing measures to control pollution.

These results are consistent with abating firms passing on the costs of abatement to workers in the form of lower wages, rather than the existence of a compensating wage differential where workers in high polluting firms (which are more likely to undertake abatement) demand higher wages.

Of the other interesting results in Mishra and Smyth (2012), for each additional 1% in the number of employees, the hourly wage is about 1 RMB lower (approximately 1% lower). Each additional year of schooling equates to an additional 1–1.1 RMB per hour. Males earn 2–2.4 RMB per hour higher than females. There is a wage premium for being married and being a member of the Communist Party. Married individuals earn 1.5–1.6 RMB per hour more than those who are single, while Communist Party members earn 1.8–2.1 RMB per hour more than those who are not members of the Communist Party. To put the cost to workers of firms implementing pollution controls in perspective, based on the upper bound estimate of 1.9 RMB per hour, the returns for working in a firm which does not implement measures to control pollution, relative to one that does, is approximately equivalent to the returns for being a member of the Communist Party (1.8–2.1 RMB per hour), or two additional years of schooling (2–2.2 RMB per hour).

Chapter 1.3
Event study literature

Event studies in finance can be traced back to the 1930s when there was a first study by Dolley (1933) on price effects. Other attempts were made in the late 1960s by Ball and Brown (1968) and Fama, Fisher, Jensen and Roll (1969) to capture the effects of certain events. Around a quarter of a century later, a technique was developed by Brown and Warner (1985) and at present this model is extensively adapted and modified by financial researchers when it comes to studying the consequences of a particular occurrence. Nevertheless, Mills, Coutts and Roberts (1996) argue that one must be careful when it comes to selecting an appropriate model for an event study, and until now certain difficult choices have had to be made when carrying out such studies. I will provide a review of a paper by Cam and Ramiah (2011) which explain the effects that these choices may have on researches' results.

1.3.1 The main reference for event study methodology in my work: Brown and Warner (1985)

Brown and Warner (1985) examine properties of daily stock returns and how the particular characteristics of these data affect event study methodologies for assessing the share price impact of firm-specific events. The paper extends earlier work (Brown and Warner 1980) in which the authors investigate event study methodologies used with monthly returns. According to Brown and Warner (1985), daily and monthly data differ in potentially important aspects. For example, daily stock returns depart more from normality than do monthly returns (Fama 1976). In addition, the estimation of parameters from daily data is complicated by non-synchronous trading, a complication described as 'especially severe' by Scholes and Williams (1977).
Brown and Warner (1985) first study the statistical properties of both observed daily stock returns and of daily excess returns, given a variety of alternative models for measuring excess returns. To examine the implications of these properties for event studies, a procedure similar to one developed previously in Brown and Warner (1980) is applied to observed daily returns. Various event study methodologies are simulated by repeated application of each methodology to samples that have been constructed by random selection of securities and random assignment of an 'event-date' to each security. Brown and Warner (1985) state that with randomly selected securities and event dates there should be no abnormal performance on average if performance is measured correctly. They study the probability of rejecting the null hypothesis of no average abnormal performance when it is true. They also evaluate the power of the tests, that is, their probability of detecting a given level of abnormal performance.

The use of daily data in event studies involves a number of potentially important problems. These can be summarized as follows, from Brown and Warner (1985):

a. Non-normality: the daily stock return for an individual security exhibits substantial departures from normality that are not observed with monthly data. (Fama 1976);

b. Non-synchronous trading and market model parameter estimation: when the return on a security and the return on the market index are each measured over a different trading interval, ordinary least squares estimates of market model parameters are biased and inconsistent. With daily data, the bias can be severe (Scholes and Williams, 1977; Dimson, 1979);
c. Variance estimation: with both daily and monthly data, estimation of the variance of the sample average excess return is important for tests of statistical significance. Brown and Warner (1985) investigate several variance estimation issues. The first issue is the time-series properties of daily data: as a consequence of non-synchronous trading, daily excess returns can exhibit serial dependence. (Ruback, 1982). The second issue is cross-sectional dependence of the security-specific excess returns. (Brown and Warner, 1980; Beaver 1981; Dent and Collins 1981). The third issue is stationarity of daily variances: there is evidence that the variance of stock returns increases for the days immediately around events such as earnings announcements (Beaver, 1968; Patell and Wolfson, 1979).

Important properties captured by simulation: the basis for inference in event studies is a test statistic, typically the ratio of the average excess return to its estimated standard deviation. A complication is that variables such as the degree of non-synchronous trading can simultaneously affect both average and variance estimators (Scholes and Williams, 1977).
Brown and Warner (1980) propose a market adjusted model but they argue that the average adjusted model does not differ from the market adjusted model. The daily returns at time *t,* DR_{it} for all individual stocks *i* in a sample are estimated using the following formula

$$DR_{it} = \ln\left(\frac{SRI_{it}}{SRI_{it-1}}\right)$$

where SRI_{it} is the stock return index for stock *i* at time *t.*
The e*x-post* abnormal return $\left(AR_{it}^{BW}\right)$ for each firm following the Brown and Warner (1985) is calculated as the difference between the daily return and the expected return, $E(R_{it})$ and is represented by the equation:

$$AR_{it}^{BW} = DR_{it} - E(R_{it})$$

where the expected return, $E(R_{it})$, is the average return over a pre-event period. The average is estimated over a 239-day period starting 244 days prior to the event day t and closing 6 days before the event and is represented by the equation:

$$E(R_{it}) = \frac{1}{239}\sum_{t=-244}^{-6} DR_{it}$$

As a second option Brown and Warner (1985) propose to estimate the expected return with an ordinary least squares (OLS) regression utilizing the market model:

$$A_{i,t} = R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i R_{m,\ t'}$$

where $\hat{\alpha}_i$ and $\hat{\beta}_i$ are OLS values from the estimation period.
The standardized excess return t–test (Brown & Warner 1985) is used to measure level of statistical significance of the abnormal returns and cumulative abnormal return on the event day. It consists in using a t-statistic like in the equation below:

$$\frac{\bar{A}_t}{\hat{S}(\bar{A}_t)}$$

Where:

$$\bar{A}_t = \frac{1}{N_t}\sum_{i=1}^{N_t} A_{i,t'}$$

$$\hat{S}(\bar{A}_t) = \sqrt{\frac{\sum_{t=-244}^{t=-6}(\bar{A}_t - \bar{\bar{A}})^2}{238}}$$

$$\bar{\bar{A}} = \frac{1}{239} \sum_{t=-244}^{t=-6} \bar{A}_t$$

and where N_t, is the number of sample securities whose excess returns are available at day t.

Brown and Warner (1985) observe that the results from simulations with daily data generally reinforce the conclusions of their previous work with monthly data: methodologies based on the ordinary least squares market model and using standard parametric tests are well-specified under a variety of conditions. They also observe that the characteristics of daily data generally present few difficulties in the context of event study methodologies. Furthermore, according to the authors, some of Brown and Warner's (1985) results indicate a striking similarity between the empirical power of the event study procedures and the theoretical power implied by a few simple assumptions and 'back of the envelope' calculations. This reinforces the view that the use of daily data is straightforward.

Hamilton (1995) provides an example of event study methodology applied to environmental events. This study investigates whether pollution data released by the EPA in the June 1989 Toxics Release Inventory (TRI) were "news" to journalists and investors. This study examines the reaction of two groups, journalists and stockholders, to the first release of the TRI data. The results indicate that the higher pollution figures (such as air emissions or offsite shipments of toxic waste) were in a firm's TRI reports, the more likely print journalists were to write about the firm's toxic releases. Stockholders in firms reporting TRI pollution figures experienced negative, statistically significant abnormal returns upon the first release of the information. According to Hamilton's (1995) estimates, these abnormal returns translated into an average loss of $4.1 million in stock value for TRI firms on the day the pollution figures were first released.

1.3.2 The influence of model choices in event studies: Cam and Ramiah (2011)

The consequences of choosing a particular technique and forgoing others are not properly documented in the existing literature previous than Cam and Ramiah (2011): this study makes a contribution in that area. Unlike most empirical studies using event study methodology, Cam and Ramiah (2011) do not implicitly assume that alternative asset pricing models will generate the same results. Instead, they argue that two outcomes are possible. The first one is that the results of an event study are the same regardless of the different approaches used and this is consistent with the underlying assumptions of most existing examinations. They argue that researchers must conduct these alternative tests as robustness tests to confirm their findings. The second scenario that they propose, although rare in authors' opinion, occurs when the results of an event study changes with alternative tests. Such an outcome demonstrates that the quality of the result can be highly subjective and therefore one must be cautious when drawing conclusions. Cam and Ramiah (2011) follow Brown and Warner (1985), adding CAPM and Fama and French 3-factors model to their analysis. Cam and Ramiah (2011) also control for behavioral short-term phenomena by estimating the Cumulated Abnormal Return on 5 subsequent days after the event day, as the equation below:

$$CAR_{it}^{BW} = \sum_{t=1}^{5} AR_{it}^{BW}$$

Cam and Ramiah (2011) also perform the Corrado and Zivney (1992) non-parametric rank test as a robustness test. The proponents of this non-parametric test argue that the rank t-test performs better than the standardized tests when the distribution is not normally distributed (Campbell and Wasley 1993; Campbell, Lo and MacKinlay 1997; Hamill, Opong and McGregor 2002; MacKinlay 1997).

Cam and Ramiah (2011) observe that most event studies do not report their alternative tests as robustness tests and consequently a question remains as to whether or not different methodologies yield different outcomes. They illustrate this by analyzing abnormal returns estimated from the initial impact of the September 11, Bali, Madrid and London bombings on different industries in the United States in Cam and Ramiah (2011). The objective of this paper is to demonstrate that the results from these different events are susceptible to changes and may depend on the method used by the researcher. First, Cam and Ramiah (2011) document how abnormal returns vary according to various expected return estimation techniques. Abnormal returns are estimated using three different approaches: namely Brown and Warner (1985), the CAPM, and the Fama and French three-factor model. Secondly, they show that when the size of abnormal returns are comparable, the statistical significance of the returns is variable, because this is dependent on econometric adjustments made, such as CAPM and the Fama and French three-factor model. Using these different models they illustrate how using a different technique generates a different outcome.

Cam and Ramiah (2011) conclusions challenge the implicit assumption that different event study techniques generate the same outcomes. Starting with the Brown and Warner (1985) model, where they argue that there is no consideration of risk in the determination of expected return, they subsequently control for systematic risk from the market using the CAPM. They show that the abnormal return from these two models differs after controlling for this first risk factor. Given that the American equity market is prone to two additional risk factors, namely size and value/growth systematic risk (Fama and French 1993), they also control for them as well, using the Fama and French three-factor model.

Cam and Ramiah (2011) show that the introduction of these two factors has a significant impact on the abnormal returns, and thus the abnormal returns from these three models are different. Another interesting finding from Cam and Ramiah (2011) is that this effect varies with the different classes of abnormal return. In other words, the effects observed for negative abnormal returns can be different from the positive abnormal return ones.

When econometrics adjustments are made to the CAPM and Fama and French three-factor model, they observe a weak change in the abnormal return and thus the economic benefit of financial econometrics becomes questionable.

Cam and Ramiah (2011) found that an analysis controlling for systematic risk factors usually detects fewer and smaller abnormal returns than an evaluation based on Brown and Warner (1985).
In some instances, studies using the Brown and Warner (1985) approach can detect twice as many abnormal returns than studies using asset pricing models. Cam and Ramiah (2011) thus warn researchers to be aware that abnormal returns are sensitive to the methodology used.

1.3.3 Three examples of event study methodology applied to terrorism and natural catastrophes

The very reference used to work on my project and write Ramiah, Pichelli, Moosa (2012a, 2012b) papers is constituted by some examples of application of event study methodology which use as study events the Boxing day tsunami in 2004 (Ramiah, 2012) and five world-impacting terrorist attacks (Ramiah et al., 2010; Graham and Ramiah, 2012). The main methodology features contained in these papers have been subsequently used for this thesis project and they are therefore reported in the chapter dedicated to methodology (see Chapter 2).

1.3.3.1 Ramiah et al (2010)

Ramiah et al (2010) investigate the impact of five terrorist attacks on equities listed on the Australian Stock Exchange (the September 11 and Bali, Madrid, London and Mumbai bombings). Following the Global Industry Classification Standard, they analyze how these events affect the different sectors in Australia. Using parametric and non-parametric tests, they investigate the relationship between stock returns for equities listed in these sectors and terrorist attacks. They report significant short-term negative abnormal returns around the September 11 attacks and to a lesser extent, the Madrid and London Bombings. Their evidence shows a weak positive equity response to the Bali bombing, and no response from the Mumbai attack in the Australian market. They also document negative industry abnormal returns as high as 37.30% on the day in the Utilities sector. Ramiah et al (2010) find out that systematic risk of certain sectors increased after the events of September 11 but remained unchanged for the other attacks. Using the Bali Bombing evidence, the authors argue that terrorist attacks do not always nurture negative sentiment but can also be good for the neighboring country. Another interesting finding is that the Mumbai bombing had no effect on the Australian market. The Mumbai evidence can be used to demonstrate that some capital markets can be insensitive to some terrorist attacks, and thus the authors observe that investment havens may exist even just after an attack.

1.3.3.2 Graham and Ramiah (2012)

The adaptive expectations model posits that economic agents' expectations adjust by constant proportion of previous discrepancy and the forecast for the following period is the same for all the subsequent future periods, if the expectation is a permanent. Graham and Ramiah (2012) apply this hypothesis and event study methodology to examine the impact of five terrorist attacks (New York World Trade Centre, Bali, Madrid, London, and Mumbai) on Japanese industries. Being a watershed event, the negative impact of the attacks in the U.S. was apparent. Their evidence suggests an initial step-change in risk incorporated into expectations after the U.S., Bali and Madrid bombings. The two subsequent attacks had no effect on the market implying that risk expectations in Japan after the initial terrorist attacks were not subject to forecast error. Following the adaptive expectations model, Graham and Ramiah (2012) initially hypothesize that those subsequent terrorist events after the September 11 2001 bombings in the U.S. would not have significant impact on abnormal returns and risk in Japanese equity markets as investors have already incorporated geopolitical risks resulting from terrorism in their expectations around the 9/11 attacks.
For the four terrorist attacks subsequent to September 11, Graham and Ramiah's (2012) results generally suggest no impact on abnormal returns on the first trading day immediately after the incidents. In terms of the short term systematic risk, they generally observe no change in most sectors following the terrorist attacks. However they observe a step-change adjustment in long term risk following the Bali and Madrid bombings but no effect resulting from the subsequent two attacks in London and Mumbai, implying that risk expectations in Japan after the initial terrorist attacks were not subject to forecast error.

1.3.3.3 Ramiah (2012)

Ramiah (2012) discusses the consequences of Boxing Day Tsunami on world stock markets. According to Roll (1988), stock markets throughout the world react differently to major events. Furthermore, Rietz (1988) and Barro (2006) postulate that rare and extreme events change risk premiums in financial markets. According to Ramiah (2012), the literature in the area of how international markets are affected by this incident is also sparse. Thus, the objective of Ramiah (2012) paper is to test the hypotheses of Roll (1988), Rietz (1988) and Barro (2006) regarding whether a major event, such as the Boxing Day tsunami, affects the volatility and return of capital markets throughout the world. The growing body of literature on the effect of disasters on GDP, wages, and labour markets shows that disasters in general have important and sizable effects (see Kahn 2005; Toya and Skidmore 2007; Strömberg 2007; Raschky 2008).

The findings of Ramiah's (2012) paper provide some support for the hypotheses of Roll (1988), Rietz (1988) and Barro (2006) because he observes that the Boxing Day tsunami has the potential to increase the long-term systematic risk of equity portfolios. Nonetheless, there were minimal statistical changes in the abnormal returns for most of the studied portfolios. These results lead to further consider the conclusions of Keys, Masterman-Smith and Cottle (2006) and Worthington and Valadkhani (2004) in terms of the insensitivity of financial markets to the tsunami.

Ramiah (2012) shows that equity markets (especially the industrial portfolios of countries that were directly affected and the market portfolios of other nations) were virtually insensitive to this event despite the negative sentiment that prevailed following the incident.

Ramiah (2012) argues that the effects that were observed are more likely to involve region-specific issues, as shown by Bird et al. (2007) and Bandara and Naranpanawa (2007).

1.3.4 The ancestor of this thesis: "How does the stock market react to the announcement of green policies?" (Ramiah, Martin and Moosa, 2012)

The objective of this study is to examine the effect of green policy announcements on the Australian stock market. This is an important issue, given the level of commitment that Australia has assigned to green policies, particularly with respect to climate change. Ramiah, Martin and Moosa (2012) focus on the measures undertaken by the Australian government to build a greener country by examining a series of green policies that have been announced since 2005. They concentrate on how the Australian stock market reacted to the Kyoto Protocol, the climate change review, the carbon pollution reduction scheme (CPRS), and renewable energy schemes.

One important question that the Australian government and equity investors ask about green policies is the uncertainty they instigate within the economy. Ramiah, Martin and Moosa (2012) study the impact of green policies on the short-term and long-term systematic risk of 35 industries. The change in short-term systematic risk and the overall short-term change in risk within an industry over the period 2005-2011 are estimated. Ramiah, Martin and Moosa (2012) draw two major conclusions from their findings. First, there is an industry effect in risk variation following the announcement of green policies. The outcomes can be positive, negative or neutral. The second conclusion is that the majority of sectors did not experience a change in overall short-term systematic risk.

They first use a regression with an aggregate dummy variable, whose coefficient should absorb the abnormal effect on event days. The aggregate dummy variable is created to represent the 19 announcements and this variable takes the value of one of the announcement date and zero otherwise. They observe, however, that conclusions may not be accurate as this first model provides a general result whereby positive reactions cancel out negative effects, leading to a neutral response.

They state thus that it is imperative to disaggregate the effects of each announcement, which allows researchers to identify the change in the short-term risk originating from each announcement. To that end another model, including a set of individual dummy variables is estimated. The individual dummy variables set is created to represent each one of 19 announcements separately and this variables takes the value of one of the announcement date and zero otherwise. Ramiah, Martin and Moosa (2012) detect in this way a statistical change in short-term systematic risk for more industries, which account for just over 30% of their sample.

Despite the problem associated with the first model as explained earlier, it is a good starting point for a risk analysis exercise as it provides an overall perspective. After this consideration Ramiah, Martin and Moosa (2012) create another version of this model that is equipped with some long-term dummy variables for the purpose of capturing the overall long-term change in systematic risk. At a first glance, the authors observe green policies to have more of a long-term, rather than short-term, effect on risk.

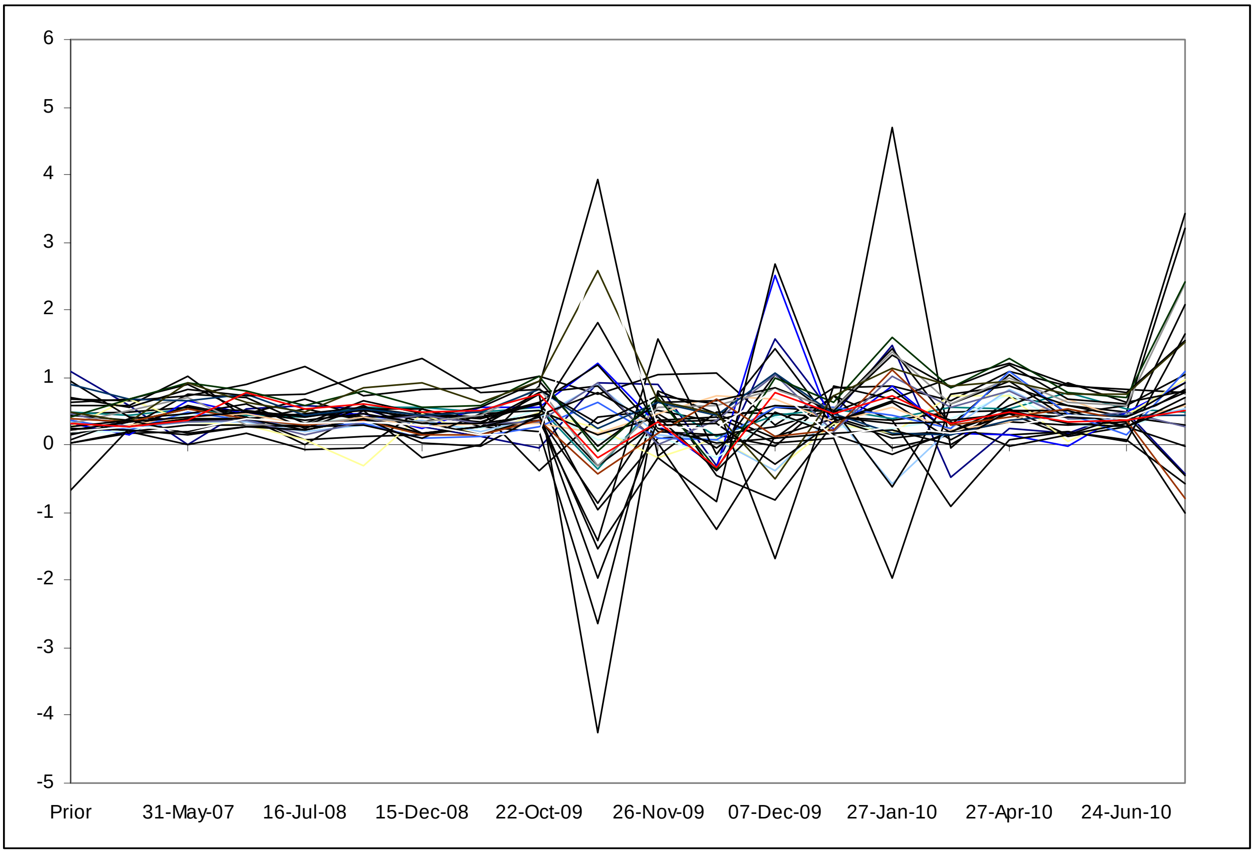
A very interesting finding of Ramiah, Martin and Moosa (2012) is thet systematic risk is affected by a reversal pattern. The diamond shapes observed in subsequent periods (as shown in Figure 8) provide an indication that similar interactions occur.

According to the Ramiah, Martin and Moosa (2012) three main conclusions can be drawn from this picture.

a) green policy announcements have led to a number of uncertainties through changes in the long-term systematic risk of industries.
b) there are industry effects whereby the policy implication varies from one industry to another in terms of the change in systematic risk (the long-term change can be either positive or negative).
c) the time series analysis of green policy announcements tends to lead to diamond risk.
d)

The objective of green policies is to reduce the production of toxic products and to move towards environmentally-friendly methods of production. The Australian government argued that the objective is to penalize the biggest polluters (top of the list are electricity producers). Ramiah, Martin and Moosa's study shows that the wealth of shareholders in the electricity industry was not affected—this is direct evidence that the biggest polluters are not affected by the introduction of green policies.

FIGURE 8 - Rolling Regression Estimates of Beta



Ramiah, Martin and Moosa (2012) make the assumption that polluters are passing (or capable of passing) higher costs to consumers. It is for this reason that green policies in their current form may not be effective in Australia. The shareholders of other industries that are not viewed as the biggest polluters experienced value destruction, with no compensation. Furthermore green policies create uncertainty in the market through diamond risk. In general, however, the effect on the Australian stock market seems to be mixed although the evidence shows more sectors experiencing negative than positive abnormal returns.

Chapter 1.4
Financial momentum

In order to improve Fama and French (1993) cross-sectional analysis methods, some authors from the 90s explored the impact of a fourth factor, in addition to Beta, SMB and HML used in Fama and French 3-factors model: the financial momentum factor (often called MOM). Among these authors, Narasimhan Jegadeesh and Mark Carhart hold particular interest.

1.4.1 The milestone for financial momentum: Jegadeesh and Titman (1993)

At the moment of writing their paper, Jegadeesh and Titman (1993), a popular view held by many journalists, psychologists, and economists was that individuals tend to overreact to information (Kahneman and Tversky, 1982; De Bondt and Thaler, 1985; Shiller, 1981).

A direct extension of this view, suggested by De Bondt and Thaler (1985, 1987), was that stock prices also overreact to information, suggesting that contrarian strategies (buying past losers and selling past winners) achieve abnormal returns. De Bondt and Thaler (1985) show that over 3- to 5-year holding periods stocks that performed poorly over the previous 3 to 5 years achieve higher returns than stocks that performed well over the same period. However, the interpretation of the De Bondt and Thaler's results were still being debated when Jegadeesh and Titman (1993) did their study. Some have argued that the De Bondt and Thaler results can be explained by the systematic risk of their contrarian portfolios and the size effect (Chan 1988; Ball and Kothari 1989; Zarowin 1990; and Chopra, Lakonishok, and Ritter, 1992).

Afterwards papers by Jegadeesh (1990) and Lehmann (1990) provide evidence of shorter-term return reversals. These papers show that contrarian strategies that select stocks based on their returns in the previous week or month generate significant abnormal returns. However, since these strategies are transaction intensive and are based on short-term price movements, their apparent success may reflect the presence of short-term price pressure or a lack of liquidity in the market rather than overreaction. Jegadeesh and Titman (1991) provide evidence on the relation between short-term return reversals and bid-ask spreads that supports this interpretation. In addition, Lo and MacKinlay (1990) argue that a large part of the abnormal returns documented by Jegadeesh (1990) and Lehmann (1990) is attributable to a delayed stock price reaction to common factors rather than to overreaction.

Jegadeesh and Titman (1993) analysis of NYSE and AMEX stocks documents significant profits in the 1965 to 1989 sample period for each of the relative strength strategies examined. They provide a decomposition of these profits into different sources and develop tests to evaluate their relative importance.

For example, the strategy they examine in most detail, which selects stocks based on their past 6-month returns and holds them for 6 months, realizes a compounded excess return of 12.01% per year on average.
Further tests by Jegadeesh and Titman (1993) suggest that part of the predictable price changes that occur during these 3- to 12-month holding periods may not be permanent. The stocks included in the relative strength portfolios experience negative abnormal returns starting around 12 months after the formation date and continuing up to the thirty-first month. For example, the portfolio formed on the basis of returns realized in the past 6 months generates an average cumulative return of 9.5% over the next 12 months but loses more than half of this return in the following 24 months.
Jegadeesh and Titman (1993) provide an interpretation of their results positing that transactions by investors who buy past winners and sell past losers move prices away from their long-run values temporarily and thereby cause prices to overreact. This interpretation is consistent with the analysis of DeLong, Shleifer, Summers, and Waldman (1990) who explore the implications of what they call "positive feedback traders" on market price. Alternatively, Jegadeesh and Titman (1993) provide the interpretation that the market underreacts to information about the short-term prospects of firms but overreacts to information about their long-term prospects. They find this plausible given that the nature of the information available about a firm's short-term prospects, such as earnings forecasts, is different from the nature of the more ambiguous information that is used by investors to assess a firm's longer-term prospects.

1.4.2 On financial momentum: possible explanations by Chan, Jegadeesh and Lakonishok (1996)

Following Jegadeesh and Titman (1993), Chan, Jegadeesh and Lakonishok (1996) focused again on financial momentum research. They starting from the statement that investment strategies that exploit such momentum, by buying past winners and selling past losers, predate the scientific evidence and was implemented by many professional investors. They noticed that the popularity of this approach grew to the extent that momentum investing constituted a distinct, well-recognized style of investment in the United States and other equity markets.

In contrast to the rich array of testable hypotheses concerning long- and short term reversals, Chan, Jegadeesh and Lakonishok (1996) remarked a woeful shortage of potential explanations for momentum. A previous article by Fama and French (1996) tried to rationalize a number of related empirical regularities, but failed to account for the profitability of the Jegadeesh and Titman (1993) strategies. In the absence of an explanation, the evidence on momentum stood out as a major unresolved puzzle. Chan, Jegadeesh and Lakonishok (1996) said that from the standpoint of investors, that state of affairs should also have been a source of concern. The lack of an explanation suggests them that there is a good chance that a momentum strategy will not work out-of-sample and is merely a statistical fluke. The objective of their article was thus to trace the sources of the predictability of future stock returns based on past returns. Being natural to look to earnings to try to understand movements in stock prices, they explore this way to rationalize the existence of momentum. In particular, Chan, Jegadeesh and Lakonishok (1996) article relates the evidence on momentum in stock prices to the evidence on the market's underreaction to earnings-related information.

One possibility that Chan, Jegadeesh and Lakonishok (1996) propose is that the profitability of momentum strategies is entirely due to the component of medium-horizon returns that is related to these earnings-related news. If this explanation is true, then momentum strategies will not be profitable after accounting for past innovations in earnings and earnings forecasts. Affleck-Graves and Mendenhall (1992) examine the Value Line timeliness ranking system (a proprietary model based on a combination of past earnings and price momentum, among other variables), and suggest that earnings surprises account for Value Line's ability to predict future returns. Another possibility they provide is that the profitability of momentum strategies stems from overreaction induced by positive feedback trading strategies of the sort discussed by DeLong, Shleifer, Summers, and Waldmann (1990).

This explanation implies that "trend-chasers" reinforce movements in stock prices even in the absence of fundamental information, so that the returns for past winners and losers are (at least partly) temporary in nature. Under this explanation, it is expected that past winners and losers will subsequently experience reversals in their stock prices. Finally, it is possible that strategies based either on past returns or on earnings surprises (referred to as "earnings momentum" strategies) exploit market under-reaction to different pieces of information.

For example, an earnings momentum strategy may benefit from underreaction to information related to short-term earnings, while a price momentum strategy may benefit from the market's slow response to a broader set of information, including longer-term profitability. In this case it would be expected that each of the momentum strategies is individually successful, and that one effect is not subsumed by the other. Chan, Jegadeesh and Lakonishok (1996) conclude with the confirm that drifts in future returns over the next six and twelve months are predictable from a stock's prior return and from prior news about earnings.

They found that the returns for companies that are ranked lowest by past earnings surprise are persistently below average in the following two to three years. Security analysts' forecasts of earnings are also slow to incorporate past earnings news, especially for firms with the worst past earnings performance. According to Chan, Jegadeesh and Lakonishok (1996) the bulk of the evidence thus points to a delayed reaction of stock prices to the information in past returns and in past earnings.

1.4.3 A model derived from financial momentum: the Carhart's 4-factors pricing model (1997)

A direct implementation of these results was made by Carhart (1997) in a paper that analyze the persistence of mutual fund performance.

In this paper Carhart constructs a 4-factor model using Fama and French's (1993) 3-factor model plus an additional factor capturing Jegadeesh and Titman's (1993) one-year momentum anomaly. According to the author, this is motivated by the 3-factor model's inability to explain cross-sectional variation in momentum-sorted portfolio returns (Fama and French, 1996). Chan, Jegadeesh, and Lakonishok (1996) suggest that the momentum anomaly is a market inefficiency due to slow reaction to information. However, the effect is robust to time-periods (Jegadeesh and Titman, 1993) and countries (Asness, Liew, and Stevens, 1996).

The 4-factor model is consistent with a model of market equilibrium with four risk factors. Alternately, it may be interpreted as a performance attribution model, where the coefficients and premia on the factor-mimicking portfolios indicate the proportion of average return attributable to four elementary strategies: high versus low beta stocks, large versus small market capitalization stocks, value versus growth stocks, and one-year return momentum versus contrarian stocks.

Carhart (1997) employs the model to "explain" returns and leave risk interpretations to further studies. He estimates performance relative to the CAPM, 3-factor, and 4-factor models as:

$$r_{it} = \alpha_{iT} + \beta_{iT}\mathrm{VWRF}_t + e_{it} \qquad t = 1, 2, \cdots, T$$

$$r_{it} = \alpha_{iT} + b_{iT}\mathrm{RMRF}_t + s_{iT}\mathrm{SMB}_t + h_{iT}\mathrm{HML}_t + e_{it} \qquad t = 1, 2, \cdots, T$$

$$r_{it} = \alpha_{iT} + b_{iT}\mathrm{RMRF}_t + s_{iT}\mathrm{SMB}_t + h_{iT}\mathrm{HML}_t + p_{iT}\mathrm{PR1YR}_t + e_{it} \qquad t = 1, 2, \cdots, T$$

Where:

a. r_{it} is the return on a portfolio in excess of the one-month T-bill return;
b. VWRF is the excess return on the value-weighted portfolio of all NYSE, Amex, and Nasdaq stocks;
c. RMRF is the excess return on a value-weighted aggregate market proxy;

d. SMB, HML, and PR1YR are returns on value-weighted, zero-investment, factor-mimicking portfolios for size, book-to market equity, and one-year momentum in stock returns. SMB and HML are obtained from Gene Fama and Kenneth French. Carhart constructs PR1YR as the equal-weight average of firms with the highest 30 percent eleven-month returns lagged one month minus the equal-weight average of firms with the lowest 30 percent eleven-month returns lagged one month. The portfolios include all NYSE, Amex, and Nasdaq stocks and are re-formed monthly.

Table 3

Performance Measurement Model Summary Statistics, July 1963 to December 1993

VWRF is the Center for Research in Security Prices (CRSP) value-weight stock index minus the one-month T-bill return. RMRF is the excess return on Fama and French's (1993) market proxy. SMB and HML are Fama and French's factor-mimicking portfolios for size and book-to-market equity. PR1YR is a factor-mimicking portfolio for one-year return momentum.

Factor Portfolio	Monthly Excess Return	Std Dev	*t*-stat for Mean = 0	Cross-Correlations				
				VWRF	RMRF	SMB	HML	PR1YR
VWRF	0.44	4.39	1.93	1.00				
RMRF	0.47	4.43	2.01	1.00	1.00			
SMB	0.29	2.89	1.89	0.35	0.32	1.00		
HML	0.46	2.59	3.42	−0.36	−0.37	0.10	1.00	
PR1YR	0.82	3.49	4.46	0.01	0.01	−0.29	−0.16	1.00

Source: Carhart (1997)

Summary statistics on the factor portfolios reported in Table 3 indicate that the 4-factor model can explain considerable variation in returns. Carhart (1997) underscore the relatively high variance of the SMB, HML, and PRIYR zero-investment portfolios and their low correlations with each other and the market proxies. According to the author this suggests that the 4-factor model can explain sizeable time-series variation. Further, he observes that the high mean returns on SMB, HML, and PRIYR suggest that these three factors could account for much cross-sectional variation in the mean return on stock portfolios. In addition, the low cross-correlations imply that multicollinearity does not substantially affect the estimated 4-factor model loadings.

In other tests Carhart finds that the 4-factor model substantially improves on the average pricing errors of the CAPM and the 3-factor model. He estimated pricing errors on 27 quantitatively-managed portfolios of stocks from Carhart, Krail, Stevens, and Welch (1996), where the portfolios are formed on the market value of equity, book-to-market equity and trailing eleven-month return lagged one month. Not surprisingly, according to him, the 3-factor model improved on the average pricing errors from the CAPM, since it includes both size and book- to-market equity factors. However, the 3-factor model errors are strongly negative for previous year's loser stock portfolios and strongly positive for previous year's winner stock portfolios. In contrast, Carhart observes that the 4-factor model noticeably reduces the average pricing errors relative to both the CAPM and the 3-factor model. For comparative purposes, the average absolute errors from the CAPM, 3-factor, and 4-factor models in Carhart's research were 0.35 percent, 0.31 percent, and 0.14 percent per month, respectively. In addition, the 4-factor model eliminated almost all of the patterns in pricing errors, indicating that it well describes the cross-sectional variation in average stock returns.

1.4.4 Ex-post evaluation of different explanation to momentum strategies

In a paper published in 2001, Jegadeesh and Titman go back over the topic of their previous paper. Jegadeesh and Titman (2001) evaluate various explanations for the profitability of momentum strategies documented in Jegadeesh and Titman (1993).

Some critics to Jegadeesh and Titman (1993) have argued that the results provide strong evidence of "market inefficiency", others have argued that the returns from these strategies are either compensation for risk, or alternatively, the product of data mining (Jegadeesh and Titman 2001).

Jegadeesh and Titman (2001) say that the criticism that observed empirical regularities arise because of data mining is typically the hardest to address because empirical research in non-experimental settings is limited by data availability. However, with the passage of time, they had nine additional years of data that enable researchers to perform out-of-sample tests as well as to assess the extent to which investors may have learned from the earlier return patterns. Using the data over the 1990 to 1998 sample period, Jegadeesh and Titman (2001) find that Jegadeesh and Titman's (1993) momentum strategies continue to be profitable and that past winners outperform past losers by about the same magnitude as in the earlier period. Jegadeesh and Titman (2001) posit that this is noteworthy given that other well-known anomalies such as the small firm effect documented by Banz (1981) and the superior performance of value stocks relative to growth stocks are not observed after the sample periods examined in the original studies. Indeed, the average Fama-French size factor in the sample period 1965 to 1981 (which precedes the publication of Banz, 1981) is 0.53% per month with a t statistic of 2.34. However, in the 1982 to 1998 sample period, the average size factor is only -0.18% with a t statistic of -1.01. Similarly, the average book-to-market factor return in the 1990 to 1998 period (subsequent to the sample period in Fama and French 1993) is 0.12% per month (t statistic of 0.47), which is not statistically different from zero. However, there are other out-of-sample results that support the value/growth phenomenon. For example, Fama and French (1998) and Davis, Fama, and French (2000) find that this is an international phenomenon and also that this phenomenon was observed in sample periods prior to that considered in the early studies.

Jegadeesh and Titman (2001) observe that given the persistence of momentum anomaly, it is important to understand its cause. A number of authors, for example, Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), and Hong and Stein (1999), present behavioral models that are based on the idea that momentum profits arise because of inherent biases in the way that investors interpret information. Others, however, have argued that it is premature to reject the rational models and suggest that the profitability of momentum strategies may simply be compensation for risk. Most notably, Conrad and Kaul (1998) argue that the profitability of momentum strategies could be entirely due to *cross-sectional* variation in expected returns rather than to any predictable *time-series* variations in stock returns. Hence, under the Conrad and Kaul (1998) hypothesis, momentum strategies yield positive returns on average even if the expected returns on stocks are constant over time.

The behavioral models and Conrad and Kaul's arguments make diametrically opposed predictions about the returns of past winners and losers over the period following the initial holding period. Following Jegadeesh and Titman's (2001) suggestions, it is possible to observe that the behavioral models imply that the holding period abnormal returns arise because of a delayed overreaction to information that pushes the prices of winners (losers) above (below) their long-term values. These models predict that in subsequent time periods, when the stock prices of the winners and losers revert to their fundamental values, the returns of losers should exceed the returns of winners. In contrast, Conrad and Kaul (1998) suggest that the higher returns of winners in the holding period represent their unconditional expected rates of return and thus predict that the returns of the momentum portfolio will be positive on average in any post-ranking period.

To test the conflicting implications of these theories, Jegadeesh and Titman (2001) examine the returns of the winner and loser stocks in the 60 months following the formation date. Consistent with earlier work, they find that over the entire sample period of 1965 to 1998, the Jegadeesh and Titman (1993) momentum portfolio yields significant positive returns in the first 12 months following the formation period. In addition, the cumulative return in months 13 to 60 for the Jegadeesh and Titman (1993) momentum portfolio is negative, which is consistent with the behavioral theories but is inconsistent with the Conrad and Kaul hypothesis, Jegadeesh and Titman (2001) say. In addition, although Jegadeesh and Titman (2001) find strong evidence of return reversals in the 1965 to 1981 period, the evidence of return reversals is substantially weaker in the 1982 to 1998 period. This is noteworthy because there is no distinguishable difference between either the magnitude or the significance of the momentum profits in the two sub-periods.

Jegadeesh and Titman (1993) find a striking seasonality in momentum profits. They document that the winners outperform losers in all months except January, but the losers significantly outperform the winners in January. Jegadeesh and Titman (2001) posit that this seasonality could potentially be a statistical fluke; January is one of twelve calendar months and it is possible that in any one calendar month momentum profits are negative. With more years of data available Jegadeesh and Titman (2001) examine the out-of-sample performance of the strategy in January to examine whether this seasonality is real or whether it was the result of looking too closely at the data. Their analysis that replicates the momentum strategies using the sample selection criteria in Jegadeesh and Titman (1993) found results very similar to theirs for the 1990s, suggesting that the earlier finding was not a statistical fluke. They use a sample that excludes both stocks priced under $5 per share and stocks in the smallest size decile. The momentum profits in January for this sample are also negative in all sub-periods but they are only marginally significant. Following Jegadeesh and Titman (2001) suggestions, this indicates that most of the previously reported negative returns in January are due to small and low-priced stocks, which are likely to be difficult to trade at the reported CRSP prices[7]. Jegadeesh and Titman (2001) found that the January momentum profits, however, are significantly smaller than the momentum profits in other calendar months in all sample periods (see Table 4).

[7] CRSP is the Center for Research in Security Price of United States

Analyzing the characteristics of the momentum portfolios and the risk-adjusted momentum portfolio returns, Jegadeesh and Titman (2001) found that both winners and losers tend to be smaller firms than the average stock in the sample, because smaller firms have more volatile returns and are thus more likely to be in the extreme return sorted portfolios. The average size rank for the winner portfolio is larger than that for the loser portfolio. The results indicate that the market betas for winners and losers are virtually equal. However, the losers are somewhat more sensitive to the size factor than are the winners (see Table 5).

Table 4

Momentum Portfolio Returns in January and outside January

This table reports the average monthly momentum returns, the associated t statistics to test whether the returns are reliably different than zero, and the percentage of monthly momentum returns that are positive. The table reports returns for January as well as non-January months, and returns in the 1965-1989, Jegadeesh and Titman (1993) sample period, the 1990-1998 subsequent period, as well as the entire 1965-1998 period. The sample includes all stocks traded on the NYSE, AMEX, or Nasdaq, excluding stocks priced less than $ 5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size decile cutoff). The momentum portfolios are formed based on past six-month returns and held for six months. P1 is the equal-weighted portfolio of 10 percent of the stocks with highest past six-month returns and P10 is the equal-weighted portfolio of the 10 percent of stocks with the lowest past six-month returns. (Jegadeesh and Titman, 2001).

	P1	**P10**	**P1-P10**	***t* statistic**	**Percent Positive**
1965-1989					
Jan	4.01	5.67	-1.67	-1.50	36
Feb-Dec	1.42	-0.01	1.43	6.20	69
All	1.63	0.46	1.17	4.96	66
1990-1998					
Jan	1.72	2.95	-1.24	-2.08	11
Feb-Dec	1.69	0.06	1.63	5.32	69
All	1.69	0.30	1.39	4.71	64
1965-1998					
Jan	3.40	4.95	-1.55	-1.87	29
Feb-Dec	1.49	0.01	1.48	7.89	69
All	1.65	0.42	1.23	6.46	66

Source: Jegadeesh and Titman, 2001.

Table 5

Portfolio Characteristics

This table reports the characteristics of momentum portfolios. The sample includes all stocks traded on the NYSE, AMEX, or Nasdaq, excluding stocks priced less than $ 5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size cutoff). P1 is the equal-weighted portfolio of 10 percent of the stocks with the highest past six-month returns, P2 is the equal-weighted portfolio of the 10 percent of the stocks with the next highest past six-month return, and so on. Average size decile rank is the average rank of the market capitalization of equity (based on NYSE size decile cutoffs) of the stocks in each portfolio at the beginning of the holding period. FF factor sensitivities are the slope coefficients in the Fama-French three-factor model time-series regressions. “Market” is the market factor (the value-weighted index minus the risk-free rate) “SMB” is the size factor (small stocks minus big stocks) and HML is the book-to-market factor (high minus low book-to-market stocks). The sample period is January 1965 to December 1998 (Jegadeesh and Titman, 2001).

		FF Factor Sensitivities		
	Average Size Decile Rank	Market	SMB	HML
P1	4.81	1.08	0.41	-0.24
P2	5.32	1.03	O.23	0.00
P3	5.49	1.00	0.19	0.08
P4	5.41	0.99	0.17	0.14
P5	5.49	0.99	0.17	0.17
P6	5.41	0.99	0.19	0.19
P7	5.36	O.99	0.22	0.19
P8	5.26	1.01	0.24	0.16
P9	5.09	1.04	0.30	0.11
P10	4.56	1.12	0.55	-0.02
P1-P10	0.25	-0.04	-0.13	-0.22

Source: Jegadeesh and Titman, 2001.

Chapter 2
Methodology

2.1 Abnormal return analysis

Event study methodology is used to assess the impact of announcements on industrial daily returns (*R*) downloaded from DataStream. The starting point is the Brown and Warner (1985) average adjusted model to calculate the abnormal returns, with some adaptations.

Following this methodology, the daily returns at time *t,* (DR_{it}) for all individual industries (*i*) in the sample are estimated using the following formula:

$$DR_{i,t} = \ln\left(\frac{SRI_{i,t}}{SRI_{\mathrm{i,t-1}}}\right) \quad (1)$$

where SRI_{it} is the return index for industry *i* at time *t*, downloaded from DataStream.

The *ex post* abnormal returns (*AR*) are calculated by using a simple rolling average model (v=1) as the difference between the daily return and the expected return, $E(R_{it})$, and are represented by the equation below:

$$AR_{i,t,v=1} = DR_{i,t} - E\left(R_{i,t,v=1}\right) \quad (2)$$

where the expected return, $\mathrm{E}(\mathrm{R}_{it})$, is estimated over a period of 260 trading days prior to the event day and is represented by equation:

$$E\left(R_{i,t,v=1}\right) = \frac{1}{260}\sum_{t=-260}^{-1} DR_{i,t} \quad (3)$$

The parametric test used is the standard t-statistic for the abnormal return, calculated as:

$$t_{AR_{i,t,v=1}} = \frac{AR_{i,t,v=1}}{Std.Dev.\left(AR_{i,t,v=1}\right)} \quad (4)$$

Where *Std.Dev.* assumes the meaning of the usual statistic Standard Deviation function on a sample.

The standard deviation of the abnormal returns is calculated using a window of 244 days prior to the event and 15 days after the event. This parametric test relies on the important assumption that the industry abnormal returns are normally distributed.

A statistically significant positive AR represents an increase in wealth for investors in that industry, whereas a statistically significant negative *AR* represents wealth destruction. When statistically significant abnormal returns are not observed, no change in wealth is implied. Ramiah, Pichelli and Moosa's (2011a, 2011b) hypotheses are that the wealth of investors in polluting industries are adversely affected by the announcement of green policies whereas the wealth of environmentally-friendly investors are expected to increase. Abnormal returns of industries with no major exposure to pollution are not expected to change.

One criticism of the abnormal return model as represented by equation (3) is that it does not control for systematic risk factors such as those resulting from size, value-growth and momentum effects. In this study various asset pricing models (υ= 1 to 5) are used to control for these effects. In particular, returns are adjusted using the market model (υ=2), the CAPM (υ=3), the Fama and French three-factor model (υ=4) and the Carhart four-factor model (υ=5). These asset pricing models are specified as follows[8]:

$$E\left(R_{i,t,v=2}\right)=\beta_0^{v=2}+\beta_1^{v=2}\left(\tilde{r}_{mt}\right) \tag{5}$$

$$E\left(R_{i,t,v=3}\right)=\beta_0^{v=3}+\beta_1^{v=3}\left(\tilde{r}_{mt}-\tilde{r}_{ft}\right) \tag{6}$$

$$E\left(R_{i,t,v=4}\right)=\beta_0^{v=4}+\beta_1^{v=4}\left(\tilde{r}_{mt}-\tilde{r}_{ft}\right)+\beta_2^{v=4}\left(SMB_t\right)+\beta_3^{v=4}\left(HML_t\right) \tag{7}$$

$$E\left(R_{i,t,v=5}\right)=\beta_0^{v=5}+\beta_1^{v=5}\left(\tilde{r}_{mt}-\tilde{r}_{ft}\right)+\beta_2^{v=5}\left(SMB_t\right)+\beta_3^{v=5}\left(HML_t\right)+\beta_4^{v=5}\left(MOM_t\right) \tag{8}$$

[8] The well-known versions of CAPM, 3-factor and 4-factor models contain the risk-free rate $\tilde{r}_{ft}$ additional term, since left part of equations is *E(R)* - $\tilde{r}_{ft}$. However, while using regression methods, the intercept (commonly referred to as α and expected to be equal to zero) appears. Thus, it is possible to write our model considering that β_0 is the sum of the risk-free rate and the intercept α.

$\tilde{r}_{mt}$ is the market portfolio return, proxied by a total return index for the considered market (S&P500 for the US, a Thomson Reuters total return index for China, see Chapter 3 for further information).

$\tilde{r}_{ft}$ is the risk free rate, proxied by 10 years Treasury Bond for the US and the 5-year lending rate for China).

The size factor (SMB), the book-to-market factor (HML) and the momentum factor (MOM) are not readily available for China, hence we have to construct them following the instructions available on the Kenneth French's official website[9], while changing the formation period for momentum from a monthly to a daily basis. They are instead readily available for the US on the same website[10].

Following Fama and French (1993), in order to estimate the daily SMB and HML values it is necessary to calculate the return of six different portfolios. The portfolios, which are constructed at the end of each June, are the intersections of 2 portfolios formed on size (market value, ME) and 3 portfolios formed on the ratio of book equity to market equity (BE/ME). The size breakpoint for year t is the median market equity at the end of June of year t. BE/ME for June of year t is the book equity for the last fiscal year end in t-1 divided by current ME. The BE/ME breakpoints are the 30th and 70th market percentiles.

[9] The web addresses are as follows:

http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_factors.html

http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/six_portfolios.html

http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_mom_factor.html

[10] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#International

The following scheme gives a representation of these portfolios:

	Median ME	
	Small Value	Big Value
70^{th} BE/ME percentile		
	Small Neutral	Big Neutral
30^{th} BE/ME percentile		
	Small Growth	Big Growth

During this study, data from DataStream have been used. Namely, Market Value data (MV on DataStream) and Price-to-Book-Value data (PBTV on DataStream) have been downloaded, the latter being equivalent to $(BE/ME)^{-1}$. Stocks whose data for either Market Value or Price-to-Book-Value were not available have been consequently excluded.
Once these portfolios constructed, their *ex-post* market-value-based-weighted average daily returns are estimated. SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios:

$$\begin{aligned} SMB = \ & 1/3\ (\text{Small Value} + \text{Small Neutral} + \text{Small Growth}) \\ & - 1/3\ (\text{Big Value} + \text{Big Neutral} + \text{Big Growth}) \end{aligned} \quad (9)$$

HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios:

$$HML = 1/2\ (\text{Small Value} + \text{Big Value}) - 1/2\ (\text{Small Growth} + \text{Big Growth}) \quad (10)$$

Using daily portfolios returns, it is possible to estimate daily SMB and HML factors.

In order to estimate daily momentum (MOM) values, different portfolios are constructed following Fama and French's methods (see their website), with some adjustments, as below.

The portfolios, which are constructed daily, are the intersections of 2 portfolios formed on size (market equity, ME) and 3 portfolios formed on prior return. In this study, prior return is calculated as the total return on the period lasting 230 days and ending one month before the event day. The daily size breakpoint is the median market equity. The daily prior return breakpoints are 30th and 70th market percentiles. The market equity has been downloaded from DataStream as previously explained. Stocks whose Market Value was not available have been excluded. The following scheme gives a representation of these portfolios:

Median ME

	Small Up	Big Up
70^{th} prior percentile		
	Small Medium	Big Medium
30^{th} prior percentile		
	Small Down	Big Down

Once these portfolios constructed, their *ex-post* market-value-based-weighted average daily returns are estimated. MOM is the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios:

$$MOM = 1/2\ (Small\ High + Big\ High) - 1/2(Small\ Low + Big\ Low) \qquad (11)$$

Using daily value for portfolios returns, it is possible to estimate daily MOM factor.

Ramiah, Pichelli and Moosa (2011b) believe that the first model (υ=1) generates the largest abnormal returns, which decline as they control for risk factors. Given that the market model and the CAPM control for the same factor, they expect similar results from these two models (υ=2, 3). They also expect to see lower abnormal returns from the three-factor model and four-factor models (when compared to υ = 1 to 3).

So far it has been described how to test the significance of abnormal return on the first day of trading after any green policy announcement. The efficient market hypothesis (EMH) postulates that abnormal returns do not persist past this one-day period, the market reacts instantly to new information arrival and prices reflect all available information. However, opponents of the EMH (for example, the proponents of behavioral finance) argue that there may be either delayed responses (underreaction) or overreaction. To that end, abnormal returns are cumulated over a period of 5 days to find out if the EMH holds around green policy announcements.

The cumulative abnormal return for each industry over five days is estimated using the equation:

$$CAR_{i,t} = \sum_{j=t}^{t+4} AR_{i,j} \tag{12}$$

And the relative parametric t-statistic test is:

$$t_{AR_{i,t}} = \frac{CAR_{i,t}}{Std.Dev.\left(CAR_{i,t}\right)} \tag{13}$$

2.2 Risk regression analysis

Typically, change creates uncertainty in the market. Before a new policy is implemented, it invariably goes through various debates and revisions. While it induces insecurity, the process prompts businesses to think about the possible outcomes if the legislation was to be implemented. When the legislation is announced, systematic risk is expected to rise for polluting industries when there is a legislation supporting a greener planet policy, which necessarily implies that rejection of such a policy may result in a fall in the systematic risk of polluting industries. On the other hand, environmentally-friendly industries are expected to experience a fall (rise) in systematic risk when green policies are adopted (rejected). Industries with no exposure to climate change are expected to maintain their prior systematic risk levels.

For the purpose of testing changes in systematic risk following a green policy announcement, an excess return CAPM model that has two components (intercept and slope) is estimated. The Chow break-point test[11] is used to explore the possibility of structural breaks in the risk model. The essence of the Chow test is to fit the CAPM separately for each sub-sample (before and on the day of the green policy announcement) to find out if there are significant differences in the estimated equations. A significant difference indicates a structural break. Nevertheless, the Chow test can be used to detect changes in the CAPM but not to specify which component of the model has changed. Also, the test is not equipped to differentiate between the short-term and long-term effects of environmental regulation. Therefore, an alternative approach is adopted to assess short-term and long-term changes in systematic risk.

To determine the short-term change in systematic risk of an industry i after an announcement on a day T, a multiplicative dummy variable is introduced

[11] The Chow test is a statistical and econometric test of whether the coefficients in two linear regressions on different data sets are equal (Chow, 1960)

in the standard excess return CAPM, which gives rise to the following equation:

$$\tilde{r}_t^i - \tilde{r}_{ft} = \phi_i + \beta_i [\tilde{r}_{mt} - \tilde{r}_{ft}] + \beta_i^{\mathrm{ST,T}} [\tilde{r}_{mt} - \tilde{r}_{ft}] * ID_T + \tilde{\varepsilon}_{it} \quad (14)$$

where $\tilde{r}_t^i$ is the industry *i* portfolio return at time *t*. ID_T is an individual dummy variable that takes the value of 1 on day *T* and 0 otherwise. *T* represents the announcement, ϕ_i is the intercept (expected to be zero in an excess return CAPM), β_i is the beta of the industry *i*, and $\beta_i^{\mathrm{ST,T}}$ is the short-term change in systematic risk for the industry *i* as a result of the announcement *T*.

The inclusion of an additive dummy variable in equation (14) results in a near singular variance-covariance matrix, as the additive dummy variable and the multiplicative dummy variable are highly correlated. As a result, it is necessary to drop the additive dummy variable in the short-term model (there is not the $\phi_i^{ST,T} * ID_T$ term).

The model used to capture the long-term change in systematic risk in industry *i* after a particular event, *T*, is as follows:

$$\tilde{r}_t^i - \tilde{r}_{ft} = \delta_i^1 + \beta_i [\tilde{r}_{mt} - \tilde{r}_{ft}] + \beta_i^{\mathrm{LT,T}} [\tilde{r}_{mt} - \tilde{r}_{ft}] * LD_T + \delta_i^2 LD_T + \tilde{\varepsilon}_{it} \quad (15)$$

The long-term dummy variable (LD_T) in equation (15) takes the value of 0 prior to the announcement *T* and 1 afterwards. The coefficient on the variable LD_T, $\beta^{\mathrm{LT,T}}$, captures the long-term change in the beta of the industry *i* following the announcement *T*.

Equations (14) and (15) measure the effects of each announcement independently of each other. Conversely the following equation is used to measure the joint effects of green policy announcements:

$$\tilde{r}_t^i - \tilde{r}_{ft} = \alpha_i^1 + \beta_i [\tilde{r}_{mt} - \tilde{r}_{ft}] + \beta_i^{\mathrm{overall}} [\tilde{r}_{mt} - \tilde{r}_{ft}] * JD + \alpha_i^2 JD + \tilde{\varepsilon}_{it} \quad (16)$$

To assess the overall change in beta, $\left(\beta_i^{\text{overall}}\right)$, of the industry *i* after all the announcements, an interaction variable is added to the excess return CAPM. The interaction term comes in the form a multiplicative dummy variable (*JD*), which takes the value of one every time an announcement is made and zero otherwise.

The aggregate model tends to underestimate the effects when a series contains both positive and negative reactions. It is thus important to identify the change in systematic risk factors for each individual green announcement to understand the full extent of the impact of these announcements over time. To that end, an individual dummy variable (ID) for each policy announcement (*p*) is created, taking the value of one on the announcement day and zero otherwise. The model incorporating the CAPM is written as

$$\tilde{r}_{It} - \tilde{r}_{ft} = \phi_i + \beta_i\,[\tilde{r}_{mt} - \tilde{r}_{ft}] + \sum_{p=1}^{n} \gamma_{I,pt}[\tilde{r}_{mt} - \tilde{r}_{ft}] * ID_{pt} + \tilde{\varepsilon}_{it} \tag{17}$$

where n is the number of announcements in the model and the term $\sum \gamma_{I,pt}[\tilde{r}_{mt} - \tilde{r}_{ft}] * ID_{pt}$ is equal to the term $\beta_i^{overall}[\tilde{r}_{mt} - \tilde{r}_{ft}] * JD_t$ of equation (14) if an additive ID is added to equation (17). The additive ID is dropped out to reduce multicollinearity, which is a major a major problem in the model incorporating the Fama-French formulation, which is written as:

$$\begin{aligned} \tilde{r}_{It} - \tilde{r}_{ft} &= \beta_I^0 + \beta_I^1[\tilde{r}_{mt} - \tilde{r}_{ft}] + \sum_{p=1}^{n} \gamma_{I,pt}[\tilde{r}_{mt} - \tilde{r}_{ft}] * ID_{pt} \\ &+ \sum_{p=1}^{n} \delta_{I,pt}[SMB] * ID_{pt} + \sum_{p=1}^{n} \phi_{I,pt}[HML] * ID_{pt} + \tilde{\varepsilon}_{it} \end{aligned} \tag{18}$$

It is because of the multicollinearity problem that equation (17) is preferred to equation (18). These models are designed to estimate the immediate change in systematic risk factors originating from green policies.

The risk analysis process is repeated using all the remaining asset pricing models (the market model, the Fama-French three-factor model and the

Carhart four-factor model). These three models are fitted with interaction terms-dummy variables to assess the short-term, long-term and overall change in systematic risks.

Cable and Holland (2000) and Mills, Coutts and Roberts (1996) argue that event studies are susceptible to autoregressive conditional heteroscedasticity (ARCH) effects, and to correct for these disturbances a generalised autoregressive conditional heteroscedasticity (GARCH) model is required. A GARCH (*p,q*) model minimises the autocorrelation problem, controls for heteroscedasticity and enhances model fit[12]. A GARCH (*1,1*) model is most effective in financial time series 'structure' in volatility. As a result, equations 14, 15, 16 and 17, and the respective modified versions of other asset pricing models (the market model, the Fama-French three-factor model and the Carhart four-factor model) are re-estimated to control for ARCH effects.

[12] The variance of financial time series can be auto-correlated and has an autoregressive structure. With the introduction of the conditional variance, the GARCH(1,1) model captures the some of underlying 'structure' in time series data (Chappell & Eldridge 2000)

Chapter 3

Data and empirical results

During the research work underlying this thesis, a computational model has been constructed including all aspects described in Chapter 2. This model, although with some differences, has been run twice with two different datasets. The first dataset concerns US data while the second Chinese data. These datasets led to two separate papers, respectively, Ramiah, Pichelli and Moosa (2011a), and Ramiah, Pichelli and Moosa (2011b).

The empirical results are hereafter separately presented in Chapter 3:

- *3.1 Data and empirical results (US)*
- *3.2 Data and empirical results (China)*

3.1 Data and empirical results (US)

3.1.1 Data (US)

Daily data are downloaded from Datastream for 194 GICS[13] S&P500 portfolios[14], the S&P 500 index, 45 FTSE country indices[15], and FTSE All-World index over the period January 1996 to September 2011.

The risk-free rate, the book-to-market factor (HML) and the size factor (SMB) are downloaded from professor Kenneth French's website[16].

Indexes are published on Datastream also for public holidays where the stock market is closed. In this case the daily return is zero but the expected return is not zero. This generates an erroneous abnormal return for that day. In order to avoid this, S&P official published data are cleaned from these erroneous values.

Data cover 4110 trading days, 197 sectors, the S&P index, the risk-free rate, and SMB, HML and momentum factors for a total of roughly 830,000 data points.

The announcements are sourced from various institutional websites: United States Senate, Office of the Clerk, U.S. House of Representative, United States Environmental Protection Agency, U.S. Climate Change Science Program, and California Climate Change Portal.

3.1.2 Empirical results (US)

The results confirm that announcement of U.S. green policies had a major impact on both U.S. and other stock returns. The Kyoto Protocol on climate change highlighted the importance of green policies, which were endorsed by Obama's *New Energy for America* plan as stated in his

[13] Global Industry Classification Standard

[14] On Datastream 230 GICS different categories are available. However, given the 4-level structure of GICS classification, some categories are constituted by exactly the same stocks as others, thus reporting the same index value, the same daily return and accounting twice (or three times) in our analysis. For this reason, 33 categories have been excluded from our analysis.

[15] Indices are adjusted to U.S. dollar equivalent.

[16] The web addresses are as follows:
http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

electoral program. In total, Ramiah, Pichelli and Moosa (2011a) study 133 days when major green policies and other environmental events were announced over the period July 1997 to March 2011 for all industrial portfolios. Figure 9 shows the number of domestic U.S. industries that were affected by the announcement of green policies over that period. The pattern is similar regardless which asset pricing model is used. Interestingly, when a control for three risk factors is enabled (see fourth graph of Figure 9 and compare it with the first graph), the number of observed abnormal returns declines significantly.

Two different effect are detected and separately analyzed, as shown below:

a. 3.1.2.1 The Obama Effect;
b. 3.1.2.2 The Climate Change Effect;

3.1.2.1 The Obama Effect

In President Barack Obama's 2004 election campaign, he promised to tackle two issues related to our study, energy policy and climate change, but there were many other matters on his agenda. When he was elected on 4 November 2008, the market reacted significantly (see the vertical line in Figure 9).[17]

As shown in Figure 9, a number of industries reacted to his election—Table 6 to 9 provide a deeper analysis of the Obama effect. A summary of the domestic effects is shown in Tables 6 to 9, while Table 9 displays the international effects. It is discernible from Table 6 that 43 out of 194 industrial portfolios were positively affected, with an average positive abnormal return of 4.29%. This positive reaction was short-lived as the average CAR dropped to 1.31% five days later.

Table 7 shows the top ten sectors that prospered with the election of President Obama: real estate (diversified REITs, retail REITs and office REITs), casinos and gaming, agricultural products, construction and

[17] A number of other issues in his campaign were not related to green policies. Unfortunately the methodology used in this study cannot isolate other effects from that of green policies (at present no such technique is available). Instead of attributing market reaction to green policies, we classify it as a general Obama effect.

engineering, diversified metals and mining, life and health insurance, homebuilding and motorcycle manufacturers. Diversified REITs experienced the highest abnormal return of 9.24% and a cumulative abnormal return of 6.79% five days later.

Table 6 reports that 19 industrial portfolios were negatively affected by the presidential election, and Table 8 shows the top ten losers. Interestingly, four of these sectors are related to the health care industry. Health care facilities recorded a staggering abnormal return of -47.05% whilst managed health care, health care providers and services, and health care equipment and services experienced abnormal returns of -6.99%, -3.92% and -2.67%, respectively. Two utilities industries (gas and multi), real estate management and development, biotechnology, home furnish retail, and industrial power production were also adversely affected.

President Obama's campaign contained international policies, thus his election affected foreign markets, as shown in Table 9. The countries that reacted positively were predominantly European countries like Denmark, Greece, Portugal, Italy, Sweden, Austria, Netherlands and Spain. The other two countries were Canada and Argentina. It is worth noting that the AR for Argentina and Greece are 3.82% and 3.76%—rising to 9.93% and 7.73%, respective, cumulated over the five following days. Countries that were negatively affected are primarily from East Asia, namely Singapore, China, Korea and Hong Kong. The remaining two countries were Russia and Ireland.[18]

Based on these empirical findings, Ramiah, Pichelli and Moosa (2011a) conclude that President Obama had the following major effects: enhanced the real estate industry, adversely affected the health care sector, positive news for European markets and bad news for East Asian markets. In the economic agenda of his presidential campaign, he wanted to redress the housing market through more disclosure and accountability, stiff penalties against "bad faith" lenders, and controlling the subprime crisis through low mortgage rates. In simple terms, this shows how he tackled the start of the global financial crisis, and these initiatives were welcomed by the

[18] It is noticeable that there is a strong presence of authoritarian governments in China, Singapore and Russia.

real estate industry. Another item on his agenda was to bring down the health care cost, which consequently led to a decrease in profit for these sectors. One possible explanation for the positive response from European countries is the strong similarity with Obama's priorities and Europe priorities.[19] This same Obama priority list led to a "neglected country hypothesis" within East Asian countries whose markets reacted negatively.

3.1.2.2 The Climate Change Effect

Although climate change was part of President Barack Obama's campaign, this issue affected the stock market well before the election.

As shown in Figure 9, a number of industrial portfolios reacted positively and negatively to the announcement of green policies.

Tables 10 and 11 summarize the major announcements that negatively and positively affected the U.S. stock markets, respectively. On 28 March 2001, President George W. Bush announced that the United States would not implement the Kyoto Protocol on global warming (the first announcement in Table 10). Industrial portfolios (such as energy, oil gas and consumer fuel, and integrated oil and gas) recorded an abnormal return of about -2%.[20] The reasons provided by the Bush administration were the energy crisis, early scientific evidence on climate change, and the lack of tools to deal with the storage and removal of carbon dioxide. This non-compliance behaviour created uproar among domestic and international (predominantly European) environmental activists. On 12 May 2006, there was a public review of the best practice approaches for characterizing, communicating, and incorporating scientific uncertainty in decision making. The market reacted to this news with oil and gas exploration and production, industrial machinery, and road and rail industrial portfolios recording negative abnormal returns of around 3%.

[19] Europe's priorities were the Middle East, Russia, the Balkans and climate change, while the priorities of the U.S. were Afghanistan, disarmament, China, the Middle East and climate change. (Ramiah, Pichelli and Moosa, 2011a)

[20] Note that Ramiah, Pichelli and Moosa (2011a) estimate changes for all sectors and for all of the announcements, but for brevity they are not reported in the tables. They are available by the corresponding author upon request.

More announcements were made around these particular events over the years, and the market responded negatively on 22 December 2008 and 16 January 2009. A number of other announcements produced negative abnormal returns, including[21] the creation of the Western Regional Climate Action Initiative (WCI),[22] the Midwestern Greenhouse Gas Reduction Program, rejection of the 2007 Climate Stewardship and Innovation Act, and the American Recovery and Reinvestment Act of 2009. On the other hand, a number of initiatives led to positive abnormal returns, as shown in Table 11, including the Sustainable Communities and Climate Protection Act of 2008, WCI's recommendations for a cap-and-trade system, Obama's official speech on Clean Energy Bill, and the abandonment of the American Clean Energy and Security Act.

While Ramiah, Pichelli and Moosa's (2011a) hypothesis is that the abnormal returns of polluting industries are negative, their empirical results show that this is not necessarily the case. Although they predominantly observe negative reactions, a number of instances witnessed positive abnormal returns for polluters. Ramiah, Pichelli and Moosa (2011a) use the oil and gas refining and marketing industrial portfolio as an example to illustrate this point (Table 12). There were at least 16 days/events when this industry responded negatively as opposed to 9 events when it reacted positively. The highest negative abnormal returns occurred on 30 September 2008 following the re-assessment of historical climate data for key atmospheric features. As shown in Table 13, the AR and CAR are -8.63% and -18.68%, respectively. The highest positive abnormal return, however, was reported on 23 September 2008 when the WCI released its recommendations for a cap-and-trade system—the AR and CAR were 4.25% and 6.11%, respectively. This shows that the negative reactions are typically greater than positive reactions.

[21] Refer to Table 1A for the full list where negative abnormal returns have been detected.

[22] On 26 February 2007, governors from five states (Arizona, California, New Mexico, Oregon and Washington) announced the Western Regional Climate Action Initiative (WCI) to reduce greenhouse gas emissions in their states.

Ramiah, Pichelli and Moosa (2011a) expect environment-friendly industries to generate positive abnormal returns. Surprisingly, their evidence shows that these industries have been resilient to green announcements, which in a way can be viewed as implying ineffectiveness of green policies.

As shown in Table 14, the environmental and facilities services reacted only to five announcements:

(i) the signing by President Bill Clinton of the Kyoto Protocol (4.68%)

(ii) the unveiling by President Bush of the voluntary plan to reduce global warming (7.98%)

(iii) the Energy Policy Act of 2005 (-6.52%), (iv) the release by the WCI of its recommendations for a cap-and-trade system (-3.04%)

(iv) the re-assessment of historical climate data for key atmospheric features (-3%).

Systematic risk is expected to rise (fall) for polluters (environment-friendly industries) and stays unchanged for industries that are not affected by green policies. The results of the estimation equation 16 are summarized in Table 15. Seventy portfolios (36%) experienced an increase in risk, 33 portfolios (17%) experienced a decrease in risk, and 47% of the portfolios did not record any change in risk. According to the EPA, the largest polluters in the United States are power plants and petroleum factories—Table 16 shows that oil and gas refining and marketing industry experienced the second largest increase in systematic risk. In that sense, these results are consistent with the view of the EPA. Of the industries that experienced a fall in systematic risk are the health care sector, the computer sector, industrial conglomerates and few others (Table 17).

Similar to short-term changes in systematic risk, Ramiah, Pichelli and Moosa (2011a) expect three different outcomes: an increase, a decrease and no change in the long-term systematic risk. To test for this effect, equation 17 is estimated to identify the change in risk after each announcement. Then the industry beta is added to each of these changes to track down the time-varying systematic risk. Figure 10 shows the results for various sectors. It is possible to visualize the effects where the three expected outcomes are observable. Furthermore the figure shows us three different eras in environmental regulation in the U.S.: prior to 2001, past 2001 to 2005 and after 2005. More variations are observed after 2005, which is consistent with the observation that the Kyoto Protocol on climate change came into force on 16 February 2005.

3.1.2.3 Robustness Tests

The robustness tests undertaken in Ramiah, Pichelli and Moosa (2011a) involve the use of various asset pricing models in the estimation of abnormal returns and systematic risk. As shown in Figure 9, the results are sensitive to the choice of the asset pricing model. As one controls for more systematic factors, less statistically significant results are observed. Although a decrease in the number of industries that have statistically significant ARs is observed, the conclusions of this paper are not altered. In the estimation of systematic risk, Ramiah, Pichelli and Moosa (2011a) face a major econometric problem, multicollinearity, in the FF model (equation 18). Severe multicollinearity makes not possible to estimate the equations in certain instances.

For this particular reason, empirical results are focused on the CAPM (equation 17). The Carhart (1997) four-factor model was also used an alternative asset pricing model. Findings from this model are not reported as the results/problem are similar to the FF model.

Figure 9: Number of domestic industries affected by US green policies

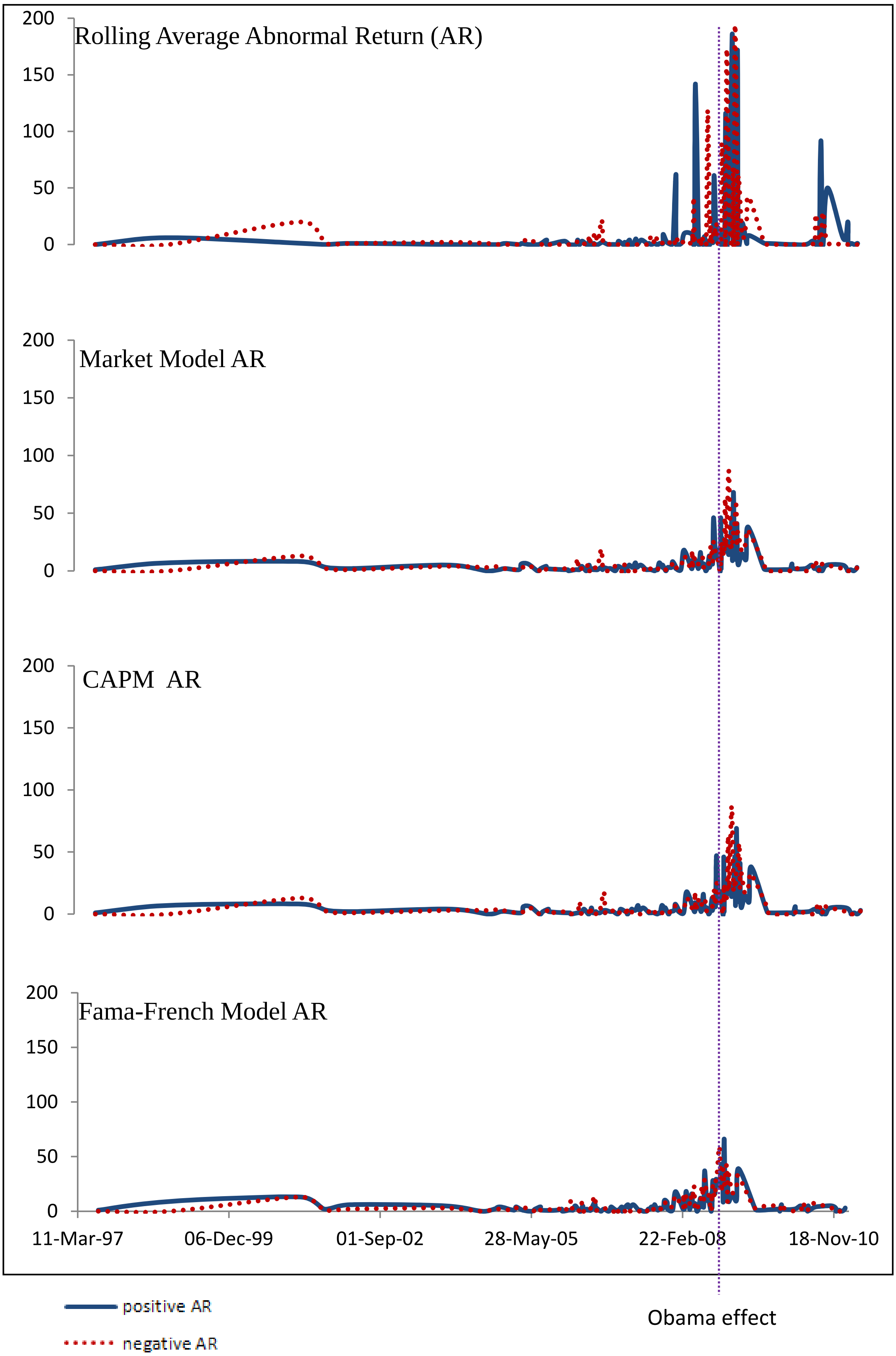


Table 6: Obama Effect - Summary

Industry	Number	Avg. AR	t-stat	Avg. CAR	t-stat
Positive Reaction	43	4.29	2.44	1.31%	0.23
Negative Reaction	19	-5.32	-0.52	-5.41%	-0.38
No reaction	132				

Table 7: Obama Effect – Top Ten US Industries that were Positively Affected

Industry	AR	t-stat	CAR	t-stat
Diversified REIT's	9.24	4.6	6.79	3.09
Casinos & Gaming	8.87	4.65	-1.92	-0.46
Agricultural Products	8.64	4.84	13.51	3.59
Construction & Engineering	7.15	3.68	7.44	1.79
Diversified Metals & Mining	5.76	2.75	-2.52	-0.53
Retail REIT's	5.65	2.64	0.51	0.23
Office REIT's	5.26	2.65	-1.88	-0.9
Life & Health Insurance	5.24	4.01	8.10	3.07
Homebuilding	5.21	2.49	9.41	2.09
Motorcycle Manufacturers	5.09	2.79	-0.93	-0.28

Table 8: Obama Effect – Top Ten US Industries that were Negatively Affected

Industry	AR	t-stat	CAR	t-stat
Health Care Facilities	-47.05	-18.87	-61.60	-10.77
Managed Health Care	-6.99	-3.89	-3.15	-0.75
Real Estate Mgt & Dev.	-6.65	-1.68	-3.27	-0.78
Biotechnology	-4.31	-2.46	-3.43	-0.94
Health Care Providers & Serv	-3.92	-3.36	1.31	0.49
Home Furnish Retail	-3.65	-2.23	-8.51	-4.06
Ind. Power Prod. & Energy	-3.28	-1.97	1.30	0.55
Gas Utilities	-2.75	-2.29	-1.37	-0.5
Multi Utilities	-2.71	-1.68	-3.56	-1.11
Health Care Equipment & Serv	-2.67	-3.08	0.37	0.19

Table 9: Obama Effect – International Markets

Country	AR	t-stat	CAR	t-stat
Positive				
Denmark	4.39	3.99	3.00	1.38
Argentina	3.82	1.76	9.93	2.15
Greece	3.76	2.02	7.73	2.02
Portugal	3.40	2.98	3.74	1.52
Italy	3.39	3.05	4.78	2.20
Sweden	3.28	2.38	4.80	1.92
Austria	2.58	2.07	3.68	1.49
Netherlands	2.48	2.41	3.75	2.08
Spain	1.89	1.66	3.38	1.47
Canada	1.81	1.97	2.22	1.24
Negative				
Singapore	-5.95	-4.02	3.15	0.96
Russia	-5.56	-1.96	3.87	0.63
China	-5.12	-2.58	11.13	2.50
Korea	-4.91	-1.93	-2.34	-0.45
Hong Kong	-4.04	-2.68	3.43	1.16
Ireland	-3.14	-2.17	-4.76	-1.63

Table 10: Selected Announcements that Negatively Affected Stock Markets

Date	Announcement
28/03/2001	President Bush opposes the Kyoto Protocol
12/05/2006	Uncertainty created by climate change in decision making processes
26/02/2007	Western Regional Climate Action Initiative is created (called WCI)
20/07/2007	Effects of global change on human health and welfare
15/11/2007	Midwestern Greenhouse Gas Reduction Program
2008: 28/02, 20/06	Review of adaptation options for climate-sensitive ecosystems and resources
4/03/2008	Focusing on weather and climate extremes
6/03/2008	The Environmental Protection Agency (EPA) denies permission to California to adopt his own standards
6/06/2008	2007 Climate Stewardship and Innovation Act - rejected by Senate
2/09/2008	Thresholds of Climate Change in Ecosystems
2008: 4/09, 9/09	Climate projections based on emissions scenarios for radioactively active gases and aerosols
2008: 9/09, 23/11	Research on the impact of climate change on water resources
2008: 9/09, 13/11	Trends in emissions of ozone-depleting substances and implications for ultraviolet radiation exposure
23/09/2008	WCI releases recommendations for a cap-and-trade system
2008: 30/09, 11/12	Re-assessment of historical climate data for key atmospheric features.
7/10/2008	“Abrupt Climate Change” report
23/10/2008	Coastal sensitivity to sea-level rise
4/11/2008	Election of Obama - New Energy for America Plan in electoral program
17/11/2008	Obama announces introduction of cap and trade system
29/11/2008	Past climate variability and change in the arctic and at high latitudes
13/02/2009	American Recovery and Reinvestment Act of 2009
26/02/2009	President's budget draws clean energy funds from climate measure
1/05/2010	Obama opposes new offshore drilling leases
22/06/2010	Judge blocks Gulf offshore drilling moratorium

Table 11 Selected Announcements that Positively Affected StockMarkets

Date	Announcement
13-Nov-07	North American carbon budget and its implications for the global carbon cycle
2008: 18/03, 9/09, 23/11	Research on the impact of climate change on water resources
2008: 18/03, 09/09,13/11	Trends in emissions of ozone-depleting substances and implications for ultraviolet radiation exposure
2008: 14/04, 30/09	Re-assessment of historical climate data for key atmospheric features.
2008: 11/07 15/12	Atmospheric aerosol properties and climate impacts
17-Jul-08	Analyses of the effects of global change on human health and welfare and human systems
30-Aug-08	Sustainable Communities and Climate Protection Act of 2008
2-Sep-08	Thresholds of Climate Change in Ecosystems
9-Sep-08	Climate projections based on emissions scenarios for radioactively active gases and aerosols
23-Sep-08	Western Climate Initiative (WCI) releases recommendations for a cap-and-trade system
2008: 7/10, 16/12	Abrupt Climate Change
23-Oct-08	Coastal sensitivity to sea-level rise
4-Nov-08	Election of Obama - New Energy for America Plan in electoral program
17-Nov-08	Obama announces introduction of cap and trade system
29-Nov-08	Past climate variability and change in the arctic and at high latitudes
26-Feb-09	President's budget draws clean energy funds from climate measure
2-Jun-10	Obama official's speech on Clean Energy Bill
10-Jun-10	Senate resolution against an EPA rule
22-Jul-10	American Clean Energy and Security Act abandoned by Senate

Table 12: Abnormal Returns of a Polluting Industry (Oil and Gas Refining and Marketing)

Date	Announcement	AR	t-stat	CAR	t-stat
	Negative				
25-Apr-06	Research on the impact of climate change on water resources	-3.15	-1.91	-9.30	-2.71
19-Sep-06	North American carbon budget and its global impact	-3.85	-2.33	-8.62	-2.51
28-Feb-08	Review of adaptation options for climate-sensitive ecosystems and resources	-3.50	-2.12	-4.71	-1.37
06-Mar-08	EPA denies permission to California to adopt his own standards	-3.05	-1.85	-9.02	-2.62
12-Mar-08	Impact of climate variability on transportation systems and infrastructure	-5.95	-3.60	-9.83	-2.86
08-May-08	Earth science and its relationship with climate change	-3.20	-1.94	-0.86	-0.25
27-May-08	Effects of climate change on agriculture and other key areas	-2.79	-1.69	8.48	2.47
06-Jun-08	2007 Climate Stewardship and Innovation Act - rejected by Senate	-3.20	-1.94	-5.58	-1.62
31-Jul-08	Climate Models: An Assessment of Strengths and Limitations	-3.29	-1.99	0.40	0.12
02-Sep-08	Thresholds of Climate Change in Ecosystems	-4.86	-2.94	2.58	0.75
09-Sep-08	Numerous announcements see Table 1A	-6.38	-3.86	-2.33	-0.68
30-Sep-08	Re-assessment of historical climate data for key atmospheric features.	-8.63	-5.23	-18.68	-5.43
23-Oct-08	Coastal sensitivity to sea-level rise	-5.89	-3.57	-6.67	-1.94
23-Nov-08	Research on the impact of climate change on water resources	-2.80	-1.70	-2.09	-0.61
22-Dec-08	Uncertainty created by climate change in decision making processes	-4.51	-2.73	-2.73	-0.79
07-May-10	EPA issue the light-duty vehicle on GHGs emissions	-2.90	-1.76	4.07	1.18

Table 13: Abnormal Returns of a Polluting Industry (Oil and Gas Refining and Marketing)

Date	Announcement	AR	t-stat	CAR	t-stat
	Positive				
07-Mar-07	North American carbon budget and its global impact	3.48	2.11	5.20	1.51
10-Jul-07	Greenhouse Gas Emissions and Atmospheric Concentrations	2.96	1.79	0.33	0.10
25-Oct-07	Impact of climate variability on transportation systems and infrastructure	2.76	1.67	-0.66	-0.19
30-Jun-08	Atmospheric aerosol properties and climate impacts	3.89	2.35	-2.35	-0.68
17-Jul-08	Effects of global change on human health and welfare and human systems	2.73	1.66	-0.02	-0.01
23-Sep-08	WCI releases recommendations for a cap-and-trade system	4.25	2.57	6.11	1.78
11-Dec-08	Re-assessment of historical climate data for key atmospheric features	2.79	1.69	12.16	3.54
16-Jan-09	Uncertainty created by climate change in decision making processes	4.56	2.76	3.01	0.87
03-Mar-11	Republicans launch bill to axe EPA carbon rules	4.12	2.50	0.56	0.16

Table 14: Abnormal Returns of an Environment-friendly Industry (Environmental and Facilities Services)

Date	Announcement	AR	t-stat	CAR	t-stat
12-Nov-98	Bill Clinton signs the Kyoto Protocol	4.68	2.74	-1.66	-0.44
14-Feb-02	Bush unveils voluntary plan to reduce global warming	3.86	2.26	7.94	2.10
28-Jul-05	Energy Policy Act of 2005 - House approval	-6.52	-3.82	-5.29	-1.40
23-Sep-08	WCI releases recommendations for a cap-and-trade system	-3.04	-1.78	-2.28	-0.60
30-Sep-08	Re-assessment of historical climate data for key atmospheric features	-3.00	-1.76	2.50	0.66

Table 15: Average Change in Short-Term Systematic Risk

Reaction	Number	Average Change in Risk	t-stat
Positive	70	0.25	9.03
Negative	33	-0.16	-5.92
Nil	91		

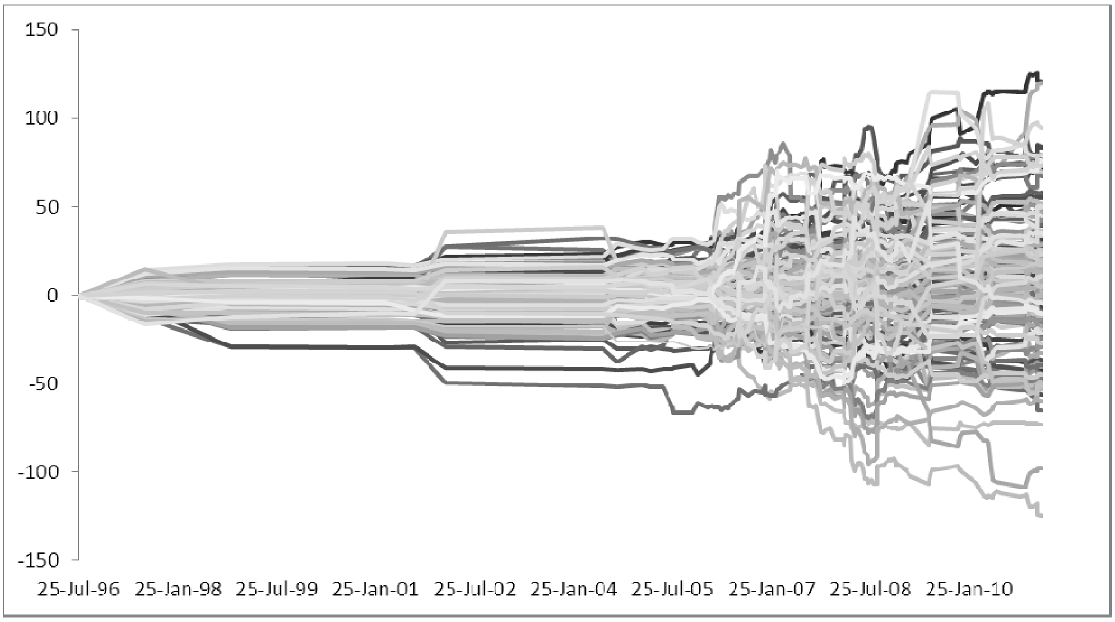
Table 16: Top-Ten Industries that Experienced the Largest Increase in Short Term Systematic Risk

	Intercept	Beta	Short-term Change in Risk	Short-term Change in Intercept
Increase in Risk				
Consumer Electronics	0.00	0.01	1.65	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Oil and Gas Refining & Marketing	0.00	0.70	0.75	0.00
	(0.14)	(0.00)	(0.00)	(0.86)
Homebuilding	0.00	1.17	0.64	0.00
	(0.49)	(0.00)	(0.00)	(0.05)
Diversified Metals & Mining	0.00	0.95	0.54	0.00
	(0.61)	(0.00)	(0.01)	(0.26)
Steel	0.00	1.15	0.49	0.00
	(0.27)	(0.00)	(0.00)	(0.25)
Other Diversified Financial Services	0.00	1.54	0.48	0.00
	(0.19)	(0.00)	(0.00)	(0.56)
Auto Parts & Equipment	0.00	0.86	0.45	0.00
	(0.23)	(0.00)	(0.00)	(0.92)
Construction & Engineering	0.00	1.12	0.44	0.00
	(0.15)	(0.00)	(0.00)	(0.03)
Automobile Components	0.00	0.89	0.44	0.00
	(0.25)	(0.00)	(0.00)	(0.85)
Tires and Rubber	0.00	1.09	0.41	0.00
	(0.15)	(0.00)	(0.00)	(0.64)

Table 17: Top-Ten Industries that Experienced the Largest Decrease in Short Term Systematic Risk

	Intercept	Beta	Short-term Change in Risk	Short-term Change in Intercept
Decrease in Risk				
Health Care Facilities	0.00	0.67	-0.75	0.00
	(0.59)	(0.00)	(0.00)	(0.25)
Health Care Supplies	0.00	1.09	-0.42	0.00
	(0.00)	(0.00)	(0.00)	(0.30)
Computer Storage & Peripherals	0.00	1.26	-0.29	0.00
	(0.37)	(0.00)	(0.00)	(0.29)
Semiconductor Equipment	0.00	1.38	-0.25	0.00
	(0.25)	(0.00)	(0.03)	(0.85)
Oil and Gas Storage and Transportation	0.00	1.20	-0.24	0.00
	(0.27)	(0.00)	(0.00)	(0.06)
Computer Hardware	0.00	1.05	-0.22	0.00
	(0.33)	(0.00)	(0.00)	(0.97)
Computers and Peripherals	0.00	1.08	-0.21	0.00
	(0.30)	(0.00)	(0.00)	(0.71)
Multi-Sector Holdings	0.00	1.63	-0.21	0.00
	(0.96)	(0.00)	(0.06)	(0.60)
Industrial Conglomerates	0.00	1.11	-0.21	0.00
	(0.86)	(0.00)	(0.00)	(0.74)
Health Care Providers and Services	0.00	0.70	-0.20	0.00
	(0.26)	(0.00)	(0.00)	(0.00)

Figure 10: Long-Term Changes in Systematic Risk



3.2. Data and results (China)

3.2.1 Data (China)

On 13 July 2001, it was announced that Beijing would have hosted the Olympic Games in 2008. One of the major concerns that emerged soon after this announcement was the high pollution level in the city—it appeared as a major hindrance for athletes to compete. Consequently a number of measures were undertaken to reduce the city's pollution level. The event sample starts on 13 July 2001 broadcast and ends on 22 November 2011 with the release of the white paper on climate change. In total 25 environmental announcement are examined —these announcements were sourced from various institutional websites including the Chinese government's official website, the United Nations' website, the Xinhua News Agency (the official press agency of the People's Republic of China), and the Environmental Resources Management Consulting Group. Table 18 summarizes these announcements. Some key examples of these policies are the Solid Waste Pollution Prevention Law, the Kyoto Protocol on Climate Change, China's National Environment and Health Action Plan (NEHAP), Prevention and Control of Water Pollution, China Tort Liability Law on Environmental Liabilities, and the Environmental Management of New Chemical Substances (EMNCS). It is explored how these policies affect risk and return in the Chinese stock market.

Event study methodology is used to assess the impact of the 25 announcements on 96 industrial daily returns (R) downloaded from DataStream.

Daily return indexes chosen on DataStream are the Thomson Reuters Sectors Local Currency Indexes; they are available for 97 sector, following the Global Industry Classification Standard (GICS).

The total return index (Thomson Reuters China Local Currency; code: TR CHINA L) and the 5-year lending rate (name: China Lending Rate 5y and Above) are used as proxies for the market return and risk-free rate, respectively.

The size factor (SMB), the book-to-market factor (HML) and the momentum factor (MOM) are not readily available for China, hence we have to construct them following the instructions described in Chapter 2.

In order to construct SMB and HML factors, a huge amount of data is necessary. With respect to the US case, where these two factors are available to download from professor Kenneth French's webpage[23], in this case it is necessary to start from scratch, by downloading Return Index (RI), Price-to-Book-Value (PTBV) and Market Value (MV) for each stock of our considered universe. To be consistent with the chosen market index (TR CHINA L), it is necessary to download these data for the 1505 different stocks that are used by Thomson Reuters as constituents to calculate and publish the index itself.

Indexes are published on DataStream also for public holidays where the stock market is closed, together with other closing periods in Chinese stock market. In this case the daily return is zero but the expected return is not zero. This generates an erroneous abnormal return for that day. Further, being the number of published closing days in the year not entirely negligible, it may affect our rolling methods for linear regression. In order to avoid this, official published data are cleaned from these erroneous values.

Data cover 3112 trading days, 96 sectors, the total index return and the risk-free proxied rate, for a total of roughly 305 000 data points for abnormal return analysis. In addition to this, data used to construct SMB and HML factors cover the same number of days and three different index for each one of the 1505 stocks considered, totaling about 14 millions data points.

Total size of excel files used to store data and subsequent calculations accounts for roughly one gigabyte and a half.

[23] The web addresses are as follows:

http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_factors.html

http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/six_portfolios.html

http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_mom_factor.html

3.2.2 Results (China)

The results are presented in the following order:

a. 3.2.2.1a The overall effectiveness of environmental regulation;
b. 3.2.2.1b Estimates of abnormal returns;
c. 3.2.2.1c The industries mostly affected by environmental regulation;
d. 3.2.2.1d Systematic risk;
e. 3.2.2.1e Robustness tests.

Further below, the top five announcements are analysed, as revealed by the empirical results:

a. 3.2.2.2a The National Environment and Health Action Plan;
b. 3.2.2.2b Upgrading of the State Environmental Protection Administration;
c. 3.2.2.2c The Beijing Declaration on Sustainable Development;
d. 3.2.2.2d The Revised Provision on New Chemical Substances.

3.2.2.1a The Overall Effectiveness of Environmental Regulation

Following the announcement that China would have hosted the Olympic Games, a series of green policies were initiated. Table 18 displays the number of industries that reacted positively and negatively to each of the 25 announcements. It is apparent that the Olympic Games announcement did not have any impact on stock returns as it is not observed any industrial portfolio with statistically significant abnormal returns.[24] Interestingly, the Kyoto Protocol on climate change had minimal effects on the Chinese market with only one sector reacting positively, providing evidence that the Chinese market is typically resilient with respect to international laws. When the Beijing Olympic Committee announced its plan to create a greener environment for the athletes (announcement number 7), four industries reacted negatively and one positively.

[24] Likewise announcements 6, 24 and 25 did not have any impact.

In percentage terms, we can conclude that around 5% of Chinese industrial portfolios reacted to the environmentally-friendly games. Similar results are observed around the announcements made prior to 2007 and around announcement numbers 11, 16, 20 and 21. Ramiah, Pichelli and Moosa's (2011b) argument is that policies that affect a small proportion of industries (like the 5% in this case) cannot be viewed as effective. On the other hand, announcements 10, 12, 14, 17 and 19 affected a larger proportion of industries.

3.2.2.1b Estimates of Abnormal Returns

The lowest and highest levels of abnormal returns, detected by using the five different asset pricing models (v=1 to 5; Brown and Warner's average, market model, CAPM, Fama and French's 3-factors model and Carhart's 4-factors model), are reported in Table 19.[25] When the simple rolling average model (v=1) is used to estimate the abnormal returns after a green policy announcement, the highest positive abnormal return is 9.01%. After adjusting for different systematic factors, the highest abnormal return drops to 5.98% (the Fama-French three-factor model). It is clear that the highest abnormal return after green policy announcements is around 6% and the percentage of industry where positive abnormal return is observed is around 5%. According to the figures reported in Table 19, the highest positive cumulative abnormal return recorded is 13.79% in the market model while the remaining models show that the highest CAR is around 11.5%. On the negative side, the worst abnormal return and cumulative abnormal returns are -10.15% and -28.24%, respectively. The conclusion that can be drawn from these results is that if investors traded on Chinese green policy announcement they could have earned abnormal returns as high as 13% whereas the potential loss could have been up to 28%.

[25] The purpose of this study is to assess the impact of green policy announcements on the stock market and not to present an elaborate discussion on the performance of asset pricing models. Our results indicate that different asset pricing models tend to give relatively similar results.

3.2.2.1c The Industries Mostly Affected by Environmental Regulation

Table 20 shows the top ten industries where the highest abnormal returns are observed. Ramiah, Pichelli and Moosa (2011b) expect the ten industries with the highest positive abnormal returns to be environmentally-friendly and the top ten industries with negative abnormal returns to the biggest polluters. However, the results show that this does not necessarily hold. For instance, coal is one of the worst contaminants; hence it is expected to see the coal industry in the top ten with negative abnormal returns. As expected, the coal industry appears on the top-ten list, with abnormal returns of -7.02% after the announcement of the National Environment and Health Action Plan (NEHAP, announcement number 10). Surprisingly, however, the coal industry comes up as number one on the top-ten list of positive abnormal return, with abnormal return of 6.87%, after the 12th 5-year plan was submitted to the National People's Congress on 5 March 2011. The unexpected result of the coal industry being in the top-ten positively affected list may be explained in terms of the lack of enforcement of environmental regulation and the importance assumed by the coal industry in China, which makes it immune to environmental regulation. Another explanation lies in the fact that one of the limitations of event study methodology is that it cannot identify the exact abnormal return associated with one particular announcement when multiple announcements are made on the same day.[26] The 5-year plan also shows that the Chinese government intends to accelerate the merger and reorganisation of coal mining enterprises, development of large coal mining bases and large and medium-size modern coal mines. The energy industry is another example where a particular portfolio falls into both positive (5.59% after the 5-year plan) and negative (-4.68% after NEHAP).

With the limitation of the event study methodology in mind, Table 20 shows that industries where the highest positive abnormal returns are documented, other than coal and energy, are the following: construction and engineering, transportation, real estate, airlines, specialty mining and

[26] Currently no existing methodology allows us to capture the isolated effect of a particular policy announcement when multiple announcements are made.

metals, fishing and farming, industrial services, and airlines. The biggest negative abnormal returns are recorded, other than coal and energy, in the steel, aluminium, construction materials, industrial machinery and equipment, marine transportation, hotels and entertainment services, drug retailers and leisure, and recreation. The magnitude of these abnormal returns and the corresponding announcements are reported in Table 20.

3.2.2.1d Systematic Risk

Ramiah, Pichelli and Moosa (2011b) argue that systematic risk is a component of market risk—the implicit assumption being that the beta of polluting industries will rise by an amount that reflects systematic risk, and vice versa for environmentally-friendly industries. Furthermore, systematic risk can be both short-term and long-term. Table 21 shows the short-term systematic risk for certain industries, calculated from equation 16. Prior to the 25 announcements, the beta for the energy sector was 1.05. The overall increase in the risk following the 25 announcements is 0.27, representing the overall short-term systematic risk. The beta for the energy industry after the 25 announcements is thus 1.05 plus 0.27 (which is equal to 1.32). Similar observations can be made of coal, construction materials, heavy machinery and vehicles, apparel and accessories, mineral resources and marine services. The coal industry is a classic example of a polluter—in that sense Ramiah, Pichelli and Moosa (2011b) find support for their hypothesis that the risk of polluters generally rises. The increase in risk observed in these sectors implies that environmental regulation creates uncertainty for the firms belonging to these sectors.

On the other hand, Table 21 shows a larger number of industries that experienced a decrease in overall short-term systematic risk such as real estate, communications equipment and food processing. One observation from these industries is that none of them has the "typical characteristic" of an environmentally-friendly business. Unfortunately the methodology used in this study can only detect these changes—it cannot provide any explanation as to why they occur. In total, 18 industries are exposed to short-term systematic risk change, implying that the remaining 81% (the majority) of the industries are insensitive to short-term risk.

Equation 15 is estimated for all of the 96 industries to assess long-term systematic risk—the results are presented in Figure 11. Similar to the short-term effects, Ramiah, Pichelli and Moosa (2011b) detect three outcomes from Figure 11. There is evidence of a rise, fall and no change in long-term systematic risk. Furthermore, the evidence provided by Figure 11 reinforces our view that environmental regulation was not generally an issue in the earlier part of the sample. It is clear that more variability occurred after 2005, which arguably was triggered by the Kyoto Protocol (16 February 2005). A vertical line is visible on 26 December 2009 when the China Tort Law on Environmental Liabilities was publicized. Article 65 of the Tort Law states that polluters will be held liable for the damage they cause and that they will be forced to internalize the negative externality cost. However, when multiple polluters are involved, the externality cost will be shared. Polluters will not be held liable if they are able to prove that they did not contribute to the pollution. As of 26 December 2009, a reversal in long-term systematic risk is observed for portfolios that have experienced a general increase in long-term systematic risk.

3.2.2.1e Robustness Tests

Ramiah, Pichelli and Moosa (2011b) undertake a number of robustness tests, primarily through the use of alternative asset pricing models, including the simple rolling average model, the market model, CAPM, the Fama-French three-factor model and the Carhart four-factor model. Except for Table 19, all the other tables are based on the CAPM.

The simple rolling average model does not control for any risk factor while the market model generates similar results to those obtained by using the CAPM. Acute multicollinearity arises when the Fama-French three-factor model and the Carhart four-factor model are fitted with interaction terms. Ramiah, Pichelli and Moosa (2011b) detect small discrepancies in values when different models are used—Table 19 illustrates the degree of variation. Nevertheless, Ramiah, Pichelli and Moosa's (2011b) discussion and conclusions are not altered after considering the results from all of these models.

3.2.2.2 The top five green policy announcements

3.2.2.2a The National Environment and Health Action Plan - NEHAP

As discussed before, rapid economic growth, if not environmentally managed adequately, leads to pollution and adverse health effects. In response to these negative externalities, the Chinese government has undertaken action through the NEHAP, aiming to protect public health through effective environmental management. Ramiah, Pichelli and Moosa's (2011b) hypothesis is that the NEHAP has led to a decrease in sales revenue in the health sector, resulting in negative abnormal returns. The outcomes of NEHAP are displayed in Table 22—surprisingly the health sector is not listed. There is no support for the hypothesis that the health sector is adversely affected by NEHAP, which triggers a question as to its effectiveness in achieving its primary objective of enhancing the health status of Chinese citizens. Furthermore, Ramiah, Pichelli and Moosa (2011b) expect environmentally-friendly industries to generate positive abnormal returns, instead they find this result to be valid for the computer and technology industries.

Nevertheless, NEHAP appears to be successful in other areas. The industries experiencing negative abnormal returns (for example coal, aluminium, energy and few others listed in Table 22) provide evidence indicating that the policy is successful to a certain extent. At this earliest stage, NEHAP has been successful in adversely affecting certain polluting industries. Furthermore, NEHAP led to a rise in the short-term and long-term systematic risk of these polluters. The results of an increase in systematic risk are shown in the last two columns of Table 22.

It is worth noting that short-term risk is greater than long-term risk, which is consistent with the adaptive expectations theory.[27]

3.2.2.2b Upgrading of the State Environmental Protection Administration

The Chinese government sent a strong signal to market participants by upgrading SEPA to a ministry, signalling seriousness about environmental regulation and the desire to improve the efficiency of regulatory enforcement. The energy industry reacted negatively to this announcement. Interestingly, 20 other industries reacted positively on the first day of trading but 15 of these industries exhibited negative cumulative abnormal returns after five days[28] (see Table 23). Ramiah, Pichelli and Moosa (2011b) argue that this is evidence of delayed reactions in the Chinese market. Generally, when a new policy emerges, market participants may not know immediately the full extent by which their firms will be affected—say within the first 24 hour or on the first day of trading. However, five days later they have a clearer picture as to how their firms will be affected. Another observation worth noting is that short-term systematic risk fell for all of the 20 industries and rose for the energy industry.

3.2.2.2c The Beijing Declaration on Sustainable Development

The heads of state of 16 Asian countries and 27 European countries gathered in Beijing on 24 and 25 October 2008 to discuss key issues pertaining to climate change, the environment and energy. When the Chinese stock market opened on the Monday, 27 October, 14 industries reacted negatively and 5 responded positively. Table 24 displays abnormal returns as well as short-term and long-term systematic risks for these

[27] The adaptive expectations theory states that economic agents' expectations are adjusted by a constant proportion of previous discrepancy and the forecast for the following period is the same for all the subsequent future periods, if the expectation is a permanent.

[28] The remaining five industries reacted positively. Except for marine services, the other four industries are in the finance and banking industries.

industries. The industries that were positively affected are construction and engineering, industrial services, highways and rail tracks, electric utilities and industrials. A decline in beta is also observed for these industries. One aspect that engineers tend to consider when they build new products is the carbon emissions level of their products.

3.2.2.2d The Revised Provision on New Chemical Substances

The provision on Environmental Management Of New Chemical Substance states that firms are required to obtain registration certificates to use new chemicals. Firms must inform the authorities about the content of these new chemicals, provided that the latter will maintain the trading secrets of these products when requested. However, any chemical that can potentially harm human life cannot be kept as a secret. Research in new chemical substances is encouraged, the objective being to produce chemicals that are environmentally friendly.

Ramiah, Pichelli and Moosa (2011b) assess two announcements on this policy. The first announcement was made on 30 December 2009 when a revised provision was adopted. The second announcement occurred on 15 October 2010 when the revised provision became effective. Our results show that the Environmental Management of New Chemical Substances (EMNCS) affected the Chinese stock market the most. Around 26% of the industries were affected on 30 December 2009 (Table 25) and 46% were affected when EMNCS came into force (Tables 26 and 27). As shown in Table 25, the banking and finance sector reacted positively while the chemical sector reacted negatively. Tables 26 and 27 provides evidence indicating that Chinese green policies have eventually worked in terms of improving the health of Chinese people as the following abnormal returns occur: pharmaceutical and medical research (-2.05%), healthcare (-2.08%), diversified pharmaceuticals (-2.17%), pharmaceuticals (-2.24%), and generic and specialty pharmaceuticals (-2.32%).

Table 18: Announcements of Environmental Regulation and the Number of Positive and Negative Reactions

No.	Date	Announcement	Reaction +	Reaction -
1	13/7/01	Beijing to host the 2008 Olympic Games	0	0
2	13/6/02	Release of the official Beijing Olympic Action Plan.	0	1
3	29/10/04	Symposium on Hydropower and Sustainable Development in Beijing.	2	7
4	29/12/04	Adoption of the Solid Waste Pollution Prevention Law.	0	1
5	16/2/05	Kyoto Protocol on climate change comes into force.	1	0
6	1/4/05	The Solid Waste Pollution Prevention Law takes effect.	0	0
7	19/11/05	Beijing Olympic Committee agrees to environmentally friendly games.	1	4
8	30/12/05	China plans to build 20 additional sewage disposal plants to improve the water quality in the reservoir.	1	3
9	30/7/07	Environmental regulator blacklist 30 polluting companies.	7	0
10	12/11/07	Release of China's National Environment and Health Action Plan.	9	16
11	28/2/08	Prevention and Control of Water Pollution is promulgated.	3	0
12	27/3/08	State Environmental Protection Administration is upgraded to the Ministry of Environmental Protection.	20	1
13	1/6/08	Prevention and Control of Water Pollution comes into force.	5	4
14	25/10/08	Beijing declaration on Sustainable Development at the 7th Asia-Europe Meeting.	5	14
15	26/11/09	China emissions reduction target of 40-45% by 2020.	7	5
16	26/12/09	China Tort Liability Law on environmental liabilities is publicized.	5	0
17	30/12/09	A revised Provision on the Environmental Management of New Chemical Substances is adopted.	4	22
18	1/7/10	China Tort Liability Law takes effect.	1	7
19	15/10/10	The revised Provision on the Environmental Management of New Chemical Substances becomes effective.	7	38
20	5/3/11	12th 5-Year Plan submitted to the National People's Congress.	3	0
21	14/3/11	The Chinese government passes the 12th 5-Year Plan.	6	0
22	30/5/11	Hundreds of factories closed in an effort to tackle poisoning.	3	9
23	21/9/11	The 12th 5-Year Plan for the Environmental Health- Work of National Environmental Protection.	0	1
24	7/11/11	Business Summit on Climate Leadership 2011.	0	0
25	22/11/11	Chinese white paper titled "China's Policies and Actions for Addressing Climate Change"	0	0

Table 19: Highest and Lowest Abnormal Returns Following Announcements

	AR (%)			CAR (%)		
	Maximum	Minimum	Proportion*	Maximum	Minimum	Proportion*
Positive Abnormal Returns						
Rolling Average Model	9.01	2.69	5.29	13.42	3.19	2
Market Model	6.83	1.05	4.58	11.73	2.13	4.71
CAPM	6.87	0	4.54	11.57	0	4.53
3-factor model	5.98	0	5.17	12.09	1.05	4.38
4-factor model	6.67	0	4.31	13.79	3.76	4.31
Negative Abnormal Returns						
Rolling Average Model	-10.15	-2.28	12.85	-28.24	-2.96	5.54
Market Model	-9.03	-1.54	6.71	-21.99	-1.95	6.29
CAPM	-9.03	0	6.83	-16.85	-0.15	6.83
3-factor model	-8.96	0	4.5	-20.57	0	7.79
4-factor model	-8.82	0	7.82	-19.89	0	7.82

**The percentage of industries where we observe statistically significant abnormal returns*

Table 20: Industries Most Affected by Environmental Regulation

Industry	Announcement Number	AR	*t-stat*	CAR	*t-stat*
Top-Ten Positively Affected					
Coal	20	6.87	4.07	3.52	4.07
Construction & Engineering	14	5.61	6.1	4.22	6.1
Energy	20	5.59	4.63	3.16	4.63
Transportation	10	5.48	5.67	3.74	5.67
Real Estate	12	5.47	4.9	-4.73	4.9
Airlines	19	5.39	2.5	4.22	2.5
Specialty Mining & Metals	15	5.25	2.84	0.88	2.84
Fishing & Farming	12	5.12	2.55	-16.85	2.55
Industrial Services	14	4.93	5.89	2.96	5.89
Airline Services	19	4.9	3.05	3.4	3.05
Top-Ten Negatively Affected					
Marine Transportation	8	-9.03	-6.33	-10.54	-6.33
Aluminium	10	-7.51	-3.98	4.18	-3.98
Coal	10	-7.02	-4.16	-5.98	-4.16
Industrial Machinery & Equipment	10	-6.74	-5.08	-8.91	-5.08
Construction Materials	3	-4.68	-3.58	-4.38	-3.58
Energy	10	-4.68	-3.88	-1.89	-3.88
Steel	7	-4.45	-4.05	-1.05	-4.05
Drug Retailers	18	-4.37	-3.12	-6.02	-3.12
Hotels & Entertainment Services	19	-4.25	-2.92	1.95	-2.92
Leisure & Recreation	19	-4.08	-2.56	2.41	-2.56

Table 21: Short-Term Climate Change Risk

Industry	Beta	Climate Change Risk	*P-value*
Decrease in Risk			
Real Estate	1.08	-0.25	(0.05)
Communications Equipment	1.06	-0.21	(0.09)
Food Processing	0.97	-0.17	(0.04)
Specialty Mining & Metals	1.24	-0.16	(0.03)
Food & Beverages	0.92	-0.15	(0.06)
Retailers	0.99	-0.13	(0.05)
Banking & Investment Services	1.01	-0.12	(0.08)
Financials	1.05	-0.12	(0.02)
Cyclical Consumer Goods and Services	0.92	-0.12	(0.08)
Rail, Road & Sea Passenger Transportation	0.95	-0.12	(0.01)
Oil and Gas	1.07	-0.04	(0.01)
Increase in Risk			
Coal	1.14	0.33	(0.01)
Energy	1.05	0.27	(0.00)
Construction Materials	0.93	0.26	(0.02)
Heavy Machinery and Vehicles	1.01	0.25	(0.00)
Apparel & Accessories	0.97	0.15	(0.05)
Mineral Resources	1.01	0.14	(0.02)
Marine Services	0.90	0.09	(0.09)

Table 22: Effects of the National Environment and Health Action Plan

Industry	AR	CAR	Beta	Short-term Climate Change risk	Long-term Climate Change risk
Positive Abnormal Returns					
Rails & Roads Transportation	5.48	3.74	0.90	-1.35	-0.05
Computer Hardware	4.67	6.14	0.97	-1.21	-0.12
Computers & Office Equipment	4.61	6.63	0.98	-1.19	-0.12
Rail, Road & Sea Passenger Transport.	3.60	3.46	0.95	-0.87	-0.03
Technology Equipment	3.10	4.31	1.04	-0.84	-0.10
Semiconductors & Semi. Equip.	2.77	3.18	1.06	-0.81	0.05
Technology	2.46	2.70	1.02	-0.68	-0.11
Textiles & Leather Goods	2.10	7.10	1.01	-0.53	0.10
Financials	1.52	-1.08	1.05	-0.44	0.02
Negative Abnormal Returns					
Industrial Services	-1.53	1.52	0.99	0.41	-0.07
Apparel & Accessories	-2.04	-0.31	0.97	0.59	0.12
Industrial Goods	-2.10	-1.95	1.03	0.52	-0.04
Machinery, Equip. & Comp.	-2.31	-2.40	1.03	0.57	-0.05
Marine Services	-2.34	-2.29	0.91	-0.02	0.05
Basic Materials	-2.75	0.78	1.05	0.72	0.08
Construction & Engineering	-2.98	-0.41	0.98	0.79	-0.10
Specialty Chemicals	-3.33	-4.15	1.05	0.76	-0.06
Marine Transportation	-3.41	-2.81	1.14	0.75	0.10
Mineral Resources	-3.42	1.64	1.01	0.92	0.11
Metals & Mining	-3.58	1.62	1.07	0.96	0.11
Heavy Electrical Equipment	-3.76	-2.59	0.98	0.93	-0.08
Energy	-4.68	-1.89	1.05	1.22	0.04
Industrial Machinery & Equipment	-6.74	-8.91	1.04	1.64	0.06
Coal	-7.02	-5.98	1.14	1.85	0.10
Aluminium	-7.51	4.18	1.18	1.87	0.18

Only statistically significant results are reported in this table and for brevity purposes the t-statistics are not reported.

Table23: Effects of the Ministry of Environmental Protection

Industry	AR	CAR	Beta	Short-term Climate Change risk	Long-term Climate Change risk
Positive Abnormal Returns					
Real Estate	5.47	-4.73	1.08	-0.66	0.04
Food & Tobacco	5.12	-15.93	0.98	-0.27	0.02
Fishing & Farming	5.12	-16.85	0.99	-0.59	0.04
Industrial Machinery & Equip.	4.87	-5.35	1.04	-0.63	0.05
Paper Products	4.21	-4.59	1.04	-0.50	0.17
Paper & Forest Products	3.55	-6.76	1.05	-0.46	0.13
Banks	3.45	11.57	0.96	-0.45	-0.02
IT Services & Consulting	3.08	-4.77	0.87	-0.36	-0.07
Banking & Investment Services	3.07	10.24	1.01	-0.41	0.04
Banking Services	3.07	10.24	1.00	-0.41	-0.03
Rails & Roads Transportation	2.68	-8.08	0.90	-0.20	-0.05
Financials	2.39	10.19	1.05	-0.30	-0.01
Heavy Machinery & Vehicles	2.33	-5.96	1.01	-0.25	0.05
Retailers	2.20	-7.87	0.99	-0.31	-0.05
Machinery, Equip. & Components	2.12	-12.35	1.03	-0.29	-0.03
Agricultural Chemicals	2.06	-12.51	0.99	-0.33	0.08
Marine Services	2.00	1.70	0.90	-0.28	0.06
Industrial Goods	1.91	-12.79	1.03	-0.27	-0.01
Transportation	1.52	-2.25	0.97	-0.14	0.07
Industrials	1.45	-3.53	0.99	-0.16	0.02
Negative Abnormal Returns					
Energy	-2.64	-0.50	1.05	0.28	0.07

Table 24: Effects of the Beijing Declaration on Sustainable Development

Industry	AR	CAR	Beta	Short-term Climate Change risk	Long-term Climate Change risk
Positive Abnormal Returns					
Construction & Engineering	5.61	4.22	0.98	-0.57	-0.10
Industrial Services	4.93	2.96	0.99	-0.51	-0.08
Highways & Rail tracks	3.21	-1.90	0.85	-0.34	-0.06
Electric Utilities	1.79	6.25	0.89	-0.14	-0.19
Industrials	1.65	-1.98	0.99	-0.15	-0.01
Negative Abnormal Returns					
Non-Cyclical Cons. Gds & Services	-1.55	-3.31	0.90	0.13	-0.03
Textiles & Apparel	-1.85	-7.04	1.03	0.22	0.08
Apparel & Accessories	-1.86	-5.00	0.97	0.23	0.08
Beverages	-2.08	-0.84	0.77	0.16	-0.08
Textiles & Leather Goods	-2.09	-9.81	1.01	0.23	0.09
Food Processing	-2.13	-6.70	0.97	0.19	0.00
Food & Beverages	-2.13	-3.74	0.92	0.17	-0.04
Energy	-2.30	-0.36	1.04	0.16	0.16
Food & Tobacco	-2.31	-7.21	0.98	0.19	0.01
Distillers & Wineries	-2.36	-1.89	0.75	0.17	-0.09
Retailers	-2.45	-8.60	0.99	0.20	-0.02
Rail, Road & Sea Passenger Trans.	-2.56	-10.74	0.95	0.24	0.00
Semiconductors & S. Equipment	-2.72	-5.76	1.06	0.23	0.10
Marine Port Services	-2.96	-5.50	0.91	0.29	0.07

Table 25: Effects of the Adoption of the Environmental Management of New Chemical Substances

Industry	AR	CAR	Beta	Short-term Climate Change risk	Long-term Climate Change risk
Positive Abnormal Returns					
Banking Services	3.08	0.70	1.00	-5.88	-0.10
Banks	2.47	0.68	0.96	-6.07	-0.16
Banking & Investment Services	2.04	1.01	1.01	-5.05	-0.10
Financials	1.84	0.47	1.05	-4.44	-0.10
Negative Abnormal Returns					
Basic Materials	-1.23	-0.67	1.05	2.63	0.06
Machinery, Equip. & Components	-1.53	-1.53	1.03	3.83	0.07
Chemicals	-1.55	-0.35	1.02	3.61	0.15
Commodity Chemicals	-1.58	0.30	1.03	3.54	0.13
Industrial Goods	-1.62	-0.56	1.03	4.04	0.07
Cyclical Consumer Goods & Services	-1.66	-1.10	0.92	3.89	0.03
Auto, Truck & Motorcycle Parts	-1.71	-4.84	1.02	4.40	0.06
Automobiles & Auto Parts	-1.75	-2.56	0.98	4.06	0.13
Non-Cyclical Cons. Gds & Services	-2.02	-1.03	0.90	4.87	-0.06
Retailers	-2.07	-1.01	0.95	4.85	-0.08
Food & Beverages	-2.11	-0.86	0.87	5.13	-0.06
Cyclical Consumer Services	-2.22	1.48	0.99	5.60	-0.01
Paper Products	-2.26	-2.26	1.04	5.16	0.11
Paper & Forest Products	-2.27	0.39	1.05	5.24	0.09
Electrical Components & Equipment	-2.28	0.11	1.07	5.39	0.01
Technology Equipment	-2.32	2.30	1.04	5.59	0.05
Food & Tobacco	-2.34	-0.15	0.98	5.51	-0.01
Food Processing	-2.52	-1.15	0.97	5.80	-0.02
Media & Publishing	-2.67	3.01	0.99	6.69	-0.04
Industrial Machinery & Equipment	-2.68	-2.68	1.04	6.29	0.09
Communications Equipment	-2.77	-0.64	1.04	6.69	0.07
Semiconductors & S. Equipment	-3.50	4.18	1.06	8.20	0.06

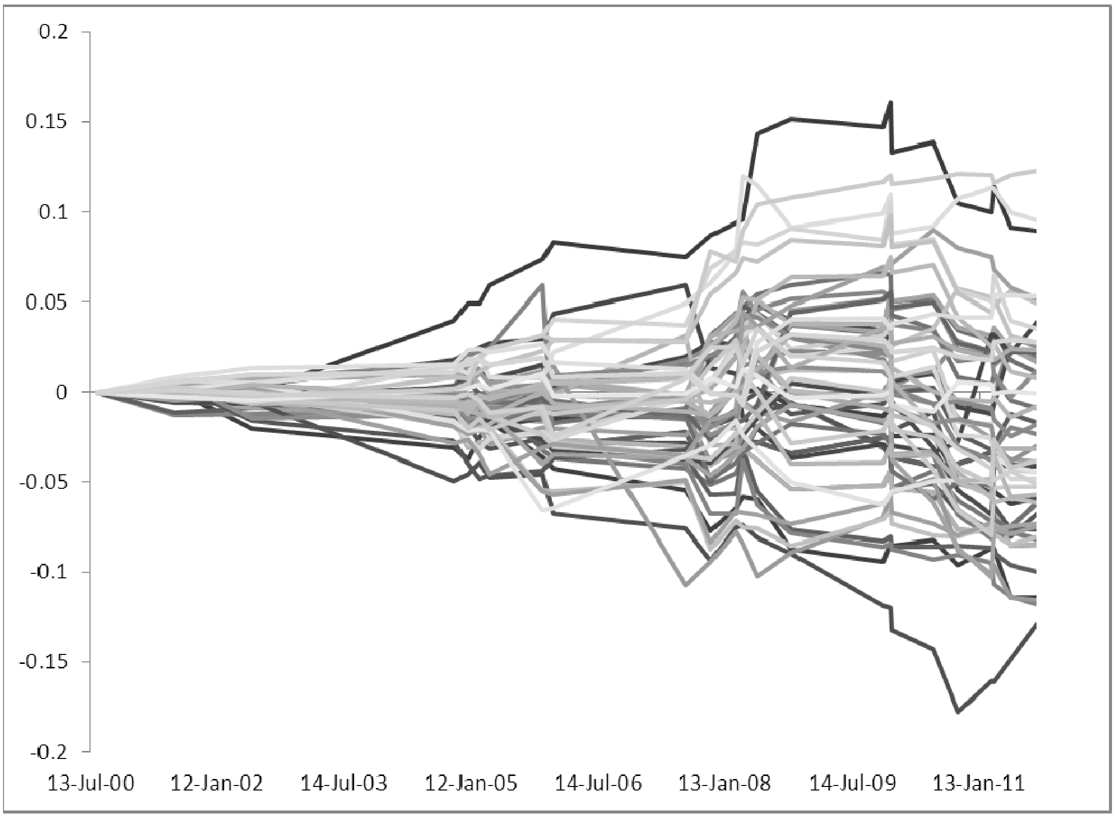
Table 26: Effects of Activating Provision on the EMNCS - *Positive Abnormal Returns*

Industry	AR	CAR	Beta	Short-term Climate Change risk	Long-term Climate Change risk
Airlines	5.39	4.22	1.11	5.95	0.15
Airline Services	4.90	3.40	0.99	5.67	0.17
Banking & Investment Services	3.37	1.61	1.01	3.40	-0.16
Banks	3.08	0.35	0.96	3.07	-0.25
Banking Services	3.08	0.35	1.00	2.94	-0.28
Financials	2.48	0.50	1.05	2.37	-0.14
Transportation	1.38	0.17	0.97	1.59	-0.05

Table 27: Effects of Activating Provision on the EMNCS - *Negative Abnormal Returns*

Industry	AR	CAR	Beta	Short-term Climate Change risk	Long-term Climate Change risk
Commodity Chemicals	-1.80	0.57	1.03	-1.64	0.17
Diversified Trading & Distributing	-1.83	-2.54	1.09	-1.80	0.02
Chemicals	-1.87	0.80	1.02	-1.66	0.18
Textiles & Apparel	-1.87	-1.42	1.03	-1.72	0.07
Automobiles & Auto Parts	-1.96	2.85	0.98	-1.74	0.16
Pharmaceuticals & Medical Research	-2.05	2.18	0.87	-2.24	0.05
Textiles & Leather Goods	-2.07	-1.24	1.01	-1.89	0.08
Healthcare	-2.08	1.96	0.87	-2.27	0.05
Diversified Pharmaceuticals	-2.17	2.21	0.77	-2.15	0.15
Pharmaceuticals	-2.24	1.91	0.87	-2.46	0.04
Auto, Truck & Motorcycle Parts	-2.24	2.62	1.11	-2.39	0.11
Generic & Specialty Pharmaceuticals	-2.32	1.67	0.90	-2.56	0.01
Non-Cyclical Cons. Gds & Services	-2.39	-0.30	0.90	-2.41	-0.05
Cyclical Consumer Products	-2.43	-1.95	1.02	-2.30	0.02
Specialty Chemicals	-2.49	-1.48	1.05	-2.31	0.19
Oil & Gas	-2.63	-3.83	1.07	-1.64	-0.96
Food & Beverages	-2.63	-1.13	0.92	-2.64	-0.07
Cyclical Cons. Gds & Services	-2.65	-0.32	0.92	-2.58	0.04
IT Services & Consulting	-2.71	0.52	0.87	-2.67	0.10
Electrical Comp. & Equip.	-2.77	-2.06	1.07	-2.81	0.02
Software & IT Services	-2.88	-0.97	0.99	-3.00	0.10
Specialty Retailers	-2.89	-1.04	1.05	-3.01	-0.01
Technology	-3.00	-1.38	1.02	-3.03	0.07
Technology Equipment	-3.08	-1.72	1.04	-3.02	0.05
Household Goods	-3.12	-2.28	0.98	-3.03	-0.03
Software	-3.14	-3.26	0.87	-3.41	0.14
Retailers	-3.15	-3.17	0.95	-3.24	-0.09
Semiconductors & Semi. Equip.	-3.21	-3.90	1.06	-3.15	0.12
Diversified Retailers	-3.27	-4.01	0.84	-3.18	-0.06
Food Processing	-3.47	-2.23	0.97	-3.36	-0.05
Communications Equipment	-3.53	-1.02	1.04	-3.55	0.07
Food & Tobacco	-3.63	-3.39	0.98	-3.50	-0.04
Construction Materials	-3.68	-2.53	1.01	-3.58	0.19
Media & Publishing	-3.90	-3.49	0.99	-4.19	0.00
Fishing & Farming	-4.03	-6.43	0.99	-3.88	0.00
Cyclical Consumer Services	-4.07	-0.85	0.99	-4.17	-0.01
Leisure & Recreation	-4.08	2.41	0.95	-3.83	0.04
Hotels & Entertainment Services	-4.25	1.95	0.99	-4.15	-0.02

Figure 11: Long-Term Climate Change Risk in China



Chapter 4

Conclusions

This thesis presents an empirical study aiming at exploring the effects of environmental regulation announcements on corporate performance in the United States and China when performance is represented by stock returns, by using event study methodology.
It also investigates market reaction to the election of President Obama in 2004 who has been associated with the introduction of green policies. Hence the Obama effect and the effect of other announcements of green policies has been called the "climate change effect" by Ramiah, Pichelli, Moosa (2012a). It is necessary to observe that the Obama effect was not only limited to his association with green policies and that the methodology cannot distinguish between the "general" Obama effect and the green-policy related Obama effect.
The results show that the announcement of US green policies has a major effect on stock markets as reflected in stock returns. This conclusion is based on an analysis of 133 days when major green policies were announced over the period July 1997 to March 2011. The results vindicate the existence of the Obama effect as 19 portfolios were negatively affected by his election—four of these sectors are related to the health care industry. Since President Obama's campaign contained international policies, his election also affected foreign markets.

Research about China green policies announcements confirms that certain announcements of environmental regulation affect risk and return in the Chinese stock market. Policy announcements following the Kyoto Protocol had some impact on the stock market. Some of these policies were successful in that it has been observed negative abnormal returns and increase in systematic risk for the polluting industries. The *Environmental Management of New Chemical Substances* regulation affected most industries and negatively affected the health industry. However, Ramiah, Pichelli, Moosa (2012a) come across some evidence for policy ineffectiveness in the following forms: (i) a number of policies affected the market only marginally, (ii) some policies fail to achieve their primary goals, and (iii) responses to these policies are rather slow. One of the most surprising results is that the coal industry came up as number one on the top-ten list of positive abnormal return, with abnormal return of 6.87%, after the 12th 5-year plan was submitted to the National People's Congress on 5 March

2011. This result may be explained in terms of the importance assumed by the coal industry in China that makes it immune to environmental regulation.

As for as the general effect of environmental regulation, the results for United States and China show that it is not necessarily the case that the announcement of green policies affects environmentally-friendly industries positively, and vice versa. One possible reason for the failure of green policies to affect negatively big polluters is their ability to pass on the extra costs induced by the green policies to consumers. In this case, this is a failure of environmental regulation. In general, however, these results suggest that the announcement in the US does affect the stock market and corporate performance as reflected in stock returns.

About China, the evidence indicating the neutrality of announcements of environmental regulation may be explained in terms of the lack of enforcement, in the sense that while the Chinese government has enacted a comprehensive set of environmental laws, the statutory scheme with respect to implementation and enforcement is rather weak. The apparent ineffectiveness of environmental regulation in China can be explained in terms of what Hills and Man (1998) call the "implementation gap", which is typically attributed to legislative shortcomings, poorly designed policy instruments, an unsupportive work environment for environmental regulators, a pro-growth political and social environment, and a cultural predisposition to harmony and consensus-building among those involved in the process.

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