Journal of Banking & Finance 37 (2013) 1747–1758

Contents lists available at SciVerse ScienceDirect

Journal of Banking & Finance

journal homepage: www.elsevier.com/locate/jbf

How does the stock market react to the announcement of green policies?

Vikash Ramiah *, Belinda Martin, Imad Moosa

School of Economics, Finance and Marketing, RMIT, Australia

ARTICLE INFO

Article history:
Received 11 January 2012
Accepted 8 January 2013
Available online 26 January 2013

JEL classification:
G1
G11
H56

Keywords:
Environmental regulation
Green
Policies
Abnormal returns
Event study
Systematic risk
Diamond risk

ABSTRACT

We investigate the impact of 19 announcements of environmental regulation on the equities listed on the Australian Stock Exchange over the period 2005–2011. Using a well-established event study methodology, we assess whether these announcements are value constructive or destructive for equity investors. Additionally, we estimate the change in systematic risk following the announcements. Our results show that the Australian market was particularly sensitive to the carbon pollution reduction scheme (CPRS) announcement. A cumulative abnormal return of −31% was recorded in the alternative energy sector after Australia submitted its target range to the Copenhagen Accord. We observe that a move towards a greener nation has a mixed effect on abnormal returns with apparent sector-by-sector differences. Green policies appear to affect the long-term systematic risk of industries, leading to the diamond risk phenomenon.

1. Introduction

A heated but unsettled debate, which often has an ideological dimension, has been raging on the economic and financial effects of regulation in general and environmental regulation in particular. Research has been conducted on the effect of environmental standards on corporate performance as measured by stock returns, profitability, risk, employment and output but there is no agreement on whether environmental regulation creates or destroys value. Opponents of regulation suggest that it inflicts damage on the economy by raising the costs of production, leading to a fall in sales and employment as well as deterioration of corporate financial indicators. Shapiro and Irons (2011), on the other hand, argue that studies of environmental regulation have consistently failed to find significant negative effects. They even suggest that the effect of environmental regulation on big polluters is small but positive.

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 Australia has assigned to green policies, particularly with respect to climate change. It is also important because Australia is one of the largest, if not the largest, per capita producer of greenhouse emissions. The importance assigned by the Australian government to green policies was confirmed by the ratification of the Kyoto Protocol as the first act of former Prime Minister Kevin Rudd after being sworn in on 3 December 2007 (Topsfield et al., 2007). We examine the reaction of the Australian stock market to the Kyoto Protocol, the climate change review, the carbon pollution reduction scheme (CPRS), and renewable energy schemes. To this end, we follow the lead of Hamilton (1995), White (1995) and Klassen and McLaughlin (1996) by using the technique of event study to explore the effect of the announcement of green policies on stock returns.

2. Literature review

Common sense tells us that it is cheaper for firms to operate in countries where environmental regulation is either lax or not enforced because regulation brings with it fines, liabilities and administrative or legal action against polluters (Stewart, 1993). There is also some evidence suggesting that environmental regulation affects productivity because it forces firms to commit resources to non-productive uses such as environmental auditing, waste treatment and litigation (Gray and Shadbegian, 1995; Haveman and Christiansen, 1981). Other channels through which environmental regulation exerts an adverse effect on firms is that, in the absence of environmental regulation, firms can recapitalize

* Corresponding author. Address: School of Economics, Finance and Marketing, RMIT, 445 Swanston Street, Melbourne, Victoria 3000, Australia. Tel.: +61 3 9925 5828; fax: +61 3 9925 5986.
E-mail address: vikash.ramiah@rmit.edu.au (V. Ramiah).

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http://dx.doi.org/10.1016/j.jbankfin.2013.01.012

old equipment that is no longer acceptable (not being environmentally-friendly) and market products that may be discouraged or banned by some environmental standards (Vernon, 1992; Korten, 1995).

On the other hand those who argue that environmental regulation creates rather than destroys value have several reasons to believe so. Arguments in favor of environmental regulation include the following (Dowell et al., 2000): (i) the cost savings associated with lower environmental standards may be exaggerated and may not even exist; (ii) when firms make new investments they may find it more costly not to adhere to higher environmental standards; (iii) firms can reduce pollution by making changes in the production process rather than by incurring direct costs; and (iv) 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".

Hamilton (1995), White (1995) and Klassen and McLaughlin (1996) use event study to demonstrate that news of high level of toxic emissions results in significantly negative abnormal returns. They also show that firms with strong environmental management practices produce higher stock returns than firms with poor practices following a major environmental disaster, such the 2010 BP incident in the Gulf of Mexico. These results are interpreted by Dowell et al. (2000) 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". Another result produced by event study is that environmental performance awards results in significant positive abnormal returns. Dowell et al. (2000) interpret this finding to imply that 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.

Apart from studying the effect of environmental regulation on stock returns, some studies consider the effect on market value and risk. Dowell et al. (2000) analyze the global environmental standards of a sample of US multinational corporations and find that those adopting higher environmental standards have much higher market values as measured by Tobin's q. 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. Feldman et al. (1996) analyze a sample of 300 US firms to find out if investment in environmental management leads to reduction in risk and whether or not this risk reduction is valued by financial markets. Their findings suggest that risk reduction would materialize, coupled with an increase in stock price.

Studies dealing with the effect of environmental regulation on corporate profitability have been conducted by Cohen et al. (1995), Hart and Ahuja (1996), Russo and Fotus (1997), and Nehrt (1996). Cohen et al. (1995) find strong correlation between environmental performance and corporate profitability, Hart and Ahuja (1996) provide evidence indicating that efforts to prevent pollution and reduce emissions are positively associated with returns on sales and assets. Russo and Fotus (1997) find environmental performance and return on assets to be positively correlated and that returns to environmental performance are higher for high-growth industries. Nehrt (1996) examines the relation between timing and intensity of investment in pollution prevention and growth in the profits of 50 firms. Again his results show that a positive relation exists between early adopters of pollution prevention measures and profit growth.

Some economists have dealt with the effect of environmental regulation on the economy at large by examining the consequences for growth and employment. Masur and Posner (2011) cast doubt on the validity of the process used by regulatory agencies to estimate the potential unemployment effect of proposed regulation, describing it as *ad hoc*. The procedure boils down to a rejection of a proposed regulation if the predicted unemployment effects are too high according to a predetermined threshold level. They suggest that a better approach is to incorporate unemployment effects into cost-benefit analysis by monetizing the unemployment effect. Morgenstern et al. (2000) provide evidence indicating that "increased environmental spending does not cause a significant change in industry-level employment". They actually detect a net gain of 1.5 jobs per $1 million of environmental spending.

3. Methodology

The methodology consists of three elements: the estimation and testing of abnormal returns, robustness tests and risk analysis. These elements are described in turn.

3.1. Abnormal return analysis

We start by calculating daily returns, represented by the first natural logarithmic difference of the underlying stock price, for all of the individual companies in our sample. Following Brown and Warner (1985), daily returns are adjusted to obtain the *ex post* abnormal returns where adjustments are approximated by the CAPM. The abnormal returns (AR) are then grouped into industries to obtain the average industry (I) abnormal returns at time t, (AR_{It}). The standard t statistic for an industry's abnormal return is computed to find out if it is statistically different from zero. This gives rise to three possible outcomes:

$$(AR_{It}) = 0 \quad (1)$$

$$(AR_{It}) > 0 \quad (2)$$

$$(AR_{It}) < 0 \quad (3)$$

Our implicit assumption is that the abnormal return of an industry is a function of revenue minus cost. Outcome (1) of zero abnormal return occurs when neither revenue nor cost changes as a result of the introduction of green policies. It may also materialize if the industry experiences a decrease in revenue, which is offset by a decrease in cost in the form of government subsidy (or vice versa). Under this scenario, the wealth of shareholders remains unchanged. Outcome (2) is that there is wealth creation for shareholders represented by positive abnormal return. We postulate that this outcome pertains to renewable energy and environmentally-friendly businesses, emerging as a result of an increase in the demand for their products and hence revenue. Introduction of the CPRS may have an adverse effect on the profitability of polluting firms as the cost of production rises by the amount of the carbon penalties. The effect depends on the ability of the polluter to pass on the extra cost to the consumer (which may be prevented by regulators) and the elasticity of demand for the underlying product. Outcome (3) will materialize if demand is elastic (hence a price rise reduces total revenue) or if the polluter cannot pass on the extra cost to consumers.In an efficient market hypothesis (EMH) framework, the stock market reacts instantly to new information arrival and prices reflect all available information. Abnormal return analysis enables us to capture the reaction of the stock market on the first day of trading following the announcement. For non-believers in the EMH, however, investors may not react rationally on the first day and there may be some delayed responses. There is a possibility for market participants either to over-react or under-react when new information is released, which means that they have a tendency to correct their mistakes in subsequent periods. To that end, we estimate the cumulative abnormal return (CAR) over the following five trading

days to find out whether or not the market reverts back to its mean process or continues to deviate from the mean price. We use the t test to determine the statistical significance of cumulative returns.

3.2. Robustness tests

According to Corrado (1989) and Corrado and Truong (2008), one of the criticisms of the Brown and Warner (1985) approach is that abnormal returns are not normally distributed, as they have a tendency to exhibit high kurtosis and positive skewness, which may introduce bias in the parametric t statistics. To circumvent this problem, we adopt the Corrado (1989) non-parametric ranking test as the first robustness test.[1] This test requires the transformation of abnormal returns into ranks over a combined period of 260 days. The period is broken up into 244 days before the event and 15 days afterwards. The ranks are then compared with the expected average rank under the null hypothesis of no abnormal returns. A non-parametric t statistic is accordingly calculated to test the null hypothesis. Ataullah et al. (2011) argue that the Carrado test is valid when applied to skewed and/or leptokurtic distributions and that it makes it possible to avoid the limitations of alternative non-parametric tests of abnormal returns. However, they suggest that little is known about the test's small sample properties.

We also use the non-parametric conditional distribution approach suggested by Chesney et al. (2011) as an alternative robustness test. The use of Kernel estimation is advocated on the grounds that it does not require the specification of a regression function, neither is it necessary to determine the distribution of the error term. This is an attractive feature because, as Chesney et al. (2011) put it, the technique "lets the data speak for itself and overcomes a disadvantage of parametric econometrics when inconsistency between data and a particular parametric specification would result in non-robustness". This is a robustness test because, compared to event study, Chesney et al. describe it as "an alternative way of studying the impact [of an event]". The results of this test will be presented graphically for two events by constructing conditional cumulative distribution functions of returns when conditioning is done on the return prevailing one day before the event date. If the conditional cumulative probability of the return on the general index (which is less than or equal to that on the event date) turns out to be less than 0.05, we conclude that the event has an extreme effect on the market.

Another problem that may be encountered is the effect of firm-specific information on abnormal returns. For instance if firm-specific information becomes available on the day when a green policy is announced, the results will reflect a combination of firm-specific information and the announcement. It is not valid to suggest that the observed abnormal return is caused entirely by a green policy announcement because we cannot determine how much of the abnormal return is associated with a particular announcement. To deal with this problem, we use a robustness test whereby we exclude from the industry portfolio all firms with firm-specific information 15 days on either side of the announcement day. Firm-specific information is defined as any announcement made by the underlying firm. The emerging abnormal return will be free from firm-specific information—it will be attributed solely to the announcement.

Chesney et al. (2011) and Graham and Ramiah (2012) highlight the need to control for asynchronicity, stock market integration, and spillover effects in event study. To that end, abnormal returns are calculated by augmenting the CAPM with three market risk premia representing Asia ($\tilde{r}_{mt}^{Asia} - \tilde{r}_{ft}^{Asia}$), Europe ($\tilde{r}_{mt}^{Europe} - \tilde{r}_{ft}^{Europe}$) and the US ($\tilde{r}_{mt}^{US} - \tilde{r}_{ft}^{US}$). Bilson et al. (2012) justify the augmentation process with reference to the factor model of Bekaert et al. (2005), which they use to estimate cross-market linkages. This model is specified on the assumption that markets are integrated either internationally or regionally. Hence the model contains a term that represents the world market factor, implying that under global market integration, expected returns should be a linear function of the excess return on the world market. The model also contains a regional factor, calculated as the market return on a portfolio of geographically proximate countries.

3.3. Risk analysis

With change comes uncertainty. The environment in which businesses operate changes significantly with the adoption of green policies, with unknown effect on systematic risk. On the one hand, environmentally-friendly products make the world safer, which may have spillover effects on the stock market. On the other hand, they may represent risk for other businesses. To test for the change in systematic risk, we adjust the CAPM by incorporating interaction variables. Our first risk model captures the average change in risk as a consequence of the 19 announcements. An aggregate dummy variable (AD), which takes the value of one on the announcement date and zero otherwise, is created to represent the 19 announcements. This dummy variable is multiplied by the market risk premium to form the first interaction variable. Hence the model takes the form

$$\tilde{r}_{It} - \tilde{r}_{ft} = \beta_I^0 + \beta_I^1[\tilde{r}_{mt} - \tilde{r}_{ft}] + \beta_I^2[\tilde{r}_{mt} - \tilde{r}_{ft}] * AD_t + \beta_I^3 AD_t + \tilde{\varepsilon}_{it} \quad (4)$$

where $\tilde{r}_{It}$ is industry i's return at time t, $\tilde{r}_{ft}$ is the risk-free rate at time t, $\tilde{r}_{mt}$ is the market return at time t, AD is a dummy variable that takes the value of one on the announcement date and zero otherwise, $\tilde{\varepsilon}_{it}$ is the error term, β_I^0, is the intercept of the regression equation ($E(\beta_I^0) = 0$), β_I^1 is the average short-term systematic risk of the industry, β_I^2 captures the change in the industry risk, and β_I^3 measures the change in the intercept of Eq. (4). The equation is estimated to calculate the aggregate effect of the 19 announcements on the stock market.

One of the problems with the aggregate model is that effects of opposite outcomes from different announcements may cancel each other. Another variation of this model can be developed to disaggregate the effects into individual announcements—this model allows us to identify the exact contribution of each green policy announcement (g). We start by creating an individual dummy variable (ID) for each announcement such that it takes a value of one on the announcement date and zero otherwise. Each dummy variable is then multiplied by the market risk premium to obtain 19 interaction variables whose coefficients represent the short-term change in systematic risk originating from news arrival. The model is written as follows:

$$\tilde{r}_{It} - \tilde{r}_{ft} = \beta_I^0 + \beta_I^1[\tilde{r}_{mt} - \tilde{r}_{ft}] + \sum_{g=1}^{19} \beta_{I,n}^2[\tilde{r}_{mt} - \tilde{r}_{ft}] * ID_{gt} + \tilde{\varepsilon}_{it} \quad (5)$$

It should be noted that the additive dummy variables that capture the change in the intercept are dropped out in Eq. (5) as the dummy variables for each announcement are highly correlated with each other, causing serious multicollinearity. Graham and Ramiah (2012) propose an alternative model specification in which the individual dummy variables take the value of one for the first 15 days and zero otherwise. By adopting this approach the following model is obtained.

$$\tilde{r}_{It} - \tilde{r}_{ft} = \beta_I^0 + \beta_I^1[\tilde{r}_{mt} - \tilde{r}_{ft}] + \sum_{g=1}^{19} \beta_{I,n}^2[\tilde{r}_{mt} - \tilde{r}_{ft}] * ID_{gt} + \sum_{g=1}^{19} \beta_{I,g}^3 ID_{gt} + \tilde{\varepsilon}_{it} \quad (6)$$

[1] Conover (1971) described non-parametric statistics as providing "approximate solutions to exact problems…as opposed to the exact solutions to approximate problems furnished by parametric statistics".

Ramiah et al. (2010) and Graham and Ramiah (2012) argue that certain events have the potential to affect the long-term systematic risk of stock markets, which provides motivation for investigating whether or not green policies affect long-term systematic risk. Eqs. (4)–(6) are re-estimated such that the aggregate dummy variable (AD) assumes the value of zero prior to the announcement and one thereafter, while the individual dummy variables (ID) take the value of zero prior to the announcement and one for the subsequent periods.

Batteries of econometric tests are carried out on all of the regression equations. For instance, we start with the Chow test to detect the presence or otherwise of structural breaks following each announcement. However, the results of the Chow test reveal the combined effect of a change in the intercept and the slope of the model. Since we are interested in systematic risk (as represented by the slope), we have to estimate Eqs. (4)–(6). When we encounter multicollinearity, the Wald test is used to check for redundant variables. As we use daily data, autocorrelation and ARCH effects are likely to be present. Appropriate AR and MA terms are introduced to control for autocorrelation, while GARCH specifications are used to correct for the ARCH effects.[2]

4. Data and empirical results

4.1. Data and announcements

We use daily data (as reported by Datastream) on 1770 individual stock prices, the ASX200 share price index (as a proxy for the market), and the 10-year bond yield (as a proxy for the risk-free rate) over the period February 2004 to March 2011. The Datastream classification standards are utilized to construct industry portfolios—altogether there are 35 industries or sectors.

Table 1 reports 19 announcements of green policies—each announcement is assigned a sequence number (from 1 to 19). Two announcements involve a *Garnaut Report*: the 2008 climate change review (Garnaut, 2008), which is announcement 5, and the Garnaut paper on carbon pricing (Garnaut, 2011), which is announcement 19. To distinguish between the two "Garnaut announcements", we call the first one "*Garnaut Climate Change Review*" and the second "*Garnaut Carbon Pricing Paper*".

4.2. The results: general observations

The results confirm the proposition that announcement of green policies had a major impact on stock returns for more than half of the industries or sectors. Of the sectors that were affected, the majority displayed negative abnormal returns, but we also document positive abnormal returns in others. Table 2 provides a summary of the estimated abnormal returns. The results show that only 14 out of 35 industries were not affected by the announcement of green policies, implying that 60% of the Australian stock market was influenced by these policies.[3] The proportions of sectors experiencing negative and positive abnormal returns were 29% and 20%, respectively.

Table 3 displays the announcements that caused positive and negative abnormal returns in the underlying sectors. Out of the 19 announcements, seven of them did not exert any influence (announcements 1, 3, 11, 12, 13, 17 and 18). Announcements 6 and 15 exerted a negative impact on a large number of sectors (eight and five, respectively) whereas announcements 5 and 7 exerted a positive impact on more sectors than other announcements (four and six, respectively). Some announcements exerted a positive impact on some sectors and a negative impact on others (announcements 2, 6, 8, 14 and 15), while others had either positive effects only (5 and 7) or negative effects only (9, 10 and 19).

Risk analysis produces evidence of changes in long-term, and to a lesser degree in short-term, systematic risk. There appears to be an industry effect whereby the impact of green policy announcements on industry betas varies across industries. Systematic risk may increase, decrease or remain unchanged. Interestingly, we observe a diamond risk phenomenon (we will return to risk analysis later on).

4.3. Sectors reacting negatively

Table 4 reports statistically significant abnormal returns, as well as their t statistics, on the first day of trading following the announcement of green policies. We document statistically significant negative responses in 10 industries: beverages, construction and materials, financial services, health care, leisure, mining, non-life insurance, oil and gas, personal goods and real estate.[4]

Consider first announcement 5, the release of the *Garnaut Climate Change Review* (Garnaut, 2008) on 30 September 2008. This report provides a gloomy picture of Australia at the end of this century if no adequate measures are adopted to reduce greenhouse gas emissions. It predicts that ecological and economic damage will follow if no actions are undertaken. The results presented in Table 4 show that the stock market did not react negatively to the release of this report, as no significantly negative abnormal return followed the announcement. However, four sectors reacted positively (industrial engineering, media, banks and general engineering). A plausible explanation for the positive reaction of the industrial engineering and general industrial sectors is that it is these sectors that will produce environmentally-friendly machinery. As a result, banks will find new business opportunities by financing green industrial and technological projects (hence bank stocks reacted positively).

Consider now the effect of the development of a plan to transform Australia into a low-carbon economy by implementing the CPRS as well as embracing an aggressive renewable energy program (announcement 6). On 15 December 2008, the Australian government released a white paper on the CPRS. The results show that abnormal return in the beverages sector was −9.50% after the announcement of the white paper—the t statistic indicates that this value is statistically different from zero. Seven other sectors (financial services, health care, leisure, personal goods, banks, electrical equipment and general industrial) exhibited negative and significant abnormal returns immediately after this announcement.

Abnormal returns vary directly with revenue and cost. If we consider the health care sector, for example, it is plausible to suggest that the introduction of the CPRS provides a better environment whereby people will be healthier, which in turn reduces the future revenue of the health care sector. In addition, the introduction of an emission trading scheme leads to a higher cost of production. The combination of these two factors provides a potential explanation for the negative abnormal return of this sector. Furthermore, Garnaut (2008) suggests that the move towards a greener Australia will result in an increase in energy prices such that low-income earners will be the worst affected. The drop in disposable income will undoubtedly have an undesirable impact

[2] The results of these tests are available upon request from the corresponding author.

[3] The sectors experiencing no reaction on the announcement day include alternative energy, chemicals, electricity, fixed line and mobile communications, food and drug retailers, forestry and paper, household goods, industrial transportation, oil equipment, pharmaceuticals, software and computing, support services, technology and travel.

[4] The tables reporting the full sets of results (all sectors and all announcements) are available from the corresponding author on request.

Table 1
Announcements of 19 Green Policies.

Number	Date	Green policies announcements
1	16/02/05	The Kyoto Protocol on climate change comes into force
2	31/05/07	John Howard's Prime Ministerial Task Group releases its report on emissions trading
3	3/12/07	Prime Minister Kevin Rudd signs the Kyoto Protocol
4	16/07/08	The Australian government's green paper is released, outlining intended emission trading design - the Carbon Pollution Reduction Scheme
5	30/09/08	The 2008 *Garnaut Climate Change Review* is presented
6	15/12/08	The Australian government's Carbon Pollution Reduction Scheme white paper is released, including intended carbon targets
7	14/05/09	The Senate rejects the Carbon Pollution Reduction Scheme bill
8	22/10/09	The Carbon Pollution Reduction Scheme bill is reintroduced into Federal Parliament
9	25/11/09	The US announces emissions reduction target of 17% on the 2005 levels by 2020
10	26/11/09	China announces emissions reduction target of 40–45% on 2005 levels by 2020
11	2/12/09	The Senate rejects the Carbon Pollution Reduction Scheme bill
12	7/12/09	First day of the Copenhagen Conference on Climate Change
13	18/12/09	Copenhagen Accord – Final day of Copenhagen Conference
14	27/01/10	Australia submits target carbon reduction range to the Copenhagen Accord. The Australian government decides not to commit beyond a 5% reduction on the 2000 levels unless a strong international agreement is reached
15	2/02/10	Carbon Pollution Reduction Scheme bill is reintroduced into Federal Parliament
16	27/04/10	Kevin Rudd officially defers Carbon Pollution Reduction Scheme
17	12/05/10	Announcement of renewable energy target split into large-scale renewable energy target and small-scale renewable energy scheme announced
18	24/06/10	Legislation to split Renewable Energy Target into Large-Scale renewable energy target and small-scale renewable energy scheme is passed through Parliament
19	17/03/11	The *Garnaut Carbon Pricing Paper* is released

Table 2
Reaction of Industries to the announcement of green policies.

	AR		CAR	
	Number	%	Number	%
Negative reaction	10	29	12	34
Positive reaction	7	20	4	11
Mixed reaction	4	11	2	6
No reaction	14	40	17	49
Total	35	100	35	100

on the leisure sector and the personal goods sector. According to the Australian Food and Grocery Council, the increase in energy cost has the potential to erode the competitiveness of the packaged food, drink and grocery products industry on the international market as other competitive markets may not have the same legislation in place. The CPRS is effectively a market imperfection that reduces output unless there is a smarter way of production. Since financial services grow with national output, the finance industry is affected adversely by the announcement of the CPRS.

After the release of the white paper on CPRS, the government consulted with numerous parties and welcomed comments from the public. Revisions were incorporated and the CPRS bill was finalized in May 2009 but it was defeated by the Coalition and Greens in the Senate in August 2009. The CPRS bill was reintroduced on 2 February 2010 (announcement 15), and this is why we study its impact on the stock market again. Table 4 shows that the beverages and financial services sectors were affected negatively by this announcement. The construction and materials sector and non-life insurance sector were also adversely affected by the same announcement.

The beverages sector, which is dominated by beer and wine producers, remains an interesting case as it was negatively affected by three other announcements released on 31 May 2007, 25 November 2009 and 26 November 2009 (announcements 2, 9 and 10). The first of the three announcements was about John Howard's Prime Ministerial Task Group releasing its report on emissions trading (Department of Prime Minister and Cabinet, 2007). The second and third ones were about the US and China announcing their emissions reduction targets.

Our analysis also shows that the oil and gas, real estate and the general industrial sectors experienced negative abnormal returns around the release of the Australian government's green paper on 16 July 2008 (announcement 4). The green paper, which came out before the white paper, reflected the government's preferred positions on issues relating to the CPRS. The primary objective of the CPRS is to raise the costs of production of top polluters, forcing them to find and adopt alternative modes of production that are environmentally friendly. On top of the list of the biggest polluters are electricity companies that use oil and gas to produce electricity. It is for this reason that the oil and gas sector experienced a negative abnormal return of -2.84% following the release of the green paper on CPRS.

4.4. Sectors reacting positively

Since green policies are designed to raise the costs of production of big polluters to a point where it is no longer profitable to engage in polluting activities, they are forced to explore alternative environmentally-friendly methods of production. Hence we should expect the industrial engineering sector to react positively to the announcement of green policies—this is displayed in Table 4. The results show that this sector experienced a positive abnormal return of 3.20% following the release of the *Garnaut Climate Change Review* (announcement 5).

The CPRS bill has been criticized for its ineffectiveness in controlling carbon emissions. According to the *Bills Digest of the Parliament of Australia* (No 165 2008–09), the CPRS in its current form is meant to position Australia as the highest per capita greenhouse gas emitter in the developed world. Mark Diesendorf, the Deputy Director of the Institute of Environmental Studies at the University of New South Wales, wanted to rename the CPRS as the Carbon Pollution Reinforcement Scheme. When the Senate rejected the CPRS bill on 14 May 2009, the industrial engineering sector welcomed the news with a positive abnormal return of 4.19% because of the feeling that the scheme was not adequately environmentally-friendly. On 27 January 2010, the Australian government submitted its target carbon reduction range to the Copenhagen Accord, deciding not to commit beyond a 5% reduction on the 2000 levels unless a strongly-binding international agreement is reached. The industrial engineering sector welcomed this move with a positive abnormal return of 3.73% immediately after the signing of the agreement.

Table 4 also shows other industries that were positively affected by the announcement of green policies: these industries are

Table 3
Announcements impacting the stock market (as indicated by significant abnormal returns).

Announcement	Positive effect	Negative effect
2	Water, gas and utilities	Beverages
4		Oil and gas
		Real estate
		General industrial
5	Industrial engineering	
	Media	
	Banks	
	General industrial	
6	Auto and parts	Beverages
		Financial services
		Health care
		Leisure
		Personal goods
		Banks
		Electrical equipment
		General industrial
7	Industrial engineering	
	Industrial mining	
	Banks	
	Electrical equipment	
	Food producers	
	General industrial	
8	Aerospace	Leisure
	General retail	
9		Beverages
10		Beverages
14	Industrial engineering	General industrial
15	General industrial	Beverages
		Construction and materials
		Financial services
		Non-life insurance
		Banks
16		Food producers
19		Mining

aerospace, automotive and parts, water, gas and utilities, industrial mining, media, and general retail. Starting with the report on emissions trading of John Howard's Prime Ministerial Task Group (released on 31 May 2007) the water, gas and utilities sector reacted positively with an abnormal return of 4.24%. The next announcement that triggered a positive response was the 30 September 2008 *Garnaut Climate Change Review* as the media sector recorded an abnormal return of 4.78%. The Australian government's CPRS white paper (released on 15 December 2008) led to an abnormal return of 5.45% in the automotive and parts sector. The reintroduction of the bill on 22 October 2009 resulted in abnormal returns of 14.69% and 3.69% for the aerospace sector and general retail sector, respectively. One of the conclusions that can be drawn from this finding is that the announcements of green policies do not have the same clear and consistent impact across industries even with respect to those that are positively affected.

Other sectors that reacted positively to the announcement of green policies are banks, electrical equipment, food producers and general industrial (placed under "mixed reactions" in Table 4). For instance, the banking sector reacted positively to the *Garnaut Climate Change Review* on 30 September 2008. When the questionable white paper was introduced on 15 December 2008, this sector reacted negatively to the proposed policies. When the Senate rejected the CPRS bill on 14 May 2009, the banking sector reacted positively again. On 2 February 2010, this sector reacted adversely when the CPRS bill was reintroduced in the Federal Parliament. These three announcements exerted significant effects on more sectors than all of the other announcements put together. It seems that the market reacted negatively whenever there was a potential for the implementation of the CPRS.

Table 4
Statistically significant abnormal returns.

Sector	Number	Date	AR (%)	*t* Statistic
Negative reaction				
Beverages	2	31/05/07	−6.45	−4.24
	6	15/12/08	−9.50	−6.25
	9	25/11/09	−2.99	−1.98
	10	26/11/09	−3.59	−2.36
	15	02/02/10	−3.40	−2.23
Construction and materials	15	02/02/10	−2.92	−2.22
Financial services	6	15/12/08	−2.64	−2.61
	15	02/02/10	−2.01	−2.00
Health care	6	15/12/08	−2.83	−2.07
Leisure	6	15/12/08	−4.47	−2.25
	8	22/10/09	−7.11	−3.58
Mining	19	17/03/11	−2.98	−2.59
Non-life insurance	15	02/02/10	−4.27	−2.49
Oil and gas	4	16/07/08	−2.84	−2.21
Personal goods	6	15/12/08	−7.33	−2.80
Real estate	4	16/07/08	−2.12	−2.08
Positive reaction				
Aerospace	8	22/10/09	14.69	4.17
Auto and parts	6	15/12/08	5.45	2.01
Water, gas and utilities	2	31/05/07	4.24	2.54
Industrial engineering	5	30/09/08	3.20	2.21
	7	14/05/09	4.19	2.89
	14	27/01/10	3.73	2.57
Industrial mining	7	14/05/09	6.16	2.51
Media	5	30/09/08	4.78	3.35
General retail	8	22/10/09	3.69	3.11
Mixed reaction				
Banks	5	30/09/08	1.58	2.52
	6	15/12/08	−1.50	−2.39
	7	14/05/09	1.89	3.02
	15	02/02/10	−1.61	−2.57
Electrical equipment	6	15/12/08	−5.65	−2.62
	7	14/05/09	4.64	2.16
Food producers	7	14/05/09	2.58	2.55
	16	27/04/10	−7.70	−7.59
General industrial	4	16/07/08	−1.86	−2.10
	5	30/09/08	2.18	2.46
	6	15/12/08	−2.19	−2.47
	7	14/05/09	3.00	3.38
	14	27/01/10	−1.76	−1.99
	15	02/02/10	1.88	2.12

4.5. Sectors not reacting

As stated earlier, 14 sectors did not experience statistically significant abnormal returns on the first day of trading following the announcement of a green policy. Surprisingly the electricity industry, which is on the top of list of the 500 biggest polluters in terms of greenhouse gas emissions, is one of these sectors. Green policies are meant to raise the cost of production of the biggest polluters, reduce the output level, consequently leading to negative abnormal returns—yet no abnormal return is associated with this sector. Such findings may be interpreted to imply the failure of green policies to target the biggest polluters. However, this interpretation may be flawed because what appears to be an ineffective policy may be due to the ability of the industry to pass on the extra cost to consumers. If this is the case, profitability is unaffected, given that the demand for electricity is inelastic. To be effective, environmental regulation must be coupled with pricing regulation (perhaps a role for the ACCC, the Australian consumer protection agency).

Another example of what seems to be ineffectiveness of environmental regulation can be found in the forestry and paper sector. Green policies are meant to be favorable to the forestry sector, but once again the results do not reveal statistically significant abnormal returns. Some of the other industries that were not

affected by these policies are chemicals, fixed line and mobile communications, industrial transportation and others.

4.6. The results of robustness tests

The results of the robustness tests corresponding to the abnormal return estimates presented in Table 4 are reported in Table 5. By considering higher significance levels than the conventional 5%, we can see that 25 out of 39 cases of significant abnormal returns are supported by at least one of the robustness tests. These results are reasonable, considering some of the problematical features of at least two of the robustness tests: the Corrado (1989) non-parametric ranking test and excluding firm-specific information from the industrial portfolios.

Apart from the point raised by Ataullah et al. (2011) about the unknown small sample properties of the Corrado test, this test can only be applied to the abnormal returns prevailing on the first day of trading (it cannot be used to test the significance of cumulative abnormal returns). Furthermore, the test can identify the sign, but not the magnitude, of the abnormal return. Kolari and Pynonnnen (2009) argue that while Corrado's (1989) rank test and its modification in Corrado and Zivney (1992) have good empirical power properties against the parametric tests of Patell (1976) and Boehmer et al. (1991), the test is derived for a one-day event window. Since the ranks of abnormal returns are dependent by construction, incremental bias is introduced in the standard error in the denominator of the simple CAR *t*-statistic of ranks as the accumulation period grows.

The exclusion of companies with firm-specific information from the industrial portfolios is also problematical because it leaves us with an extremely small number of firms within that portfolio, which may not reflect or capture the true reaction of the sector to the announcement of a green policy. Because we use a window of 30 days before and after the announcement, there is a very high probability that firms make specific announcements during this period, hence they will be excluded from the portfolio. Furthermore, the firm-specific announcement may not be independent of the announcement of a green policy—most likely the two announcements would be related. A green policy announcement may trigger a wave of announcements as firms explain how they will be affected by the new policy.

Fig. 1 provides a graphical illustration of the non-parametric conditional distribution approach suggested by Chesney et al. (2011) for two events that produced exceptionally high positive

Table 5
Robustness tests (statistically significant abnormal returns).

Sector	Excluding firm-specific information		Controlling for market integration		Non-Parametric Tests		
					Corrado Ranking Test	Conditional Probability	
	AR (%)	*t* Statistic	AR (%)	*t* Statistic		CP	*t* Statistic
Negative reaction							
Beverages	−8.48	−3.14	−6.00	−3.32	−1.63	0.019	0.74
	−3.57	−1.95	−4.57	−2.25	−1.85	0.013	0.51
	−0.19	−0.06	−0.32	−0.13	−0.97	0.001	0.08
	−0.29	−0.09	−3.61	−1.41	−1.59	0.007	3.99
	0	0.00	−2.56	−1.13	−1.82	0.037	2.42
Construction and materials	−0.14	−0.43	−1.52	−1.15	−1.44	0.009	1.74
Financial services	−0.85	−0.70	−0.24	−0.11	−1.27	0.014	1.50
	0.53	0.62	−1.05	−0.72	−1.77	0.003	1.13
Health care	−0.79	−0.63	−0.93	−0.67	−1.75	0.001	0.37
Leisure	−2.32	−0.83	−2.26	−1.84	−2.58	0.005	0.62
	−34.66	−7.21	−7.62	−3.45	−0.09	0.001	0.45
Mining	−1.39	−1.14	−0.73	−0.64	−0.86	0.004	0.23
Non-life insurance	0.46	0.49	−2.53	−2.52	−1.32	0.005	1.73
Oil and gas	−0.14	−0.04	−1.62	−0.93	−1.68	0.000	2.76
Personal goods	0	0.00	−1.03	−0.01	−0.76	0.020	1.04
Real estate	−1.01	−0.72	0.05	0.04	1.33	0.007	1.59
Positive reaction							
Aerospace	1.3	0.00	14.23	4.07	1.74	0.009	0.79
Auto and parts	10.4	2.97	10.41	2.97	1.27	0.016	1.06
Water, gas and utilities	23.19	3.71	4.3	2.75	0.48	0.005	0.15
Industrial engineering	0.33	0.20	−1.23	−0.56	1.93	0.036	2.58
	2.05	0.76	2.35	1.20	0.28	0.001	0.07
	1.33	0.69	2.17	1.37	0.45	0.005	0.44
Industrial mining	−6.71	−2.57	−2.62	−1.27	−0.01	0.023	0.13
Media	−1.49	−0.99	−0.24	−0.19	0.36	0.001	0.51
General retail	−0.07	−0.05	2.75	2.30	0.55	0.002	0.69
Mixed reaction							
Banks	0	0.00	−2.43	−1.04	1.89	0.037	3.54
	N/A	N/A	−0.71	−0.28	−1.38	0.012	2.73
	N/A	N/A	−2.09	−0.87	1.14	0.008	2.15
	0.43	0.21	0.43	0.30	−1.93	0.002	0.75
Electrical equipment	−3.19	−1.51	−0.24	−0.61	−0.97	0.004	0.82
	0	0.00	0.1	0.19	0.47	0.022	2.57
Food producers	0.15	0.09	−0.19	−0.15	1.98	0.011	2.49
	−0.33	−0.23	−8.16	−7.21	−0.17	0.000	0.05
General industrial	−1.62	−1.56	−0.82	−0.89	−1.49	0.001	0.24
	−0.77	−0.66	−1.22	−1.17	0.04	0.004	1.26
	−1.41	−1.08	−0.28	−0.24	0.65	0.002	0.76
	0.87	0.66	0.13	0.10	0.56	0.004	0.43
	−3.56	−2.25	−2.65	−2.23	−2.33	0.001	0.07
	3.51	2.26	2.92	2.50	0.28	0.023	2.83

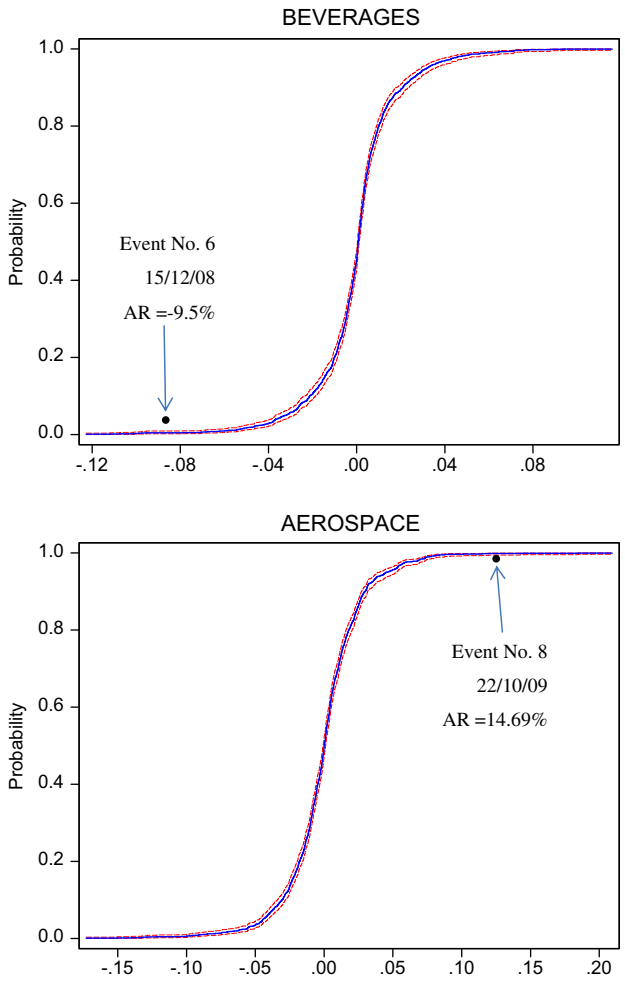

Fig. 1. Empirical CDFs for positive and negative abnormal returns. The middle graph represents the empirical CDF and the remaining two plots display the confidence interval at the 95% level.

Table 6
Statistically significant negative cumulative abnormal returns.

Sector	Number	Date	CAR (%)	*t* Statistic
Alternative energy	14	27/01/10	−31.18	−5.71
Beverages	2	31/05/07	−6.38	−2.04
	6	15/12/08	−8.83	−2.83
Financial services	3	03/12/07	−4.38	−2.02
	6	15/12/08	−4.69	−2.17
Food and drug retailing	15	02/02/10	−8.01	−2.80
	16	27/04/10	−6.35	−2.22
Food producers	6	15/12/08	−5.42	−2.61
	7	14/05/09	−5.55	−2.67
	16	27/04/10	−9.97	−4.80
Water, gas and utilities	7	14/05/09	−6.57	−1.98
	17	12/05/10	−6.54	−1.99
Industrial mining	4	16/07/08	−10.83	−2.17
Leisure	6	15/12/08	−12.33	−2.99
Oil and gas	4	16/07/08	−7.53	−2.50
	5	30/09/08	−7.06	−2.34
Oil equipment	5	30/09/08	−10.30	−2.13
Personal goods	5	30/09/08	−12.41	−2.38
	6	15/12/08	−13.17	−2.53
Real estate	6	15/12/08	−6.47	−3.01

and negative abnormal returns. The first is event number 6 (the release of the CPRS white paper), which produced a negative return of −9.5% in the beverages industry. The second is event 8 (the reintroduction of the CPRS into Federal Parliament), which produced a positive return of 14.69% in the aerospace industry. According to Chesney et al. (2011) if the conditional cumulative probability of the return is less than 0.05, the event has an extreme effect on the market. The conditional cumulative probabilities associated with the two events are 0.013 and 0.009, respectively, implying that the two announcements had significant effects.

5. Some extensions

In this section we present further results pertaining to the application of behavioral finance theories to green policies. We also consider the concept of "diamond risk".

5.1. Behavioral finance and green policies

The EMH posits that market participants react instantly to new information arrival and that prices reflect all available information. Consequently the change is captured through abnormal returns on the first day of trading, and no further abnormal returns should be observed in the following days. Behavioral finance, on the other hand, postulates that (through conservatism bias) market participants have a tendency to adjust slowly to new information arrival, leading to delayed interactions. Subsequently it is possible to observe significant abnormal returns days after the information has been released—in other words, under-reaction is observable.

We find evidence in support of the behavioral finance theory as we observe significantly negative cumulative abnormal returns for 12 industries following green policy announcements—the results are reported in Table 6. Table 7 reports the results of robustness tests corresponding to the negative cumulative abnormal returns appearing in Table 6. Out of 20 cases of significantly negative cumulative returns are supported by at least one robustness test.

The alternative energy sector recorded the highest negative cumulative abnormal return of −31.18% after the Australian government submitted its target carbon reduction range to the Copenhagen Accord on 27 January 2010. Australia decided not to commit beyond a 5% reduction on the 2000 levels unless other global emitters (such as the US, China and India) are clear about their share of the deal. Five days later (on 2 February 2010) abnormal returns arose following the reintroduction of the CPRS bill in Parliament. We also observe abnormal returns for the food and drug industry on the first day of trading, whereas a delayed response was recorded five days after the white paper release and the rejection by the Senate of the CPRS bill. The other sector for which we observe a delayed response is oil equipment.

The financial services sector provides another example of under-reaction to green policies. For instance, immediately after the release of the white paper the abnormal return was −2.64%, going down to −4.69% five days later. Other sectors that exhibited similar characteristics of negative abnormal returns are leisure, oil and gas, food producers, and personal goods. On the positive side, we could not establish an abnormal return continuation for industries that reported positive abnormal returns on the first day of trading. However, we find evidence of a market in the process of rebounding in the beverages sector. The food producers industry provides an interesting market reaction around the time that the Senate rejected the CPRS bill—it initially reacted positively to the news and negatively five days later.

5.2. Diamond risk

One important question that the Australian government and equity investors ask about green policies is the uncertainty they instigate within the economy. An answer to this question can be provided by studying the impact of green policy announcements on the short-term and long-term systematic risk of the 35

Table 7
Robustness tests (statistically significant negative cumulative abnormal returns).

Sector	Excluding firm specific information		Controlling for market integration		Conditional probability	
	CAR (%)	*t* Statistic	CAR (%)	*t* Statistic	CP	*t* Statistic
Alternative energy	−2.13	−1.17	−31.34	−4.73	0.003	2.54
Beverages	−3.72	−1.65	−4.51	−1.22	0.253	0.21
	−2.18	−1.44	0.69	0.14	0.046	1.22
Financial services	−0.92	−0.58	−0.51	−0.26	0.006	1.13
	−0.44	−0.21	−2.17	−0.64	0.006	0.37
Food and drug retailing	−2.33	−0.82	−9.55	−2.61	0.006	2.46
	−2.01	−1.15	−7.67	−1.95	0.001	0.03
Food producers	−1.48	−0.55	−3.22	−1.17	0.008	1.54
	−0.82	−0.23	−4.78	−1.48	0.001	0.45
	−3.43	−1.29	−11.52	−4.37	0.000	0.09
Water, gas and utilities	−1.76	−0.09	−6.13	−1.32	0.004	0.16
	1.69	0.31	−6.67	−1.81	0.004	1.24
Industrial mining	−4.96	−1.76	−2.91	−0.59	0.006	1.31
Leisure	−10.3	−1.68	−9.47	−1.67	0.003	0.15
Oil and gas	−11.33	−1.69	−2.3	−0.51	0.011	1.89
	−4.96	−1.32	−14.02	−2.60	0.000	1.62
Oil equipment	−4.64	−1.66	−12.05	−2.67	0.000	1.66
Personal goods	−4.52	−1.26	−3.39	−1.09	0.000	3.39
	−4.4	−0.77	−3.59	−0.90	0.015	0.30
Real estate	−0.06	−0.02	−1.04	−0.29	0.024	1.30

Table 8
Aggregate change in short-term systematic risk (*t* statistics in parentheses).

	Intercept	Beta	Short-term change in risk	Short-term change in Intercept
Increase in risk				
Alternative energy	0.00	0.53	1.62	−0.02
	(−1.42)	(14.33)	(9.36)	(−7.53)
Auto and parts	0.00	0.17	0.60	0.01
	(−0.89)	(6.02)	(2.96)	(1.53)
Mining	0.00	0.46	0.13	0.00
	(1.76)	(35.55)	(1.96)	(−2.78)
Decrease in risk				
Beverages	0.00	0.18	−0.60	−0.01
	(−2.51)	(6.08)	(−3.66)	(−4.05)
Health care	0.00	0.29	−0.26	0.00
	(−5.04)	(16.81)	(−2.06)	(−1.50)
Industrial transportation	0.00	0.44	−0.52	0.00
	(0.44)	(26.50)	(−3.49)	(2.07)

Table 9
The impact of individual announcements on short-term systematic risk (*t* statistics in parentheses).

	Constant	Beta	Event Number/Date				
			(2) 31/05/07	(5) 30/09/08	(6) 15/12/08	(12) 7/12/09	(14) 27/01/10
Aerospace	0.00	0.42	0.97	0.65	1.23	−2.09	1.13
	(−2.47)	(8.57)	(0.10)	(0.05)	(1.90)	(−0.04)	(0.07)
Auto and parts	0.00	0.18	2.35	−0.17	3.16	−0.44	−1.00
	(−1.00)	(6.19)	(6.71)	(−0.30)	(0.64)	(−0.01)	(−0.04)
Chemicals	0.00	0.47	−0.25	−0.02	0.03	−5.68	−0.92
	(−2.46)	(16.14)	(−0.19)	(−0.06)	(0.05)	(−2.18)	(−1.01)
Food and drug retailers	0.00	0.44	−1.65	0.80	0.21	−2.98	0.33
	(0.42)	(14.87)	(−0.11)	(3.00)	(0.00)	(−0.03)	(0.02)
Food producers	0.00	0.30	−0.09	0.42	0.28	−0.07	−0.49
	(−3.06)	(16.56)	(−0.11)	(2.05)	(0.70)	(−0.04)	(−0.85)
Forestry and paper	0.00	0.44	−0.10	−0.19	0.66	−3.06	−0.41
	(−0.11)	(11.85)	(−0.06)	(−0.46)	(0.82)	(−0.91)	(−0.34)
Industrial transportation	0.00	0.45	1.25	−0.49	0.31	−4.30	−3.43
	(0.51)	(26.25)	(0.12)	(−1.81)	(0.01)	(−0.24)	(−31.93)
Mining	0.00	0.46	−0.28	0.29	−0.24	1.65	0.48
	(1.63)	(35.31)	(−0.47)	(4.31)	(−0.19)	(0.74)	(0.97)
Oil and gas	0.00	0.55	1.36	0.16	0.29	−0.79	0.15
	(1.94)	(31.75)	(0.00)	(1.90)	(0.00)	(0.00)	(0.54)
Software and computing	0.00	0.31	−0.13	0.34	−0.55	0.88	0.16
	(−2.03)	(16.81)	(−0.16)	(1.63)	(−1.38)	(0.53)	(0.28)
Technology	0.00	0.23	1.44	1.22	−0.91	−2.94	0.87
	(−0.86)	(4.97)	(0.70)	(2.33)	(−0.90)	(−0.70)	(0.59)

Table 10
Aggregate change in long-term systematic risk (*t* statistics in parentheses).

	Intercept	Beta	Long-term change in risk
Increase in risk			
Fixed line and mobile communication	0.00	−0.62	0.90
	(−1.41)	(−4.49)	(6.36)
Household goods	0.00	0.04	0.25
	(0.13)	(0.31)	(1.77)
Industrial engineering	0.00	−0.05	0.51
	(−0.44)	(−0.38)	(3.69)
Industrial transportation	0.00	0.12	0.33
	(0.67)	(0.79)	(2.14)
Oil and gas	0.00	0.30	0.26
	(2.17)	(2.32)	(2.02)
Support services	0.00	0.22	0.20
	(−2.67)	(1.99)	(1.81)
Decrease in risk			
Aerospace	0.00	1.10	−0.69
	(−2.49)	(2.93)	(−1.83)
Forestry and paper	0.00	0.94	−0.51
	(−0.29)	(3.53)	(−1.89)
Non-life insurance	0.00	0.89	−0.32
	(0.03)	(7.72)	(−2.72)

industries. Eqs. (4) and (5) are estimated to determine the change in short-term systematic risk—the results are displayed in Tables 8 and 9, respectively. Eq. (4) is used to calculate the overall changes in short-term risk within an industry over the period 2005–2011. Three sectors (alternative energy, automotive and parts, and mining) experienced an increase in overall short-term systematic risk. For instance, the beta of the mining industry was 0.46 prior the announcements, increasing by 0.13 to 0.59 following the announcements (Table 8). On the other hand, three sectors (beverages, health care and industrial transportation) experienced declining short-term systematic risk.

Two major conclusions can be drawn from these findings. First, an industry effect is evident 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 the sectors (29 of them) did not experience a change in overall short-term systematic risk. This conclusion, however, may not be accurate as the model represented by Eq. (4) provides a general result whereby positive and negative reactions cancel out, leading to a neutral response. It is imperative to disaggregate the effects of each announcement, which allows us to identify the change in the short-term risk originating from each announcement.

To that end Eq. (5) is estimated and the results are reported in Table 9. As expected, we detect significant change in short-term systematic risk for more industries, eleven to be precise, which account for just over 30% of our sample. The new industries identified are aerospace, chemicals, food and drug retailers, food producers, forestry and paper, oil and gas, software and computer, and technology. If we reconsider the case of the mining industry, for which we earlier stated that the overall change in short-term systematic risk was 0.13, we can observe that the change arises predominantly because of the release of the *Garnaut Climate Change Review* on 30 September 2008. As shown in Table 9, the systematic risk of the mining industry increased by 0.29, which verifies the underestimation problem of Eq. (4). According to the results displayed in Table 9, only five out of nineteen announcements affected short-term systematic risk—these announcements are the John Howard's Prime Ministerial Task Group report on emissions trading (31 May 2007), the *Garnaut Climate Change Review* (30 September 2008), the release of the CPRS white paper (15 December 2008), the first day of the Copenhagen Conference on Climate Change (7 December 2009), and the submission of Australia's target carbon reduction range to the Copenhagen Accord (27 January 2010). When it comes to the effect on systematic risk, the *Garnaut Climate Change Review* is the most influential announcement—it affected five out of the eleven industries, boosting their short-term systematic risk.

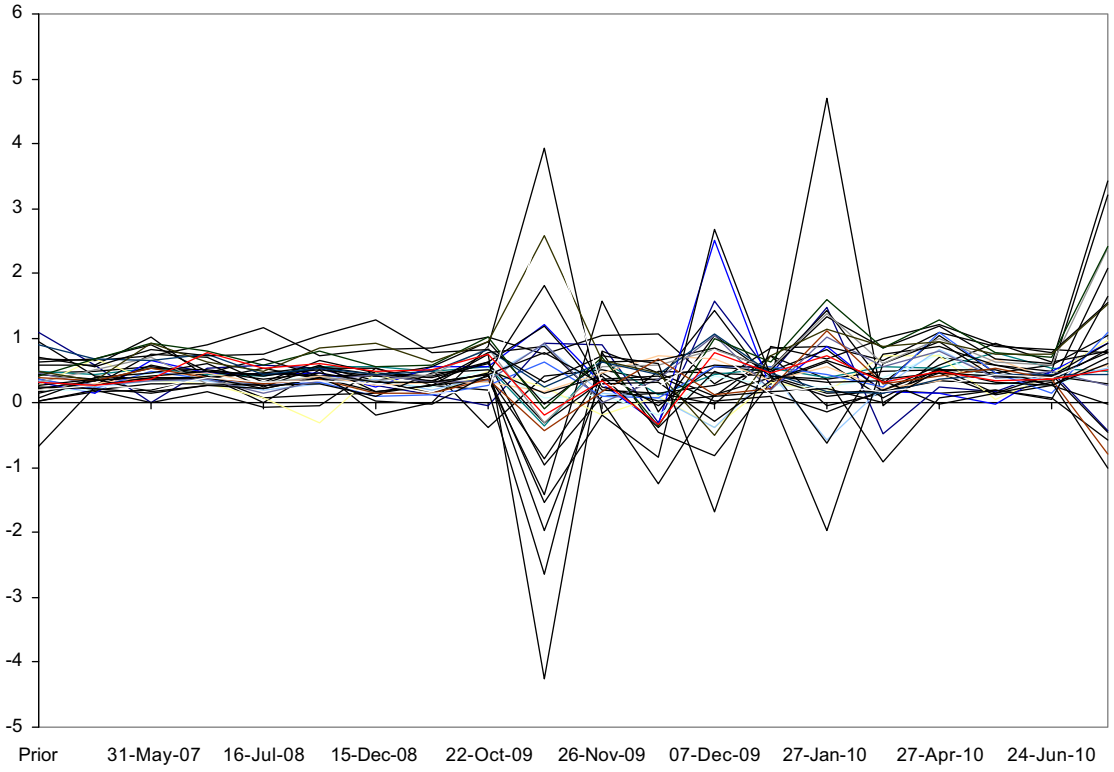

Fig. 2. Rolling regression estimates of beta.

Despite the problem associated with Eq. (4), as explained earlier, it is a good starting point for a risk analysis exercise as it provides an overall perspective. We estimate a version of Eq. (4) that is equipped with some long-term dummy variables for the purpose of capturing the overall long-term change in systematic risk. The results presented in Table 10 indicate a general change in systematic risk for nine industries. An apparent increase in risk is discerned in fixed line and mobile communication, household goods, industrial engineering, industrial transportation, oil and gas and support services, whereas a decline in risk is observed in aerospace, forestry and paper and non-life insurance. At a first glance, green policies appear to have more of a long-term, rather than short-term, effect on risk as we only detect statistically significant change in the short-term risk of six industries as opposed to nine when Eq. (4) is estimated. When the long-term version of Eq. (5) is estimated, we find that the long-term systematic risks of all industries were affected by at least one of the nineteen announcements.

Fig. 2 provides a visual of how beta changes for each of the 35 industries for the period 2005–2011 following the nineteen green policy announcements. If we consider the beta of these industries from the start of 2005 until 22 October 2009, we find that the systematic risks of these industries were stable. Following the introduction of the CPRS bill into the Australian Federal Parliament on 22 October 2009, there was a large variation in beta, implying a large degree of uncertainty. At this point, one is led to believe that green policies alter long-term systematic risk. A number of industries experienced a significant increase in long-term risk over the period 22 October to 26 November 2009 (on 25 and 26 November 2009, the US and China announced their emissions reduction targets). When the Senate rejected the CPRS bill on 2 December 2009, the long-term systematic risk of these industries declined. The reverse is also true for industries that experienced a decline in systematic risk over the period 22 October to 26 November 2009 followed by an increase in risk as a result of the rejection of the bill on 2 December 2009.

The diamond shapes observed in subsequent periods (as shown in Fig. 2) provide an indication that similar interactions occur. Another diamond is detected between 2 December and 18 December 2009. The first event that caused risk to change in this diamond was the first day of the Copenhagen Conference on Climate Change on 7 December 2009, whereas the second event was on the last day of the Copenhagen Conference. The third diamond that we observe occurred between 18 December 2009 and 2 February 2010—the first trigger being Australia submitting its target Carbon reduction range to the Copenhagen Accord whereas the second trigger was the reintroduction of the CPRS bill in Parliament. Between 2 February and 23 June 2010, systematic risk stabilized but the variation continued after 24 June 2010 when legislation was passed by Parliament to split the renewable energy target into a large-scale renewable energy target and a small-scale renewable energy schemes. Three main conclusions can be drawn from this picture. First, green policy announcements after 22 October 2009 have led to a number of uncertainties through changes in long-term systematic risk. Secondly, 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). Thirdly, the time series analysis of green policy announcements tends to lead to diamond risk.

6. Conclusion

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 argues that the objective is to penalize the biggest polluters (top of the list are electricity producers) and redistribute the income generated in the process to individuals facing the hardship caused by higher energy costs. Our study shows that the wealth of shareholders in the electricity industry did not change (no abnormal returns were observed), indicating that the biggest polluters are not affected by the introduction of green policies.

We make the plausible assumption that polluters are passing (or capable of passing) higher costs to consumers (otherwise the government will not strive to redistribute the income generated by taxing polluters). It is for this reason that green policies in their current form may not be effective. The shareholders of other industries that are not viewed as the biggest polluters (for example, beverages) experienced value destruction, with no compensation for these industries. 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.

Acknowledgments

We are grateful to the editor of this journal and an anonymous referee for useful comments on an earlier version of this paper.

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