Carbon tax, corporate carbon profile and financial return

Le Luo
Newcastle Business School, University of Newcastle, Sydney, Australia, and
Qingliang Tang
School of Business, University of Western Sydney, Sydney, Australia

Abstract

Purpose – This paper aims to investigate the impact of the proposed carbon tax on the financial market return of Australian firms. It also considers the differential tax effect on individual firms with different carbon profiles, including factors such as emissions costs, carbon disclosure and climate-change policies.

Design/methodology/approach – Utilising the event-study method, the authors examine the market reaction to seven key carbon legislative information events that occurred from February 2011 to November 2011. The sample includes 48 different firms whose emissions-related data are available from Carbon Disclosure Project reports; thus, 336 firm-event observations are used for the cross-sectional analysis.

Findings – The paper documents evidence that the proposed tax has an overall negative impact on shareholder wealth as measured by abnormal returns. The negative impact varies across sectors, with the most significant effect found in the materials, industrial and financial sectors. It was also found that a firm's direct carbon exposure (as measured by Scope 1 emissions) is significantly associated with abnormal returns, whereas the indirect exposure (as measured by Scope 2 emissions) is not, because Scope 2 emissions are not covered by the tax. In addition, the findings suggest that the information content of the events is more notable during the early stages of the development of the carbon tax.

Research limitations/implications – The sample is restricted to the largest firms with relevant carbon profile information. Thus, caution should be exercised when generalising the inferences.

Practical implications – The introduction of the carbon tax was largely unexpected and most firms were unprepared for it; thus, their carbon policy appears inadequate and does not impress investors. An understanding of how the carbon tax affects shareholder value and welfare will encourage management to take proactive actions to mitigate the compliance costs of carbon legislation.

Originality/value – The enactment of the Australian carbon tax perhaps represents one of the biggest social and economic restructuring events in the country's history. Our results offer initial insight into its impact and suggest that investors would penalise firms with heavy direct operational emissions. In addition, Australian corporate carbon policy seems inadequate, so does not reverse the negative effect of the tax on the value of a firm.

Keywords Greenhouse gas (GHG) emissions, Carbon disclosure project (CDP), Carbon reduction target, Carbon tax, Corporate carbon profile

Paper type Research paper

JEL classification – Q51, Q52, Q54, Q56

Qingliang Tang gratefully acknowledges financial support from the School of Business, University of Western Sydney. Le Luo gratefully acknowledges financial support from the National Natural Science Foundation of China (Project No. 71272237).

Pacific Accounting Review
Vol. 26 No. 3, 2014
pp. 351-373

0114-0582
DOI 10.1108/PAR-09-2012-0046

1. Introduction

The Australian government proposed a carbon tax that was eventually approved by the Australian Senate in November 2011. The enactment of the carbon tax has been associated with a shift in the market environment since 1 July 2012, such that the carbon metrics of a company relative to its competitors determines the winners or losers. Ultimately, this tax will cause the reallocation of earnings and revenue among Australian firms. In addition, the implementation of the carbon tax would leverage existing legislative and regulatory frameworks and institutional arrangements, as well as existing financial markets systems (FINSIA, 2011).

The purpose of this study is to investigate the impact of the carbon tax on the financial market return of firms as a whole and whether the effect on an individual firm varies with its carbon profile. We argue that the stock market reaction to a proposed regulation is a function of the change in the probability that the regulation will be adopted and the dollar value of the expected impact of the regulation on shareholder wealth. Accordingly, we expect that the reaction to carbon tax legislation would be most pronounced for those firms affected by the regulation.

The recent carbon tax has represented an exogenous shock to Australian firms that may have an overall adverse impact because of the direct carbon price, the costs associated with energy increase, compliance costs and so forth. Many previous studies have found that stock market valuation was correlated with levels of toxic emissions or the amount of chemical release (Al-Tuwaijri *et al.*, 2004; Clarkson *et al.*, 2011; King and Lenox, 2001; Konar and Cohen, 2001), superfund cleanup costs (Barth and McNichols, 1994; Campbell *et al.*, 1998) or SO_2 emissions (Hughes, 2000; Johnston *et al.*, 2008). Only a few studies have examined the effects of carbon costs on the value of a firm (Matsumura *et al.*, 2014) using total emissions data to assess the costs of carbon. In contrast, we use the total Scope 1 (direct exposure) and total Scope 2 (indirect exposure) emissions as two separate major proxies for carbon exposure[1]. In addition, we hypothesise that a firm's carbon policy may play a role, thus our study considers mitigating factors such as a firm's carbon transparency, reduction targets and reduction incentives, which might mitigate the negative impact of the carbon tax.

More specifically, utilising the event-study method, we examine the market reactions to seven key carbon legislative announcements/events that occurred from February 2011 to November 2011 for a sample of 48 firms (i.e. 336 firm-event observations) with complete carbon-related data[2]. The results show that firms' financial returns are adversely affected by information events that increase the probability that the carbon tax legislation will pass, particularly for the materials, industrial and financial sectors. In addition, direct carbon exposure (i.e. Scope 1 emissions) is negatively correlated with abnormal returns, suggesting that the Scope 1 emissions are most relevant for investors seeking to estimate a firm's carbon liabilities and costs. In contrast, Scope 2 emissions are not associated with abnormal returns, as these types of emissions are not directly covered by the tax. In addition, we find weak evidence that the adoption of proactive carbon policies (e.g. the presence of incentives to reduce emissions) increases the value of a firm.

Our findings are useful for understanding investor perception of carbon regulation and dynamic reactions to a firm's carbon profile. This evidence could help executives to take proactive actions to unlock potentials and set more ambitious emissions-reduction targets. In addition, fund managers and investment professionals must carefully consider how carbon exposure aggregates across portfolios and what this means for strategy and asset allocation. In the wider investment and corporate communities, both direct and indirect carbon costs must be fully evaluated, and a deeper understanding of the implications of these costs and risks is necessary.

The remainder of this study is organised as follows. Section 2 outlines the development of the Australia carbon tax legislation and the details of its Climate Change Plan. Section 3 develops the study's hypotheses. Section 4 describes the research design, and Section 5 presents our results. Finally, in Section 6, we discuss our conclusions.

2. Australian carbon tax

Numerous policies associated with emission reduction at the federal and state levels have been implemented during the past decade. In 2007, the Australian government ratified the Kyoto Protocol, which made Australia's commitment to mitigate climate change binding in international agreement. The Mandatory Renewable Energy Target encourages the generation of electricity from renewable energy sources to achieve reductions in greenhouse gas (GHG) emissions. Moreover, the National Greenhouse and Energy Reporting Act represents the first national legislation for the reporting and dissemination of information about GHG emissions and energy use and production.

The Australian government next considered a market mechanism that would allow firms to voluntarily reduce their emissions. In 2008, the independent Garnaut Climate Change Review, commissioned by the Labour Government, concluded that it was in Australia's national interest to take stronger action and recommended the cap-and-trade system as a cost-efficient way to control emissions. Subsequently, the Australian Government under Labour Party Prime Minister Kevin Rudd proposed the Carbon Pollution Reduction Scheme (CPRS), but the proposal failed to be implemented[3].

The August 2010 elections resulted in a hung parliament, with the result that Prime Minster Julia Gillard's Labour Party needed the support of one Green and three Independent Members of Parliament to form a government. These members set the implementation of a carbon price as a condition for joining the coalition necessary to ensure the balance-of-power in Parliament. Thus, a Multi-Party Climate Change Committee was established and the Committee released a brief framework document setting out the broad architecture for a carbon-price mechanism. Meanwhile, Prime Minister Gillard was criticised for this plan because she had promised prior to her election that her government would not implement a carbon tax. On 10 July 2011, the final proposal, known as the Clean Energy Agreement[4], was announced, together with the release of the Australian Government's Climate Change Plan (the Plan)[5]. The proposal was eventually successfully passed by the Australian Parliament.

The carbon price system involves the purchase of a permit (also known as "tax"), and has two phases: an initial three-year fixed price phase followed by a market-based phase. Beginning on 1 July 2012, the price starts at $23/tonne, then rises to $24.15/tonne in 2013-2014 and $25.40/tonne in 2014-2015. The carbon price will be set by the market under a cap-and-trade system from 1 July 2015. Then, the total number of permits released (the "cap") will be aligned with the emissions reduction target[6] and the permits will be either auctioned by the government or allocated for free as part of the proposed industry assistance packages. In addition, the use of international offset credits is restricted[7] and failure to surrender permits will result in an emissions charge[8].

The tax is expected to encompass approximately the top 500 CO_2 equivalent emitters[9] and to cover emissions from fossil-fuel combustion, industrial process emissions (electricity generation and industrial facilities), fugitive emissions and waste (certain landfills). Another key element of the plan is a package of complementary measures and assistance for business and households (see Appendix for more details).

3. Hypothesis development

3.1 Overall market reaction to carbon-tax-related information events

Prior studies have examined the market reaction to the enforcement of, or change in, environmental legislation and found evidence that the adoption of these environmental regulations is associated with increased compliance cost and environmental liability in affected firms (Blacconiere and Northcut, 1997; Shane, 1995). In Australia, carbon emissions have been free for a long time. The implementation of the carbon tax, therefore, appears one of the biggest structural economic reforms in the country's history, and it brings corporate costs/risks and revenue/opportunities (KPMG, 2011). We hypothesise that the announcement of carbon-tax-related information events would change the perceptions of investors regarding the probability of future cash flows to the firms involved. However, the effect of the carbon tax on an individual firm varies with the firm's characteristics and its carbon profile (e.g. its carbon policies and practices, energy efficiency measures, etc).

Generally speaking, firms will incur direct carbon-tax or carbon-permit purchase costs (Australian Government, 2011). In addition, there could be an indirect consequence of the tax because of price increases in fuel, electricity or materials (Busch and Hoffmann, 2007), or the potential for financial institutions to impose more stringent requirements and extra fees with respect to accessing debt facilities (Graham *et al.*, 2001; Schneider, 2011). Moreover, there will be compliance costs[10] and non-compliance may result in heavy financial penalties, and Australian domestic firms would face more competition from firms located in regions without such a tax (Ernst&Young, 2009; Sato *et al.*, 2007). If investors anticipate a net increase in the above costs, a decrease in firm value (i.e. a negative market reaction) is expected. This discussion leads to the first hypothesis:

H1. The overall cumulative abnormal returns of our sample firms would be negative during the information events associated with carbon tax enactment.

3.2 Cross-sectional impact of the carbon tax on market return

We then examine the factors that may differentiate impacts of the carbon tax among firms and we hypothesise that the capital market assessment is conditioned on a firm's carbon profile such as its direct and indirect carbon exposure, the level of carbon disclosure and the presence of a carbon reduction target and incentives.

3.2.1 The impact of carbon exposure. Carbon exposure refers to the exposure to current or future carbon costs, and prior studies typically use the amount of total GHG emissions as a proxy (Chapple *et al.*, 2013; Griffin *et al.*, 2012) and thus do not distinguish between direct and indirect costs. We argue that a firm's total Scope 1 emissions may determine its direct and explicit carbon costs because the affected firms will purchase and surrender an eligible permit for each tonne of emissions. The higher the total Scope 1 emissions, the more likely a firm will be a liable entity. Therefore, Scope 1 emissions increase carbon risk and costs. On the other hand, Scope 2 emissions are not directly subject to the tax and so no significant impact is expected (Nelson, 2011)[11]. Hence, we propose the following hypotheses:

H2. *Ceteris paribus*, there is a negative association between a firm's direct exposure (Scope 1 emissions) and an abnormal return during the information events associated with carbon-tax enactment.

H3. *Ceteris paribus*, there is no significant association between a firm's indirect exposure (Scope 2 emissions) and an abnormal return during the information events associated with carbon-tax enactment.

3.2.2 The impact of carbon disclosure. Here, we examine the potential uncertainty-reducing role of carbon disclosure. Campbell *et al.* (2003) find that financial statement information affects the valuation of contingent superfund liabilities by reducing uncertainty. Other studies (Blacconiere and Northcut, 1997; Blacconiere and Patten, 1994; Patten and Nance, 1998) also document that firms with more extensive environmental disclosures have a less negative market reaction to an external catastrophic accident or the enactment of new environmental regulations. It can be argued that the amount and timing of a firm's ultimate financial obligation for carbon liabilities are uncertain and subject to the outcome of future legislative events. Therefore, investors require firms to make their carbon information transparent to fully understand or estimate the inter-firm effects of changes in carbon regulation (i.e. the carbon tax) (Shane, 1995). The absence of disclosures would signal a higher level of exposure to risks or future regulatory costs (Verrecchia, 1983). Thus, our fourth hypothesis is:

H4. *Ceteris paribus*, a firm with a higher level of carbon disclosure would experience a less negative abnormal financial return during the information events associated with carbon tax enactment.

3.2.3 The impact of carbon-reduction targets and incentives. Some companies have recently begun to show the public their commitment to a low-carbon economy (Pinkse and Kolk, 2009, p. 71) and have searched for innovative solutions to minimise the potential adverse effects of proposed environmental legislation (Porter and van der Linde, 1995). These actions include the adoption of energy-efficient techniques, investment in green projects and a sound carbon-management system. Among these measures, having a clear carbon-reduction target is essential for framing and encouraging effective actions (Pershing and Tudela, 2003). Similarly, a well-designed remuneration system is critical for incentivising managers and staff. The core characteristic of this system is to incorporate carbon-performance indicators into compensation schemes, raise awareness among employees and reward good behaviour and outcomes by providing monetary or non-financial incentives. Consequently, these measures should moderate the unfavourable impact of the carbon tax. Thus, we propose the following hypotheses:

H5. *Ceteris paribus*, firms with a current emissions reduction target in place experience less negative financial return during the information events associated with carbon-tax enactment.

H6. *Ceteris paribus*, firms providing incentives for the management of climate-change issues experience a less negative return during the information events associated with carbon-tax enactment.

4. Research design

4.1 Event study

We adopt an event-study approach to estimate the share-price impact of the carbon announcements. The basic concept is to disentangle the effects of carbon tax information and other market-wide information that is likely to affect a firm's financial returns (e.g. a change in interest rates) (Mitchell and Netter, 1994). Another key issue is the measurement of normal returns and abnormal returns during these events. Authors often use the market model to calculate these returns, which assumes a stable linear relation between the market return and the security return. The model's linear specification follows from the assumed joint normality of asset returns. For any security i, the market model is:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

$$E(\varepsilon_{it}) = 0 \; Var(\varepsilon_{it}) = \delta^2_{\varepsilon i}$$

where R_{it} and R_{mt} are the period-t returns on security i and the market portfolio, respectively; $\varepsilon_{it}$is the zero mean disturbance term. $\hat{\alpha}_i, \hat{\beta}_i$ and $\delta^2_{\varepsilon i}$ are the parameters of the market model.

The abnormal return (AR) is the disturbance term ($AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt}$) which, under the null hypothesis, is conditional on the event-window market returns and is assumed to be normally distributed with a zero conditional mean and conditional variance $\sigma^2(AR_{it})$. To aggregate the observations, the sample average abnormal return is then calculated across securities or through time. Thus, the sample cumulative abnormal return (CAR) is the sum of the average abnormal returns over the event window[12]. Our model specification is discussed below.

4.2 Events related to the carbon tax

We identify the following seven carbon tax-specific information events that would affect the market participants' perceptions about the probability of the eventual passage of the legislation and its impact on earnings:

(1) *10 February 2011:* The establishment of an independent Climate Commission[13].

(2) *24 February 2011:* The initial announcement of the carbon tax plan.

(3) *23 May 2011:* The release of the Climate Commission report, "The Critical Decade: Climate science, risks and responses"[14].

(4) *10 July 2011:* The release of the Australian government's Clean Energy Plan.

(5) *23 August 2011:* A Labour Senator is involved in a credit-card scandal.

(6) *12 October 2011:* Carbon bills are passed in the Parliament House with a vote of 74 to 72.

(7) *8 November 2011:* The Clean Energy Bill and 17 complementary bills pass in the Senate.

Note that in event number 4, the Australian Government released details of the costs, scope impact and operational features of the carbon tax. This was a big shock to the financial market because Prime Minister Julia Gillard had declared that "there will be no carbon tax under a Government I lead" prior to the 2010 election. In event number 5, a

Labour Senator, the Chair of the House of Representatives Standing Committee on Economics, resigned. The consequence was the Labour Party would lose a position in the Parliament and the carbon tax would not be passed. All of these events, with the exception of event number 5, were expected to increase the probability that the tax would be enacted. As the events were largely unanticipated, we assume that the price reactions occurred subsequent to the events. Also, it is worth noting that uncertainty about the tax remained during the entire period, because the Labour Government only had a marginal majority in the Parliament and it was known that the Opposition Party would repeal the legislation should they win the next election.

4.3 Models

4.3.1 Overall market reaction model. In our study, the event days were the same for all of the firms. Thus, we anticipate that the abnormal returns for individual firms would be cross-sectionally correlated, which might understate the estimates of variance and overstate the statistical significance of the test (Corrado, 2011). To reduce the risk of this, we apply a multivariate regression model with dummy variables for the event dates (MacKinlay, 1997; Schipper and Thompson, 1983). Further, the portfolio-level returns (instead of individual firm returns) are also used to reduce the likelihood of bias towards rejection of the null hypothesis due to either cross-sectional or time-series correlations (Blacconiere and Northcut, 1997; Chapple *et al.*, 2013; Collins and Dent, 1984). To isolate the effect of the carbon tax from other contemporaneous events, we used foreign markets as a benchmark to evaluate the effect of carbon tax on Australian abnormal returns (Zhang, 2007). Our test model is as follows:

$$\begin{aligned} R_{pt} = {} & \alpha_p + \sum_{k=1}^{7} \gamma_{pk}\,\text{EventWindow}_k + \beta_{1p}\,\text{NZ\_Ret}_{mt} + \beta_{2p}\text{Tokyo\_Ret}_{mt} \\ & + \beta_{3p}\text{US\_Ret}_{mt} + \beta_{4p}\text{UK\_Ret}_{mt} + \beta_{5p}\text{China\_Ret}_{mt} + \beta_{6p}\text{US\_Ret}_{mt-1} \\ & + \beta_{7p}\text{UK\_Ret}_{mt-1} + \varepsilon_{pt} \end{aligned} \tag{1}$$

where,

R_{pt}	= return for the portfolio of firms for day t.
EventWindow_k	= dummy variable that equals 1 for each event window (3-day window) and 0 otherwise.
NZ_Ret_{mt}	= return on an equal-weighted New Zealand 50 market index for day t.
Tokyo_Ret_{mt}	= return on an equal-weighted Tokyo market index for day t.
BMC	= basic marketing capability,
US_Ret_{mt}	= return on an equal-weighted Standard & Poor's (S&P) 500 index for day t.
UK_Ret_{mt}	= return on an equal-weighted FTSE 100 index for day t.
China_Ret_{mt}	= return on an equal-weighted Chinese A share market index for day t.
US_Ret_{mt-1}	= return on an equal-weighted S&P 500 index for day t-1.
UK_Ret_{mt-1}	= return on an equal-weighted FTSE 100 index for day t-1.
BMC	= basic marketing capability,
k	= the k^{th} event, k = 1 […], 7.

In our study, firms are grouped into eight sector portfolios and one full-sample portfolio. R_{pt} ($p = 1 [\ldots], 8$) is used to represent an equally weighted sector-portfolio return for the trading day t[15]. Similarly, the full-sample portfolio return (R_{9t}) is calculated as the mean sector-portfolio return, and γ_{pk} is the estimator of the average abnormal return across the shares in the p^{th} portfolio and the k^{th} event.

We use seven foreign market index returns to evaluate portfolio normal returns instead of using just the Australian market index for three reasons. First, the changes in the Australian market index capture not only the impact of carbon-tax events but also that of other contemporary worldwide events. In other words, the inclusion of the Australian market index would underestimate the impact of the carbon tax on the affected firms (Lo, 2003; Zhang, 2007). Second, the market index returns for New Zealand, Tokyo, S&P 500, FTSE 100 and China are chosen because of their significant influence on the global market and Australian firms, and the absence of the effect of the carbon tax on these markets. Third, US_Ret_{mt-1} and UK_Ret_{mt-1} were also included in equation (1) to capture time zone differences (Zhang, 2007).

We define the announcement date as day 0; the event window for each event is a 3-day period from day 0 to day 2[16]. In addition, time-series data are used to estimate the parameters in the model over the period from 1 January 2011 to 13 February 2012. All p-values are based on heteroscedasticity-consistent standard errors.

4.3.2 Cross-sectional variation in abnormal returns around the time of the events. Here, we examine whether market reactions vary with a firm's carbon profile and practices. We pool the seven events using the following model (Larcker *et al.*, 2011):

$$\begin{aligned} CAR_{jk} \text{ or } SCAR_{jk} = {} & \delta_0 + \delta_1 \, DirectExposure_j + \delta_2 \, IndiretExposure_j \\ & + \delta_3 \, DISCLOUSRE_j + \delta_4 TARGET_j + \delta_5 \, INCENTIVE_j \\ & + \delta_6 \, ETS_j + \delta_7 \, \mathit{ForeignSale}_j + \delta_8 \, SIZE_j + \sum SectorDummy \end{aligned} \tag{4}$$

Dependent variable

We used two dependent variables: cumulative abnormal return, CAR_{jk}, is the coefficient on $EventWindow_{jk}$ determined by estimating equation (1) for each firm j; and standardised cumulative abnormal return, $SCAR_{jk}$, is CAR_{jk} divided by its standard deviation[17].

Independent variables

*Carbon exposure (*DirectExposure, IndirectExposure*).* To test the relation between market reactions and potential carbon exposure, our proxies for the magnitude of the exposure are *DirectExposure* (*IndirectExposure*), which is calculated as the nature logarithm of the total Scope 1 (2) emissions. We predict that the coefficient δ_1 would be significantly negative (*H2*) and δ_2 would be insignificant (*H3*).

*Carbon disclosure (*DISCLOSURE*)*

We use the Carbon Disclosure Leaders Index (CDLI) 2010 methodology (CDP Rating Methodology, 2010) to calculate disclosure scores (labelled as *DISCLOSURE*) to capture the extensiveness and comprehensiveness of carbon disclosures (Cotter and Najah, 2012; Griffin *et al.*, 2012; Prado-Lorenzo and Garcia-Sanchez, 2010; Tang and Luo, 2011)[18]. The final score is the total awarded score divided by the total attainable score, multiplied by 100 (i.e. a standardised score). We predict that the estimated coefficient δ_3 would be positive (*H4*).

*Carbon reduction target and incentives (*TARGET *and* INCENTIVE*)*
We coded the proxy *TARGET* (*INCENTIVE*) as 1 if a firm has an emissions target (incentive) in place and 0 otherwise[19]. *H5* and *H6* predict that the coefficients δ_4 and δ_5 will be positive.

Control variables
Some firms have already participated in a foreign emissions trading scheme (ETS) (e.g. in the European Union), so they have gained experience or developed capabilities in system integration ahead of future requirements (Cogan, 2006; Jones and Levy, 2007). This can help firms to better comply with the forthcoming local regulations (Hoffman, 2006). Thus, we expect that participating in a foreign ETS will result in a positive perception by investors (i.e. $\delta_6 > 0$). The variable *ETS* is equal to 1 if a firm participated in an ETS and 0 otherwise[20]. In addition, we control for foreign sales, as it would be difficult to pass on the tax to international consumers (*ForeignSale*, the percentage of foreign sales to total sales)[21]. Finally, the carbon legislation targets large emitters, thus large firms or firms in carbon-intensive sectors are more likely to be affected. Then we control for firm size (*SIZE*, the natural logarithm of total market capitalisation[22]) and use seven sector dummy variables to control the sector effect.

4.4 Sample firms
Our initial sample included Australian Securities Exchange top 200 firms, because the stock price effects should be most apparent for these firms. Firms that are included in the final sample meet all of the following criteria:

- The firm has stock price data available in DataStream between 1 January 2011 and 13 February 2012.
- Total 2010 Scope 1 and Scope 2 GHG emissions data are available from CDP Australian and New Zealand Report, 2011.
- The firm has other carbon-related data (e.g. disclosure, ETS, emissions target and incentives), as well as complete financial data.

Of the 200 firms, 74 have made their carbon report accessible to the public, 9 were delisted in late 2010 or 2011 resulting in missing stock price data and 17 have incomplete data. Therefore, the final sample includes 48 firms[23] (336 firm-event observations) distributed in eight Global Industry Classification Standard (GICS) sectors[24].

5. Results

5.1 Abnormal returns in carbon tax information events
Table I presents the results based on equation (1) (sector portfolio approach). Columns 1-8 (the last column) give the results for the sector subsamples (for the full sample). If investors perceive that the carbon tax reduces profitability and the event will increase the likelihood of passing the legislation, we should observe a reduced return.

After controlling for the influence of contemporaneous global news, we find negative average abnormal returns (AAR) in our full sample for five out of seven carbon-tax

Table I.
Abnormal returns in the seven carbon-tax information events

$$R_{pt} = \alpha_p + \sum_{k=1}^{7} \gamma_{pk}\text{EventWindow}_k + \beta_{1p}\text{NZ\_Ret}_{mt} + \beta_{2p}\text{Tokyo\_Ret}_{mt} + \beta_{3p}\text{US\_Ret}_{mt} + \beta_{4p}\text{UK\_Ret}_{mt} + \beta_{5p}\text{China\_Ret}_{mt} + \beta_{6p}\text{US\_Ret}_{mt-1} + \beta_{7p}\text{UK\_Ret}_{mt-1} + \varepsilon_{pt} \tag{1}$$

Portfolios	(1) Energy	(2) Materials	(3) Industrials	(4) Consumer discretionary	(5) Consumer staples	(6) Financials	(7) Telecommunication services	(8) Utilities	(9) Full sample
Dependent variable	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9
EventWindow_1	−0.007*** (0.002)	0.001 (0.003)	−0.001 (0.002)	0.003 (0.003)	−0.001 (0.003)	−0.003 (0.004)	0.003 (0.003)	−0.002 (0.002)	−0.002 (0.002)
EventWindow_2	−0.003 (0.005)	−0.009** (0.004)	−0.004*** (0.001)	0.000 (0.001)	0.002 (0.005)	−0.003 (0.003)	−0.002 (0.008)	−0.006 (0.003)	−0.004* (0.002)
EventWindow_3	−0.001 (0.003)	−0.005* (0.002)	−0.008* (0.004)	0.000 (0.002)	−0.006 (0.005)	−0.003*** (0.001)	−0.004 (0.005)	0.002 (0.004)	−0.004* (0.002)
EventWindow_4	0.000 (0.002)	−0.005*** (0.001)	−0.007*** (0.001)	−0.004 (0.003)	−0.005*** (0.001)	−0.008*** (0.001)	0.001 (0.009)	−0.002 (0.013)	−0.006*** (0.001)
EventWindow_5	0.009 (0.011)	0.006 (0.009)	−0.012 (0.013)	0.008 (0.009)	−0.003 (0.004)	0.002 (0.005)	0.012*** (0.002)	−0.002 (0.009)	0.002 (0.005)
EventWindow_6	−0.003 (0.005)	0.003 (0.006)	−0.001 (0.008)	−0.000 (0.006)	−0.001 (0.002)	−0.001 (0.004)	0.002 (0.003)	−0.001 (0.004)	−0.000 (0.004)
EventWindow_7	0.006*** (0.001)	0.009** (0.004)	0.005 (0.006)	0.010 (0.006)	0.000 (0.002)	0.002 (0.006)	−0.001 (0.002)	0.003* (0.002)	0.005 (0.004)
NZ_Ret_t	0.542** (0.225)	0.363** (0.157)	0.374** (0.145)	0.555** (0.217)	0.351*** (0.104)	0.243** (0.110)	0.619*** (0.159)	0.397** (0.169)	0.365*** (0.120)
UK_Ret_t	0.150 (0.102)	0.249*** (0.089)	0.171** (0.074)	0.167** (0.085)	0.083 (0.059)	0.151** (0.060)	0.123 (0.088)	−0.176** (0.083)	0.166*** (0.056)
US_Ret_t	0.159 (0.105)	0.097 (0.087)	0.045 (0.074)	0.060 (0.093)	0.072 (0.052)	0.112* (0.060)	0.039 (0.073)	0.319*** (0.086)	0.100* (0.057)
Tokyo_Ret_t	0.297*** (0.104)	0.400*** (0.109)	0.179*** (0.060)	0.208*** (0.070)	0.130*** (0.039)	0.205*** (0.056)	0.075 (0.055)	0.166*** (0.058)	0.248*** (0.065)
China_Ret_t	0.271*** (0.073)	0.173*** (0.065)	0.092 (0.058)	−0.033 (0.058)	0.082** (0.041)	0.128*** (0.039)	0.029 (0.063)	0.068 (0.088)	0.128*** (0.040)
UK_Ret_{t-1}	0.236** (0.099)	0.219*** (0.076)	0.132 (0.097)	0.174** (0.074)	0.051 (0.047)	0.226*** (0.053)	0.132** (0.067)	0.217* (0.120)	0.194*** (0.056)
US_Ret_{t-1}	0.088 (0.123)	0.199* (0.103)	0.219** (0.102)	0.112 (0.111)	0.025 (0.057)	0.086 (0.068)	−0.117 (0.090)	0.039 (0.100)	0.125* (0.073)
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
Observations	289	289	289	289	289	289	289	289	289
Adjusted R^2	0.481	0.559	0.434	0.253	0.312	0.572	0.205	0.213	0.618
Model significance	***	***	***	***	***	***	***	***	***

Notes: *, ** and *** represent significance at the 0.1, 0.05 and 0.01 levels, respectively (two-tailed). Robust standard errors are in parentheses. Returns used to obtain estimates of the regression model in equation (1) begin on 1 January 2011 and end on 13 February 2012 for a total of 289 workings days. R_p (p = 1, [...], 8) is calculated as the mean daily return for each sector portfolio for day t. R_9 is the return for the full sample portfolio, calculated as the mean of eight sector portfolios for day t. NZ_Ret_t, UK_Ret_t, US_Ret_t, Tokyo_Ret_t and China_Ret_t represent return on an equal-weighted New Zealand 50, FTSE 100, Standard & Poors (S&P), Tokyo and Chinese A-share market index for day t. UK_Ret_{t-1} and US_Ret_{t-1} represent return on an equal-weighted FTSE 100 and S&P market index for day t-1. EventWindow_k (k = 1 [...], 7) is a dummy variable that equals 1 within the event window for the k^{th} event and 0 otherwise. The seven information events are: number 1, 10 February 2011, the establishment of an independent Climate Commission; number 2, 24 February 2011, the initial announcement of the carbon tax plan; number 3, 23 May 2011, the release of the Climate Commission's report "The Critical Decade: Climate science, risks and responses"; number 4, 10 July 2011, the Australian Government releases the details of the Clean Energy Plan; number 5, 23 August 2011, a Labour Senator is involved in a credit-card scandal; number 6, 12 October 2011, carbon bills pass in the Parliament house; number 7, 8 November 2011, the Clean Energy Bill and a package of 17 complimentary bills pass in the Senate events, and the AAR are significant in three out of the five events (i.e. events numbers 2, 3 and 4, as indicated in Column 9 of Table I). Positive AAR occurs only in event number 5, which decreases the probability of the tax, and in event number 7, when the tax passed in the Upper House of the Parliament. This evidence supports *H1* and suggests that the carbon tax negatively impacts the shareholder wealth of our sample firms. Note that many foreign market returns were significantly associated with Australian returns, which justifies the inclusion of these markets in the model. Table I also indicates that the information content of a carbon-legislation announcement is more pronounced in the early development of carbon tax policy events; that is, events that lead to the release of the carbon tax plan, climate change reports and particularly the details of the carbon tax package deliver the most useful information for capital market participants, whereas events related to the passage of the tax in the Parliament provide little information. This is consistent with prior studies that report that events associated with the adoption of environmental regulation have little value if the passage of the bill is largely anticipated.

Next, we examined how different sectors react to the events. Column 1 of Table I shows that only investors in the energy sector react significantly and negatively to event number 1 (the coefficient on $\text{EventWindow}_1 = -0.007$, $p < 0.01$), and are not sensitive to other events. For event number 2 (the announcement of the carbon-tax plan), the coefficients on EventWindow_2 for the materials and industrial sector portfolios are -0.009 ($p < 0.05$) and -0.004 ($p < 0.01$), respectively. In addition, the overall reactions to event number 3 (the release of the first major Climate Commission report) by the materials, industrial and financial sector portfolios are significantly negative; the coefficients on EventWindow_3 for these sectors are -0.005 ($p < 0.1$), -0.008 ($p < 0.10$) and -0.003 ($p < 0.01$), respectively. Event number 4, the announcement of the details of the carbon-tax package on 10 July 2011, attracts the most negative investor reactions in four sectors – materials, industrial, consumer staples and financial – suggesting that the carbon legislation hit them most severely. However, for event numbers 5 and 6, no coefficients are significant, except the coefficient for telecommunication services for event number 5 (0.012, $p < 0.001$). Inconsistent with our prediction, most coefficients are significantly positive for event number 7, especially for the energy and materials sector portfolios ($p < 0.05$). This may be because the outcome of voting in the Senate was largely expected, resulting in a price reversal. Finally, we find that investors in the materials, industrial and financial sectors are most sensitive to a carbon tax effect, with at least two or more significant coefficients. These findings provide further evidence that investors generally perceive that the proposed carbon tax would reduce the return on their investment.

5.2 Pooled multi-event results and analysis

Here, we report our analysis of the linear relation between carbon profile proxies and changes in firm financial returns. Table II presents descriptive information for the 336 firm-event observations in our sample, including the mean and median of the variables *DirectExposure, IndirectExposure, TARGET, INCENTIVE, ETS, ForeignSale* and *SIZE* in eight sectors. Table II shows that the means of *DirectExposure* for energy and materials firms are the highest (i.e. the average Scope 1 emissions are 1,872,903 and 1,141,667 tonnes, respectively) and for the full sample are 10.99 (11.282) and 11.768 (11.862), respectively. For carbon disclosures, the average score for the full sample is 74.658 out of 100, with financial firms having the highest disclosure (mean score =

Table II.
Descriptive analysis

GICS Sector	*N*	Statistics	Direct Exposure	Indirect Exposure	DISCLOSURE	TARGET	INCENTIVE	ETS	Foreign Sale	SIZE
Energy	35	Mean	14.443	9.873	65.436	0.4	0.6	0	0.313	8.869
		Median	14.451	10.615	67.2	0	1	0	0.212	9.351
Materials	77	Mean	13.948	13.326	67.06	0.364	0.455	0.182	0.691	8.86
		Median	13.503	13.114	70.36	0	0	0	0.809	8.674
Industrials	49	Mean	10.053	10.863	76.633	0.286	0.714	0	0.357	7.452
		Median	11.158	11.326	80.71	0	1	0	0.227	7.161
Consumer Discretionary	28	Mean	8.285	10.492	74.845	0.5	0.75	0	0.187	7.694
		Median	8.082	10.607	76.575	0.5	1	0	0.018	7.747
Consumer Staples	21	Mean	13.183	13.831	78.813	0.667	0.667	0	0.124	9.948
		Median	13.086	14.726	75.56	1	1	0	0.085	10.405
Financials	112	Mean	8.222	11.497	80.616	0.688	0.75	0.063	0.297	9.297
		Median	8.7	11.801	81.36	1	1	0	0.19	8.978
Telecommunication Services	7	Mean	11.407	13.996	77.68	1	1	1	0.079	10.605
		Median	11.407	13.996	77.68	1	1	1	0.079	10.605
Utilities	7	Mean	12.608	11.486	78.96	0	0	0	0	7.577
		Median	12.608	11.486	78.96	0	0	0	0	7.577
Total	336	Mean	10.922	11.768	74.658	0.5	0.646	0.083	0.367	8.782
		Median	11.282	11.862	75.915	0	0.5	1	0.238	8.686

Notes: *N* is the number of the observations; *DirectExposure* represents the exposure to direct carbon costs associated with a firm's Scope 1 emissions and is measured as the natural logarithm of total Scope 1 emissions; *IndirectExposure* represents the exposure to indirect carbon costs associated with a firm's Scope 2 emissions and is measured as the natural logarithm of total Scope 2 emissions; *DISCLOSURE* is the level of carbon disclosure developed using content analysis according to the 2010 Carbon Disclosure Project (CDP) Carbon Disclosure Leaders Index methodology (CDP Rating Methodology, 2010); The value of the variable is standardised to a 0-100 scale. *TARGET* is a dummy variable that equals 1 if a firm has a reduction target at the firm level and 0 otherwise; *INCENTIVE* is a dummy variable that equals 1 if a firm has reduction incentives for employees and 0 otherwise; *ETS* is a dummy variable that equals 1 if a firm has participated in an emission trading scheme and 0 otherwise. *ForeignSale* is the ratio of foreign sales to total sales; *SIZE* is measured as the natural logarithm of total market capitalisation

80.616, median score = 81.36). In addition, about 50 per cent of our sample firms have a target and 64.6 per cent provide incentives to encourage emission reduction. On average, only 8.3 per cent of our sample firms participate in an ETS.

Table III reports both Pearson (parametric) and Spearman (non-parametric) correlations and coefficients for *SCAR*; the independent variables are insignificant, suggesting that the sample does not suffer from multicollinearity problems.

Table IV presents the multivariate cross-sectional analysis. The predicted sign is presented in the second column. We use the unstandardised and standardised cumulative abnormal returns (i.e. CAR_{jk} and $SCAR_{jk}$) as the dependent variables in Models 1 and 2 [equations (1) and (2)], respectively.

As predicted in *H2*, the direct exposure variable (*DirectExposure*) is consistently negative relative to the cumulative abnormal return and statistically significant at $p < 0.05$ (*H2*), whereas the coefficient on *IndirectExposure* is not significant, which does not allow us to reject the null hypothesis *H3*. The results indicate that investors mainly use firms' Scope 1 emissions to determine carbon liabilities, but are unable to accurately estimate the indirect costs based on the available information. This is probably because there is still uncertainty about the Australian regulatory environment[25], and thus firms – let alone their investors – may not be clear about the extent of their indirect costs[26].

Regarding disclosures, the coefficient on *DISCLOSURE* is not significant, but is positive, as predicted in *H4*. This is in contrast with prior studies that typically have documented a significant relationship (Blacconiere and Northcut, 1997; Blacconiere and Patten, 1994; Patten and Nance, 1998). Note that the variable *DISCLOSURE* only captures carbon transparency, not the substance of a firm's carbon strategy. If the disclosed information reveals the lack of adequate and effective reduction measures, disclosure alone is unlikely to impress investors. The results for other carbon-profile proxies are consistent with this conjecture. The coefficient on *TARGET* is not significant for both models (i.e. not consistent with *H5*), whereas the coefficient on *INCENTIVE* is positive and significant at $p < 0.1$ in Model 1 [equation (1)] only; this provides weak supporting evidence that the carbon-incentive system is helpful (consistent with *H6*). However, overall, the findings suggest the current carbon policies adopted by Australian firms are not sufficient to enhance the confidence of investors and reverse the negative impact of carbon legislation. Regarding control variables, only the coefficient on ETS is negative and marginally significant in both Models 1 and 2 [equations (1) and (2)], and both *ForeignSale* and firm size are not significant.

5.3 Additional tests

To provide extra insight, we conduct further examinations. As discussed before, among the seven events, event number 4 appears to be the most significant event predicting the carbon tax. In this event, the Government officially announced the details of the Clean Energy Bill so that it was possible to specifically assess the potential effects of the tax on individual firms and industries. Thus, this event is the strongest indicator of the passage of the carbon tax. On the other hand, event number 5 is the only event that decreases the probability of the carbon tax becoming law. Accordingly, we predict that fluctuations in the share price should be more pronounced around event numbers 4 and 5.

Thus, we present the results of the last column of Table I in Figure 1, which depicts the movement of the AAR of the whole sample of firms (the red line) during the seven

Table III.
Univariate analysis
($N = 336$)

Variable	SCAR	Direct Exposure	Indirect Exposure	DISCLOSURE	TARGET	INCENTIVE	ETS	Foreign Sale	SIZE
SCAR	1.000	−0.012	0.001	0.0002	−0.036	0.037	−0.035	−0.025	−0.107**
Direct Exposure	−0.023	1.000	0.546***	−0.286***	−0.187***	−0.219***	0.076	0.185***	0.209***
Indirect Exposure	−0.057	0.503***	1.000	0.045	0.066	0.011	0.234***	0.038	0.355***
DISCLOSURE	0.012	−0.297***	−0.017	1.000	0.436***	0.341***	−0.060	−0.303***	0.235***
ETS	−0.012	0.025	0.339***	−0.006	0.302***	0.223***	1.000	0.174***	0.310***
TARGET	−0.014	−0.170***	0.147***	0.460***	1.000	0.392***	0.302***	−0.253***	0.322***
INCENTIVES	0.063	−0.176***	−0.018	0.342***	0.392***	1.000	0.223***	−0.017	0.099*
Foreign Sale	0.032	0.170***	0.030	−0.219***	−0.284***	−0.004	0.186***	1.000	0.052
SIZE	−0.086	0.197***	0.490***	0.303***	0.302***	0.086	0.330***	0.013	1.000

Notes: *, ** and *** represent significance at the 0.1, 0.05 and 0.01 levels, respectively (two-tailed). Pearson (Spearman) correlation coefficients are in the lower (upper) triangle. Financial data here are in Australian million dollars; *DirectExposure* represents the exposure to direct carbon costs associated with a permit purchase and is measured as the natural logarithm of the total Scope 1 emissions; *IndirectExposure* represents the exposure to indirect carbon costs associated with an energy price increase and is measured as the natural logarithm of the total Scope 2 emissions; *DISCLOSURE* is the level of carbon disclosure developed using content analysis according to the 2010 Carbon Disclosure Project (CDP) Carbon Disclosure Leaders Index methodology (CDP Rating Methodology, 2010). The value of the variable is standardised to a 0-100 scale; *TARGET* is a dummy variable that equals 1 if a firm has a reduction target at the firm level and 0 otherwise; *INCENTIVE* is a dummy variable that equals 1 if a firm has reduction incentives for employees and 0 otherwise. *ETS* is a dummy variable that equals 1 if a firm has participated in an emission trading scheme and 0 otherwise; *ForeignSale* is the ratio of foreign sales to total sales; *SIZE* is measured as the natural logarithm of the total market capitalisation

$$
\begin{aligned}
\mathrm{CAR_{jk}\ or\ SCAR_{jk}} = {} & \delta_0 + \delta_1\,\mathrm{DirectExposure_j} + \delta_2\,\mathrm{IndiretExposure_j} + \delta_3\,\mathrm{DISCLOUSRE_j} \\
& + \delta_4\,\mathrm{TARGET_j} + \delta_5\,\mathrm{INCENTIVE_j} + \delta_6\,\mathrm{ETS_j} + \delta_7\,\mathit{ForeignSale}_\mathrm{j} \\
& + \delta_8\,\mathrm{SIZE_j} + \sum \mathrm{SectorDummy}
\end{aligned} \tag{4}
$$

Variables	Predicted sign	(1) CAR_{jk}	(2) $SCAR_{jk}$
Direct Exposure	−	−0.001** (−2.033)	−0.140** (−2.139)
Indirect Exposure	−	0.001 (1.240)	0.106 (1.175)
DISCLOSURE	+	0.000 (0.350)	0.014 (1.410)
TARGET	+	−0.002 (−1.291)	−0.130 (−0.490)
INCENTIVE	+	0.003* (1.659)	0.366 (1.372)
ETS	+	−0.005* (−1.901)	−0.947* (−1.804)
Foreign Sale	−	0.001 (0.454)	0.244 (0.735)
SIZE		−0.001 (−0.877)	−0.120 (−1.343)
Sector effect		Control	Control
Observations		336	336
Adjusted R^2		0.034	0.041
F statistic for the model		1.65*	1.98**

Notes: *and **represent significance at the 0.1 and 0.05 levels, respectively (two-tailed); *T* statistics based on heteroscedasticity-consistent standard errors are in parentheses. Financial data here are in Australian million dollars; *DirectExposure* represents the exposure to direct carbon costs associated with a permit purchase and is measured as the natural logarithm of the total Scope 1 emissions; *IndirectExposure* represents the exposure to indirect carbon costs associated with energy price increases and is measured as the natural logarithm of the total Scope 2 emissions; *DISCLOSURE* is the level of carbon disclosure developed using content analysis according to the 2010 Carbon Disclosure Project (CDP) Carbon Disclosure Leaders Index methodology (CDP Rating Methodology, 2010). The value of the variable is standardised to a 0-100 scale; *TARGET* is a dummy variable that equals 1 if a firm has a reduction target at the firm level and equals 0 otherwise; *INCENTIVE* is a dummy variable that equals 1 if a firm has reduction incentives for employees and equals 0 otherwise; *ETS* is a dummy variable that equals 1 if a firm has participated in an emission trading scheme and equals 0 otherwise; *ForeignSale* is the ratio of foreign sales to total sales; *SIZE* is measured as the natural logarithm of total market capitalisation

Table IV. Pooled multi-event regression

events. AAR decreases for all firms at event numbers 1, 2, 3 and 4 and is the lowest at event number 4, suggesting that this event contains the strongest message regarding the passage of the tax. In contrast, the AAR increases to 0.002 during event number 5. This reversal relative to event number 4 suggests that this event is good news for the investors of these firms. Around event number 4, the sample firms exhibit a "V" type of movement of AAR.

The blue line in Figure 1 shows the trend of the AAR of the five firms with the highest Scope 1 emissions. Of all of the firms in our sample, these will be the most severely affected by the tax, so they should be more sensitive to these events. Hence, we should observe a stronger market reaction particularly during event numbers 4 and 5. Consistent with our expectation, the AAR of high-emission firms (red line) show more fluctuation, particularly at event number 4. The steeper blue line shows a sharper

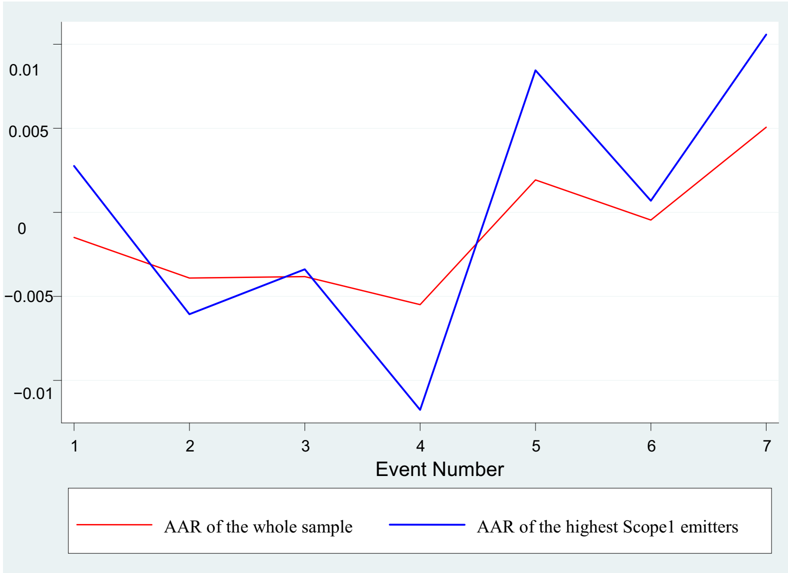

Figure 1.
Average abnormal returns during the seven events

decrease in AAR at event number 4 (from number 3) and a sharper reversal at event number 5 (from number 4). As a result, the AAR of high emitters is much lower at event number 4, but much higher than other firms at event number 5. We also plot the AAR of the top-five Scope 2 emitters. The results (not reported) show a similar tendency as Scope 1 emitters, but the tax appears to have a lesser effect on these firms than on Scope 1 emitters but more than other firms.

In sum, Figure 1 corroborates the previous findings in Table I and strengthens our theoretical prediction. It clearly shows the tax hits heavy Scope 1 emitters most significantly and the effect is most pronounced at event numbers 4 and 5. Hence, the movements of AAR reflect not only the effect of the nature of the message, but also the relative strength of the information content of these events. Note that, in these additional tests, each firm acts as its own control to increase the power of the test. These results suggest that the carbon tax has an overall unfavourable effect; however, the impact on specific firms is conditional on the perceived effect of the tax by investors, which is mostly related to the carbon profile and emissions of the firm.

To mitigate concern that other factors may be influencing AAR, we also check whether our sample firms have mergers or acquisitions that coincide with these events. Of the entire sample of firms, only one company announced a takeover, which coincided with only one event out of the seven. This should have a negligible effect on our results.

6. Conclusions

Our study documents evidence that the proposed carbon tax has an overall negative impact on shareholder wealth measured by abnormal returns. The negative impact varies across sectors with the most significant effect found in the materials, industrial and financial sectors. Our evidence also shows that a firm's direct carbon exposure (as measured by its Scope 1 emissions) is significantly associated with the abnormal return, whereas the indirect exposure measured by Scope 2 emissions is not, because Scope 2 emissions do not fall under the scope of the tax[27]. In addition, the market effect appears more significant in the early development of carbon tax-policy events. Finally, the findings suggest that the capital market gives a clear message to corporate executives that the current dominating corporate carbon strategy appears far from adequate and do not impress market participants. This is perhaps because the Australian Government suddenly and unexpectedly changed its climate-change policy, and most firms were not prepared. However, the Australian carbon tax signals a new era in the transition to a GHG-restrictive economy. Our study represents just a snapshot of the impact of this tax, and we believe more effects will be seen in the near future. The negative investor reactions documented in the paper suggest that there is an expectation gap between stakeholders and corporate practice during this pivotal period with fundamental and structural legislative reform. Thus, the practical implication of the study is that, with the increasingly stringent regulations to come, Australian firms should undertake a more proactive climate-change strategy to minimise their carbon exposure to provide long-term sustainable development.

Our study suffers from several limitations. For example, it is based on a small sample size and the firms in the sample tend to be large. Additionally, the net costs of the tax experienced by a company are not only determined by the total emissions but also their ability to pass on costs to consumers. This issue is not addressed in this paper. Further research is required to develop a proxy for a firm's ability to pass on these costs, so that the impact of the tax on each firm is fully understood. Future studies may also focus on corporate carbon-governance systems. We expect that effective carbon management systems will significantly improve energy efficiency and reduce emissions, thus amplifying shareholder wealth and simultaneously contributing to a green society.

Notes

1. Scope 1 emissions, or direct emissions, occur onsite or from sources that a company owns and controls. Scope 1 emissions include the combustion of fuels (e.g. boilers, furnaces and turbines), a company's vehicle fleet and refrigerants. Scope 2 emissions are the indirect emissions that result from the generation of the electricity, heat or steam that a company purchases.
2. Our data are from Carbon Disclosure Project (CDP) reports (https://www.cdpproject.net/en-US/Pages/HomePage.aspx). CDP is a non-governmental organisation that is committed to helping companies throughout the world to measure, manage, disclose and ultimately reduce their GHG emissions. Annually, the CDP sends its questionnaire to the largest companies, based on market capitalisation, on behalf of 551 institutional investors who had US$71 trillion of assets in 2011 (CDP Global 500 Report, 2011). The data from CDP reports are more consistent and comparable than voluntarily reported, socially oriented data typically found in annual reports or sustainability reports (Luo *et al.*, 2012, 2013; Liao *et al.*, 2014).
3. On 4 May 2009, the Prime Minister, the Hon. Kevin Rudd MP, first announced a 1-year delay in the implementation of the CPRS. On 27 April 2010, the Australian Government announced that the CPRS would not be reintroduced to Parliament until after the Kyoto emissions commitment period ended in 2012.

4. www.climatechange.gov.au/en/government/initiatives/~/media/publications/mpccc/mpccc_cleanenergy_agreement-pdf.pdf
5. www.cleanenergyfuture.gov.au/wp-content/uploads/2011/07/Consolidated-Final.pdf
6. The minimum reduction targets are 5% by 2020 and up to 15-25% depending on the scale of global action, and a longer reduction target from 60 to 80% by 2050.
7. Specifically, these credits cannot be used during the fixed-price phase, and may represent no more than 50% of a company's compliance obligation during the first five years of the cap-and-trade phase. There are also restrictions on the type of international offsets that can be used, and the credits generated from certain industrial gas projects are excluded.
8. The charge will be 1.3 times the fixed price for permits during the fixed-price period, and twice the average price of permits during the year in which they should have been surrendered during the cap-and trade period.
9. The entities that fall under this scheme are those with operational control of facilities with annual Scope 1 emissions in excess of 25,000 tonnes of CO_2 equivalent per site (excluding emissions from transport fuels and some synthetic GHGs) or landfill facilities with emissions of 10,000 tonnes of CO_2 equivalent per year.
10. Examples of compliance costs include costs to collect, manage and report on energy and emissions data for all operations, including costs associated with internal and external auditing of CO_2 data, internal and external legal advice, contract amendments to support the company's compliance under the legislation, management time to interpret and assess the impact of the legislation, the establishment of new policies and procedures and the development of human resources to support a carbon management system.
11. Scope 2 emissions for one entity are part of the Scope 1 emissions of the upstream entity. Therefore, taxing on Scope 2 would amount to a double tax.
12. In practice, a broad-based market-share index is often used for the market portfolio, and since the publication of Ball and Brown (1968) and Fama *et al.* (1969), there have been many advances in event-study methodology and variations of the market model in the literature.
13. www.climatechange.gov.au/minister/greg-combet/2011/media-releases/February/mr20110210.aspx (accessed 1 March 2012).
14. www.climatechange.gov.au/en/minister/greg-combet/2011/media-releases/May/mr20110523a.aspx (accessed 1 March 2012).
15. The alternative is to use the sector-level continuously compounded portfolio return, which is computed using equation (2) for each of the eight sectors represented in the sample (Shane, 1995):

$$R_{pt} = \ln\left(1 + \frac{1}{n_p}\sum_{i=1}^{n_p} r_{it}\right) \tag{2}$$

where r_{it} is the return on firm i's common stock on day t and n_p is the number of firms in sector portfolio p ($p = 1$ […], 8). Returns for the nine sector-level portfolios are summarised further, as described in equation (3), into a ninth portfolio of continuously compounded daily returns, R_{9t}, where the ninth portfolio gives equal weight to each of the ten sectors:

$$R_{9t} = \ln\left(1 + \frac{1}{8}\sum_{p=1}^{8}\left(\frac{1}{n_p}\sum_{j=1}^{n_p} r_{it}\right)\right) \quad (3)$$

The results are qualitatively the same as the equal-weighted portfolio return as presented in Table I.

16. On 10 July 2011 (the day of the fourth event identified in our study), the Australian Stock Exchange was closed for Sunday. Thus, the event window only includes two days: 11 July 2011, designated as day 1, and 12 July 2011, designated as day 2.
17. Standardising abnormal return is used in the literature to address event-induced variances (Binder, 1998; Boehmer *et al.*, 1991; Corrado, 2011).
18. Note that CDLI scores were only available for the largest companies in Australia, so we manually calculate the scores of our sample firms, strictly following the guidelines of the CDP methodology.
19. This was based on the answers to questions 9.2 and 1.4 in the CDP 2010 questionnaire.
20. This was based on the answer to question 21.1.
21. Sales and other financial data were retrieved from DataStream and are in millions of Australian dollars.
22. If the firm size is calculated as the natural logarithm of total assets, the results in Table IV are qualitatively the same. Therefore, our inferences do not change.
23. Some Australian organisations also report GHG emissions under NGER requirements. However, most of these entities are not listed companies, so they don't have share price data and detailed carbon management data.
24. That is, five firms in the energy sector, 11 in the materials sector, seven in the industrials sector, four in the consumer discretionary sector, three in the consumer staples sector, 16 in the financial sector, one in the telecommunication services sector and one in the utilities sector.
25. Uncertainty remains with the threat of the Opposition repealing the legislation should they win the next election.
26. Note that the indirect costs, such as increased electricity expense, also relate to the ability of the upstream firms to pass on the tax on Scope 1 emissions to the downstream firms.
27. The Australian Government indicated that about 500 organisations would be affected by the carbon tax when the law came into effect on 1 July 2012. However, the list was not released in 2011. Therefore, the market participants could not use this information for their decision-making during the carbon tax events we identified in this study.

References

Al-Tuwaijri, S.A., Christensen, T.E. and Hughes, K.E. (2004), "The relations among environmental disclosure, environmental performance, and economic performance: a simultaneous equations approach", *Accounting, Organizations and Society*, Vol. 29 Nos 5/6, pp. 447-471.

Australian Government (2011), *Securing a Clean Energy Future – The Australian Government's Climate Change Plan*, Commonwealth of Australia, available at: www.cleanenergyfuture.gov.au/wp-content/uploads/2011/07/Consolidated-Final.pdf (accessed 10 February 2012).

Ball, R. and Brown, P. (1968), "An empirical evaluation of accounting income numbers", *Journal of Accounting Research*, Vol. 6 No. 2, pp. 159-178.

Barth, M.E. and McNichols, M.F. (1994), "Estimation and market valuation of environmental liabilities relating to superfund sites", *Journal of Accounting Research*, Studies on Accounting, Financial Disclosures, and the Law, Vol. 32, pp. 177-209.

Binder, J. (1998), "The event study methodology since 1969", *Review of Quantitative Finance and Accounting*, Vol. 11 No. 2, pp. 111-137.

Blacconiere, W.G. and Northcut, W.D. (1997), "Environmental information and market reactions to environmental legislation", *Journal of Accounting Auditing and Finance*, Vol. 12 No. 2, pp. 149-178.

Blacconiere, W.G. and Patten, D.M. (1994), "Environmental disclosures, regulatory costs, and changes in firm value", *Journal of Accounting and Economics*, Vol. 18 No. 3, pp. 357-377.

Boehmer, E., Masumeci, J. and Poulsen, A.B. (1991), "Event-study methodology under conditions of event-induced variance", *Journal of Financial Economics*, Vol. 30 No. 2, pp. 253-272.

Busch, T. and Hoffmann, V. (2007), "Emerging carbon constraints for corporate risk management", *Ecological Economics*, Vol. 62 Nos 3/4, pp. 518-528.

Campbell, K., Sefcik, S. and Soderstrom, N. (1998), "Site uncertainty, allocation uncertainty, and superfund liability valuation", *Journal of Accounting and Public Policy*, Vol. 17 Nos 4/5, pp. 331-366.

Campbell, K., Sefcik, S.E. and Soderstrom, N.S. (2003), "Disclosure of private information and reduction of uncertainty: environmental liabilities in the chemical industry", *Review of Quantitative Finance and Accounting*, Vol. 21 No. 4, pp. 349-378.

CDP Global 500 Report (2011), "*CDP Global 500 Report 2011*, Carbon Disclosure Project", available at: www.cdproject.net/en-US/Results/Pages/All-Investor-Reports.aspx (accessed 4 February 2012).

CDP Rating Methodology (2010), "Rating methodology 2010", available at: www.cdproject.net/en-US/Results/Pages/leadership-index-2010.aspx (accessed 20 May 2011).

Chapple, L., Clarkson, P.M. and Gold, D.L. (2013), "The cost of carbon: capital market effects of the proposed emission trading scheme", *Abacus*, Vol. 49 No. 1, pp. 1-33.

Clarkson, P., Li, Y., Richardson, G.D. and Vasvari, F.P. (2011), "Does it really pay to be green? Determinants and consequences of proactive environmental strategies", *Journal of Accounting and Public Policy*, Vol. 30 No. 2, pp. 122-144.

Cogan, D.G. (2006), "*Corporate Governance and Climate Change: Making the Connection*, A CERES Sustainable Governance Project Report, prepared by the Investor Responsibility Research Center (IRRC)", available at: www.c2es.org/docUploads/Ceres%20–%20Corporate%20Climate%20Change%20Ranking%202006.pdf (accessed 4 February 2012).

Collins, D.W. and Dent, W.T. (1984), "A comparison of alternative testing methodologies used in capital market research", *Journal of Accounting Research*, Vol. 22 No. 1, pp. 48-84.

Corrado, C.J. (2011), "Event studies: a methodology review", *Accounting and Finance*, Vol. 51 No. 1, pp. 207-234.

Cotter, J. and Najah, M.M. (2012), "Institutional investor influence on global climate change disclosure practices", *Australian Journal of Management*, Vol. 37 No. 2, pp. 169-187.

Ernst&Young (2009), *Navigating Carbon Regulations, Impact on India Business*, Ernst&Young Private, Kolkata.

Fama, E.F. and Fisher, L., Jensen, M.C. and Roll, R. (1969), "The adjustment of stock prices to new information", *International Economic Review*, Vol. 10 No. 1, pp. 1-21.

FINSIA (2011), "*Applying Australia's Financial Markets to the Challenge of Carbon Emissions Reduction,* Financial Services Institute of Australasia", available at: www.finsia.com/AM/Template.cfm?Section=Media_Releases_2011&Template=/CM/ContentDisplay.cfm&ContentID=16372 (accessed 10 February 2012).

Graham, A., Maher, J.J. and Northcut, W.D. (2001), "Environmental liability information and bond ratings", *Journal of Accounting Auditing and Finance*, Vol. 16 No. 2, pp. 93-116.

Griffin, P.A., Lont, D.H. and Sun, Y. (2012), "The relevance to investors of greenhouse gas emission disclosures", Working Paper, University of California, University of Otago.

Hoffman, A.J. (2006), *Getting Ahead of the Curve: Corporate Strategies that Address Climate Change*, Pew Center on Global Climate Change Arlington, VA.

Hughes, K. (2000), "The value relevance of nonfinancial measures of air pollution in the electric utility industry", *Accounting Review*, Vol. 75 No. 2, pp. 209-228.

Johnston, D., Sefcik, S. and Soderstrom, N. (2008), "The value relevance of greenhouse gas emissions allowances: an exploratory study in the related United States SO_2 market", *European Accounting Review*, Vol. 17 No. 4, pp. 747-764.

Jones, C.A. and Levy, D.L. (2007), "North American business strategies towards climate change", *European Management Journal*, Vol. 25 No. 6, pp. 428-440.

King, A. and Lenox, M. (2001), "Does it really pay to be green? An empirical study of firm environmental and financial performance", *Journal of Industrial Ecology*, Vol. 5 No. 1, pp. 105-116.

Konar, S. and Cohen, M. (2001), "Does the market value environmental performance?", *Review of Economics and Statistics*, Vol. 83 No. 2, pp. 281-289.

KPMG (2011), *Australia's Climate Change Plan: How it Will Work and the Implications for Business*, KPMG, available at: www.kpmg.com/AU/en/IssuesAndInsights/ArticlesPublications/Documents/Australias-Climate-Change-Plan-v3.pdf (accessed 24 April 2012).

Larcker, D.F., Ormazabal, G. and Taylor, D.J. (2011), "The market reaction to corporate governance regulation", *Journal of Financial Economics*, Vol. 101 No. 2, pp. 431-448.

Liao, L., Luo, L. and Tang, Q. (2014), "Gender diversity, board independence, environmental committee and greenhouse gas disclosure", *British Accounting Review* (forthcoming), DOI: 10.1016/j.bar.2014.01.002.

Lo, K. (2003), "Economic consequences of regulated changes in disclosure: the case of executive compensation", *Journal of Accounting and Economics*, Vol. 35 No. 3, pp. 285-314.

Luo, L., Lan, Y.-C. and Tang, Q. (2012), "Corporate incentives to disclose carbon information: evidence from the CDP global 500 report", *Journal of International Financial Management and Accounting*, Vol. 23 No. 2, pp. 93-120.

Luo, L., Tang, Q. and Lan, Y.-C. (2013), "Comparison of propensity for carbon disclosure between developing and developed countries: a resource constraint perspective", *Accounting Research Journal*, Vol. 26 No. 1, pp. 6-34.

MacKinlay, A. (1997), "Event studies in economics and finance", *Journal of Economic Literature*, Vol. 35 No. 1, pp. 13-39.

Matsumura, E.M., Prakash, R. and Vera-Munoz, S.C. (2014), "Firm-value effects of carbon emissions and carbon disclosures", *The Accounting Review*, Vol. 89 No. 2, pp. 695-724.

Mitchell, M.L. and Netter, J.M. (1994), "The role of financial economics in securities fraud cases: applications at the securities and exchange commission", *Business Lawyer*, Vol. 49 No. 2, pp. 545-590.

Nelson, T. (2011), "The facts about emissions trading and company performance", available at: www.aglblog.com.au/2010/02/the-facts-about-emissions-trading-and-company-performance/ (accessed 14 March 2012).

Patten, D.M. and Nance, J.R. (1998), "Regulatory cost effects in a good news environment: the intra-industry reaction to the Alaskan oil spill", *Journal of Accounting and Public Policy*, Vol. 17 Nos 4/5, pp. 409-429.

Pershing, J. and Tudela, F. (2003), "A long-term target: framing the climate effort", *Pew Center on Global Climate Change*, Arlington, Virginia, available at: www.pewclimate.org/docUploads/Beyond_Kyoto_Target.pdf

Pinkse, J. and Kolk, A. (2009), *International Business and Global Climate Change*, Routledge, London and New York, NY.

Porter, M. and van der Linde, C. (1995), "Green and competitive: ending the stalemate", *Harvard Business Review*, Vol. 75 No. 3, pp. 119-134.

Prado-Lorenzo, J.-M. and Garcia-Sanchez, I.-M. (2010), "The role of the board of directors in disseminating relevant information on greenhouse gases", *Journal of Business Ethics*, Vol. 97 No. 3, pp. 391-424.

Sato, M., Grubb, M., Cust, J., Chan, K., Korppoo, A. and Ceppi, P. (2007), "Differentiation and dynamics of competitiveness impacts from the EU ETS", Working Paper, University of Cambridge, Cambridge.

Schipper, K. and Thompson, R. (1983), "The impact of merger-related regulations on the shareholders of acquiring firms", *Journal of Accounting Research*, Vol. 21 No. 1, pp. 184-221.

Schneider, T.E. (2011), "Is environmental performance a determinant of bond pricing? Evidence from the US pulp and paper and chemical industries", *Contemporary Accounting Research*, Vol. 28 No. 5, pp. 1537-1561.

Shane, P. (1995), "An investigation of shareholder wealth effects of environmental regulation", *Journal of Accounting Auditing and Finance*, Vol. 10, pp. 485-520.

Tang, Q. and Luo, L. (2011), "Transparency of corporate carbon disclosure: international evidence", Working Paper, University of Western Sydney, Sydney.

Verrecchia, R.E. (1983), "Discretionary disclosure", *Journal of Accounting and Economics*, Vol. 5, pp. 179-194.

Zhang, I.X. (2007), "Economic consequences of the Sarbanes-Oxley Act of 2002", *Journal of Accounting and Economics*, Vol. 44 Nos 1/2, pp. 74-115.

Appendix

Australian carbon tax package

The Australian government committed to a number of assistance and new spending measures. The following is a summary of the key measures:

- Carbon emissions-intensive, trade-exposed (EITE) assistance at the same levels proposed under the CPRS.
- A $1.2-billion Clean Technology Program to help improve energy efficiency in manufacturing industries and support research and development in low-pollution technologies.
- $1.37 billion in funding for the coal mining sector to compensate the high fugitive-emission "gassy" coal mines and help the industry implement carbon abatement technologies.

- $300 million in funding for the steel industry.
- $5.5 billion in compensation over six years for the coal-fired electricity sector to reduce their emissions and a government tender process to close, by 2020, high-polluting coal-fired power-generation plants producing around 2000 megawatts of power. The government will also provide short-term loans to generators to help finance purchases of carbon permits.
- A $10-billion Clean Energy Finance Corporation to drive innovation through commercial investments.
- The $3.2-billion Australian Renewable Energy Agency. This new independent statutory body was created to coordinate existing grant-funding programmes supporting research and development and to demonstrate new renewable-energy technologies.
- $1.7 billion to support agricultural carbon and biodiversity programmes.

Corresponding author
Qingliang Tang can be contacted at: q.tang@uws.edu.au