Carbon risk and corporate payout policy under the California cap-and-trade rule

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Abstract

Climate change has been of great concern to the public in recent decades. Global governments have implemented both international and regional policies to mitigate ongoing global warming. The impact of those environmental regulations on the real economy provides crucial implications for investors, managers, and policymakers. This study examines how carbon risk affects corporate payout policy by employing the California cap-and-trade rule as an exogenous shock. Our results indicate that following the cap-and-trade rule, cash dividends increase significantly, and this is more pronounced for light emitters. We further show that the cap-and-trade rule does not affect corporate leverage and capital expenditure but decreases innovation investment and total investment for heavy emitters.

Keywords: Dividend payout; carbon emission risk; California cap-and-trade rule; share repurchase.

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1. Introduction

As global warming has led to a series of adverse effects on economic and social activities, firms and policymakers are taking action to combat the financial and economic risks caused by climate change. An essential and challenging means to mitigate climate change is to curb carbon and greenhouse gas emissions, which requires the joint participation of companies and governments. Thus far, governments globally have developed, agreed, and published various policies, such as the Paris Agreement, Kyoto Protocol, European Union Emissions Trading System, and carbon tax, among others. Given the particular characteristics and economic development of different countries and states, most regulatory interventions are introduced in scattered ways and climate policies are highly decentralized, due to such heterogeneity.

Growing awareness of climate-related risks has motivated researchers to conduct a surge of studies in finance. As reported in recent global surveys of economists, professionals, and policymakers (Krueger et al., 2020; Stroebel & Wurgler, 2021), regulatory risk is regarded as the first-order climate risk for investors and businesses in the short term and has begun to materialize recently. This draws attention to the importance of understanding how corporate behavior may vary in response to specific climate regulations. In this paper, we explore how companies adjust their payout policies (especially cash dividends) to mitigate carbon emissions risk arising from the adoption of the California cap-and-trade rule. There are vast numbers of studies centred on carbon risk which mainly focus on the engagement of intuitional investors (Azar et al., 2021), stock returns (Bolton & Kacperczyk, 2021; Oestreich & Tsiakas, 2015), capital structure (Nguyen & Phan, 2020), mergers and acquisitions (Bose et al., 2021), and asset prices (Ilhan et al., 2021). However, an understanding of the effects of carbon risk on corporate payout policy is still limited, especially how such effects may vary under different environmental regulations.

At the beginning of 2013, California imposed a state-wide cap-and-trade rule to mitigate greenhouse gas emissions, which was also the first multi-sector cap-and-trade program to emerge in North America (Bartram et al., 2022). The main theoretical attraction of the cap-and-trade rule (a system of tradable emissions allowances) is to achieve emissions reductions at a lower cost through the incentives arising from emissions pricing rather than mere technological mandates or performance standards (Goulder & Schein, 2013). Carbon-intensive firms are positively correlated with higher carbon-related management costs, cost of capital, stock returns, earnings uncertainty, and financial constraints (Balachandran & Nguyen, 2018; Bolton & Kacperczyk, 2021; Nguyen & Phan, 2020; Oestreich & Tsiakas, 2015). Consequently, the implementation of climate policies in reducing carbon emissions may lead to additional regulatory costs, further negatively affecting the corporate financial condition and cash flows.

Bartram et al. (2022) explore the effect of the localized cap-and-trade rule and document that many firms shift their greenhouse gas emissions from California to other less regulated states, distorting the main goal of emission reductions. This implies that the enactment of cap-and-trade regulation not only increases regulatory costs, but also highlights the difficulties of reducing firm-level carbon emissions through complex incentivization. This is consistent with the general consensus that emission control regulations may broadly increase firms' carbon risk.

As climate policies can push firms to improve energy efficiency, conduct technological innovations, and use renewable energy sources, to limit carbon emissions (Bolton & Kacperczyk, 2021), the related management costs may be amplified dramatically in response. Similarly, the increased expense inherent in reducing carbon emissions may affect managers' confidence about their firms' future prospects (Oestreich & Tsiakas, 2015), leading to greater conflicts of interest between managers and shareholders. The aforementioned California cap-and-trade rule allows firms to trade their free carbon emission allowances so it increases the uncertainty of future emission costs given that future carbon allowance prices are determined by the carbon trading market. Moreover, the risk associated with future price of carbon allowances brings uncertainty to future cash flows (Oestreich & Tsiakas, 2015), which motivates managers to retain a higher level of cash holding, in particular for potential financing shocks. However, the excess free cash may cause shareholder concerns about overinvestment, so managers may be under shareholder pressure to distribute more dividends (Ni et al., 2020). From these conflicts of interest between managers and shareholders, we are motivated to examine how carbon risk induced by emission control regulations may affect corporate payout policy.

In this study, we utilize a difference-in-differences (DID) approach with a sample of 17,886 firm-year observations in the US markets from 2010 to 2020, to investigate the impact of climate policy on corporate payouts. To address the potential endogeneity concern, we use the California cap-and-trade rule in 2013 as a quasi-natural experiment. Since the cap-and-trade rule is designed to reduce carbon emissions, it is arguably an exogenous shock to carbon risk, especially for heavy carbon emitters (firms with high emissions), which allows us to identify the causal relationship between carbon risk and firm payout policies. In line with our expectations, the results show that the implementation of the cap-and-trade rule manifests a positive effect on cash dividends.

We further classify firms into heavy and light emitters, based on the typical carbon emission profiles of each firm's industry. The industry-based classification is independent of individual firm characteristics (Nguyen & Phan, 2020). This aims to alleviate concerns that a firm's payout policy may affect its carbon risk, and that both payout policy and carbon risk are correlated with other control variables. Consistent with our expectation, the results indicate that after the introduction of the California cap-and-trade rule, firms with light emissions increase their cash dividend payout significantly, while firms with heavy emissions do not change their dividend payout policy.

Furthermore, we conduct several robustness checks. First, we test the parallel trend assumption underlying the difference-in-differences model. We document that an increase in cash dividends for treated firms relative to control firms only occurs after adapting to the California cap-and-trade rule. Second, we examine the association between carbon risk and payout policy by adopting propensity-score matching and entropy balancing approaches. These two matching methods are employed to mitigate the concern that systematic differences between the treated and control firms may potentially drive the regression results. The estimated results based on the propensity-score matched and entropy balanced samples indicate that our main findings are robust and consistent. Third, we examine the consistency of the main results using a three-year window before and after the introduction of the California cap-and-trade rule, with our results remaining materially unchanged.

In addition, we investigate the impact of the cap-and-trade rule on corporate behavior and particularly explore the plausible channels of its effect on corporate payout. We provide evidence to support that firms decrease their share repurchases after the implementation of the cap-and-trade rule, especially heavy emitting firms, while we find no significant changes in total payout. Moreover, we show that firms with higher financial constraints are more likely to distribute cash dividends following the application of the cap-and-trade rule, especially light emitters. Our results further suggest that the rule leads to an increase in firms' cash holdings but no changes in innovation investment and total investment for light emitters, while for heavy emitters, there is a significant and negative relationship between the rule and innovation and total investment. Finally, we find that with the cap-and-trade rule imposed, firms do not change their capital expenditure and leverage.

This study makes two-fold contributions to the literature. First, it fills the research gap in associating emission risk induced by environmental policies to corporate payout policy, by complementing the extant literature that links climate-related risk to corporate payout policy. Huang et al. (2018) utilize the Global Climate Risk Index constructed by Eckstein and Kreft (2020) to examine the impact of extreme weather events on corporate policies and firm performance. Similar to Huang et al. (2018), Chang and Mi (2021) use the Global Climate Risk Index to measure climate risk and investigate its effect on payout policies. They document the substitution effect between dividends and repurchases, which increase payout flexibility to address strengthened climate risk. Hendijani Zadeh (2021) examines how corporate payout policies respond to social and environmental (E&S) transparency, as measured by Bloomberg's E&S transparency scores.

Second, our findings provide supportive evidence for the role of state environmental regulations in corporate policies, in particular payout policy. Balachandran and Nguyen (2018) throw light on the role of national climate policy, finding that after the ratification of the Kyoto Protocol, the reduction in dividend payouts is significantly stronger for polluters than non-polluters. Conversely, we reveal a novel finding that state environmental regulation increases cash dividends for light emitters but decreases share repurchases for heavy emitters.

Our study is distinct from that of Balachandran and Nguyen (2018), who explore the role of carbon risk on the likelihood of paying cash dividends and the level of cash dividends under Australia's particular tax system setting, using the Kyoto Protocol ratification as an exogenous shock on carbon risk. Notably, the Kyoto Protocol and the California cap-and-trade rule contrast in their regulatory nature. Indeed, Balachandran and Nguyen (2018) review the Australian markets with both imputation and classical tax environments quite different from the respective settings in the US markets. Finally, we utilize the characteristic of the US markets of having both cash dividends and share repurchase as their two payout means, to explore changes in both these as well as their interactions induced by the California cap-and-trade rule; meanwhile the Australian markets have not considered share repurchase as a part of their payout policy.

This paper proceeds as follows: Section 2 presents the related literature and hypothesis development; Section 3 provides the methodology and data; Section 4 exhibits the main results and alternative robustness tests; Section 5 presents some additional tests; and Section 6 concludes the study.

2. Related literature and hypotheses development

2.1.1 California's cap-and-trade program

California's cap-and-trade program started at the beginning of 2013. It is implemented by the California Air Resources Board (CARB) to reduce greenhouse gas emissions. The program establishes a declining limit on major sources of GHG emissions throughout California and creates a powerful economic incentive for significant investment in cleaner, more efficient technologies (ICAP, 2020). Covering approximately 80% of the state's GHG emissions, the program is the first multi-sector cap-and-trade program in North America (Bartram et al., 2022). The cap-and-trade rule covers all electric power facilities and industrial facilities that emit 25,000 t CO_2e or more annually, based on allocations of capped allowances with a specific calendar year vintage. The allowances are distributed via free allocation, free allocation with consignment, and quarterly auction. If firms emit more than allowances they have received, they can buy additional allowances through market transactions. That is, this program encourages firms to reduce emissions (e.g., through technological innovations) so they can sell their surplus unused allowances for profit (ICAP, 2020).

2.1.2 Hypotheses development

As regulatory risk has started to materialize recently and is regarded as the first-order climate risk for investors and businesses in the short term (Krueger et al., 2020; Stroebel & Wurgler, 2021), there is a growing body of studies exploring the effect of climate policy. Monasterolo & de Angelis (2020) show that after the announcement of the Paris Agreement, low-carbon indices are less risky than carbon-intensive indices and thus are more attractive for investment opportunities. Ilhan et al. (2021) argue that carbon-intensive firms benefit from President Trump’s election because the cost of downward option protection associated with climate policy uncertainty decreased significantly after President Trump’s election. Nguyen & Phan (2020) state that following the Kyoto Protocol ratification, the financial leverage of heavy carbon-emitting firms decreases, especially for firms with financially constraints.

However, although there is a body of studies exploring the potential effect of different climate policies, there is little empirical analysis on the association between carbon risk, climate regulations, and corporate payout policy. The most relevant literature is Huang et al. (2018), Hendijani Zadeh (2021), and Balachandran & Nguyen (2018). Huang et al. (2018) show that firms exposed to severe climate change would reduce cash dividends to better respond to unexpected climate change. This is consistent with the finding that managers in low E&S transparent firms prefer to retain more cash flow to adjust the dividend payout policy (Hendijani Zadeh, 2021). Moreover, Balachandran & Nguyen (2018) find that carbon risk leads to earning uncertainty, further reducing the dividend payout ratio. They also highlight the impact of the climate policy that after the ratification of the Kyoto Protocol, the probability of paying dividends and dividend payout ratio is lower for heavy-emitting firms.

Motivated by the most recent paper (Bartram et al., 2022) that revealed the spillover effect of the California cap-and-trade rule, this paper attempts to use the California cap-and-trade rule as a quasi-natural experiment to study its impact on corporate payout policy, particularly cash dividends, and fill the abovementioned gap. We assume that the enactment of the California cap-and-trade rule could lead to two opposing effects on cash dividends. Environmental regulations could have costly impacts on corporate activities, especially for carbon-intensive firms. The enforcement of the local climate policy leads to increases in carbon-related management costs such as regulatory costs, transition costs, and litigation costs. These increased costs could enhance earnings uncertainty, undermining managers' confidence in future profitability. As a result, managers are more cautious about payout policy and are less likely to pay cash dividends. This is consistent with the precautionary perspective that firms would retain more cash as a hedge against high external capital costs and heightened uncertainty in the future (Attig et al., 2021; Nyborg & Wang, 2021).

However, empirical evidence show that cash dividends play a relevant role in alleviating agency problems (Attig et al., 2021; Nyborg & Wang, 2021), lending further credence to the agency theory motive of corporate payout policy. The increased costs arising from the cap-and-trade rule motivate managers to pay out excess cash flow as a commitment to not overinvest (Ni et al., 2020). Furthermore, as changes in dividends convey value-relevant information about future cash-flow volatility (Michaely et al., 2021), firms have a greater incentive to distribute payout in the form of cash dividends rather than share repurchases. In other words, cash dividends signal future earnings (Bhattacharya, 1979; Millerr & Kevin, 1985), consistent with the importance of the second moment of the earnings distribution in payout decisions. Therefore, we make an alternative conjecture that the cap-and-trade rule would cause a larger increase in cash dividends.

As mentioned above, the California cap-and-trade rule was introduced to control carbon emissions, which could impose substantial risks for firms transitioning to a low-carbon economy. In addition, the implementation of the cap-and-trade rule allows firms to trade their free carbon emission allowances in the market. Heavy emitters can use their money to buy carbon emission allowances, while light emitters can sell their excess free emission allowances for a profit. In this sense, the enactment of the cap-and-trade rule leads to higher operating costs and uncertain cash flow for heavy emitters. As heavy-emitting firms may confront higher carbon allowance prices in the future due to catastrophic climate change (Oestreich & Tsiakas, 2015; Weitzman, 2009), they are exposed to higher carbon risk following the rule. As a consequence, those firms are more likely to choose conservative financing policies in response to this regulation. That is, heavy-emitting firms would hold more cash reserves, reduce cash dividends to preserve liquidity, and forgo profitable investments (Dang et al., 2022). However, since dividends are generally related to stable and permanent cash flow (Jagannathan et al., 2000), firms with heavy emitting under this rule are less likely to reduce cash dividends to avoid giving a negative signal to the market. Therefore, given the cash flow uncertainty arising from the California cap-and-trade rule, heavy emitters are more likely to maintain the initial level of cash dividends. That is, our first hypothesis is as follows:

Hypothesis 1: After the introduction of California cap-and-trade rule, firms with heavy emitting do not change their cash dividends.

Since light emitters can create more cash inflows by selling their excess allowances, they may have a higher level of cash holding and confront less cash flow uncertainty after the introduction of California cap-and-trade rule. Both the increased in cash holding and decrease in cash flow uncertainty leads to more agency conflicts between shareholders and managers in terms of resource allocation. To mitigate the shareholder's concern that managers may overinvest due to the excess cash holding, firms have more incentives to pay out excess cash as a commitment for shareholders. In particular, as firms' cash dividends may have a signalling effect about the prospects of their future earnings (Bhattacharya, 1979; Millerr & Kevin, 1985) and convey value-relevant information about future cash-flow volatility (Michaely et al., 2021), light emitters are more likely to distribute more cash dividends to send a positive signal to the markets and boost their share prices. We consequently make the conjecture that the cap-and-trade rule could lead to a greater increase in cash dividends for firms with lighter emission. That is, our second hypothesis is as follows:

Hypothesis 2: After the California cap-and-trade rule, firms with lighter emission are more likely to increase their cash dividends.

3. Methodology and Data

3.1 The baseline regression model

This paper uses the enactment of California's cap-and-trade rule in 2013 as an exogenous shock to investigate the effect of climate policy on corporate payout policy. The difference-in-difference (DID) model is applied to measure this relationship. To measure the corporate payout policy, cash dividends are used as the main dependent variable. In the additional test, share repurchase, and total payouts are used to further test the impact of the climate rule on payout policy. Cash dividends (*DVC*) represent the corporate annual cash dividends scaled by the total asset. Share repurchases (*REP*) is the corporate annual net repurchase amount by subtracting any decrease in the value of the net number of preferred stocks outstanding from purchases of common and preferred stock, also scaled by the market value. Total payouts (*Total payout*) is the sum of cash dividends (*DVC*) and share repurchases (*REP*).

The baseline regression model is as follows:

$$DVC_{it} = \beta_0 + \beta_1 CA_{it} * Post_{it} + \beta_2 X_{it-1} + \beta_3 Z_{it-1} + \rho_j + \varphi_t + \varepsilon_{it} \qquad (1)$$

Where *i*, *t* and *j* denote firm, year, and industry, respectively. DVC_{it} refers to cash dividends of firm *i* in year *t*. The original value of the payout measure is multiplied by 100 to facilitate the interpretation of estimation results (Ni et al., 2020). CA_{it} is an indicator variable equals to one if firm *i* has a plant located in California, and zero otherwise. $Post_{it}$ is a dummy variable, which equals to one if firm i is observed in the post-cap-and-trade period 2013-2020, otherwise it is zero. X_{it-1} and Z_{it-1} are a set of time-varying firm- and state-level control variables, respectively. Similar to previous studies (Balachandran & Nguyen, 2018; Grullon & Michaely, 2002; Von

Eije & Megginson, 2008), firm-level control variables contains firm size (*Size*), firm age (*Age*), return on assets (*ROA*), market-to-book ratio (*MB*), leverage (*LEV*), sales growth (*SALEG*), cash holdings (*CASH*), retained earnings (*RETAIN*), As those firm-level control variables are well-documented determinants of corporate payout policy, they are lagged by one period to alleviate potential endogenously. For state-level control variables, we consider state GDP growth (*GDPG*), and state unemployment rate (*Unemplr*), following Dang et al. (2022) and Ni et al. (2020), which are also lagged by one period to alleviate potential endogenously. The description of all variables presents in Appendix A.

To control for time-varying macro-economic conditions and the influence of industry characteristics, the year fixed effect φ_t and industry fixed effect ρ_j are included in the model. Since these two fixed effects absorb the effects of CA_{it} and $Post_{it}$, the CA_{it} and $Post_{it}$ dummies are not included as independent variables in the model. ε_{it} is the error term.

The Eq. (1) tests how corporate payout policy changes in response to the cap-and-trade rule. To further study the impact of carbon risk on corporate payout policy under the cap-and-trade rule, we estimate Eq. (1) separately for heavy emitting and light emitting firms and evaluate whether the coefficients on the interaction term $CA_{it}*Post_{it}$ are significantly different in the two models.

Firms are classified as heavy and light emitters following Balachandran & Nguyen, (2018) and Nguyen & Phan (2020). Heavy emitters are those carbon-intensive firms with the largest greenhouse gas emissions. In addition, a firm is considered as a heavy emitter if it belongs to one of the following GICS industries: (1) Oil, Gas & Consumable Fuels; (2) Electric Utilities;

(3) Gas Utilities; (4) Independent Power Producers & Energy Traders; (5) Multi-Utilities; (6) Chemicals; (7) Construction Materials; (8) Metals & Mining; and (9) Paper & Forest Products (CDP 2012).

Similar to Bartram et al. (2022), a triple-difference framework incorporated with a $Emitter_{it}$ dummy is used to alternatively compare coefficients from separate DID regressions on heavy emitting and light emitting subsamples. The triple-difference model is as follows:

$$DVC_{it} = \beta_0 + \beta_1 CA_{it} * Post_{it} + \beta_2 CA_{it} * Emitter_{it} + \beta_3 Post_{it} * Emitter_{it} + \beta_4 CA_{it} * Post_{it} * Emitter_{it} + \beta_5 X_{it-1} + \beta_6 Z_{it-1} + \rho_j + \varphi_t + \varepsilon_{it} \quad (2)$$

Like Eq. (1), DVC_{it} refers to cash dividends of firm i in year t. CA_{it} and $Post_{it}$ dummies are not included in the model since we control for industry and year fixed effects. The standard errors are adjusted by clustering at the firm level.

3.2 Data

3.2.1 Sample selection

To construct the sample, we collect annual financial data as well as GICS industry classification of all firms listed on the Compustat database from 2010 to 2020. Since the California cap-and-trade rule was implemented in the US, we only consider publicly listed U.S firms. Firms incorporated or located outside the US are excluded from the sample. As the California cap-and-trade rule was enforced in early 2013, the sample can be divided into two sub-periods: pre-rule period (2010-2012) and post-rule period (2013-2020). Financial firms (SIC 6000-6999) and utilities (SIC 4900-4999) are excluded because they are highly regulated and monitored. The information on state-level GDP growth and state-level unemployment rate are from the U.S. Bureau of Economic Analysis (BEA) and the U.S. Bureau of Labor Statistic (BLS), respectively.

In addition, firms are required to have positive total assets and sales greater than $10 million. Firms with missing or negative value for equity are also excluded. To mitigate the impact of outliers, all continuous financial variables expecting macroeconomic ones are winsorized at the 1% level. After the selection process, the sample is an unbalanced panel containing 17,886 firm-year observations and 2,765 firms.

3.2.2 Definition of treated and control group

Considering that the California cap-and-trade rule affects plants in California and these pants may be owned by companies located in California or other states, we resort firms into treated and control groups based on whether a firm has a plant in California. First, we collect plant-level data from the Facility Level Information on GHGs Tool (FLIGHT) of the EPA. The EPA published the Greenhouse Gas Reporting Program (GHGRP) in October 2009 and reported sources that emit 25,000 tons or more of CO_2e greenhouse gases per year according to the estimation methodologies prescribed by the EPA. Plant-level information from FLIGHT consists of identity, parent company ownership, geographic location, the quantity of plant annual greenhouse gas emissions since 2010, and the North American Industry Classification System (NAICS) industry code. Second, we select facilities located in California and hand-matched them with annual financial data from Compustat based on the names of parent companies.

Given that parent company names may be recorded differently in these two datasets, we use extensive google searches to account for parent-subsidiary linkages during the matching process. After this process, we find 157 firms with at least one plant in California. Combining with aforementioned sample selection criterion, the final sample contains 439 firm-year observations in the treated group and 17,447 in the control group.

The final sample is also highly unbalanced in terms of firm emitting level. It contains 2,519 observations classified as heavy emitters and 17,886 observations classified as light emitters. Therefore, in the robustness test section, we apply other categorization methods such as propensity score matching (PSM) and entropy balancing (EB) to reclassify firms and check the baseline results.

3.2.3 Summary statistics and correlation matrix

Table 1 presents summary statistics of the variables used in the baseline regression model. All variables, except for dummy and macroeconomic ones, are winsorized at 1st and 99th percentiles to alleviate the potential impact of outliers. It shows that the average cash dividend is 1.254. As firms' dividends at 25th and 50th percentile is 0, implying that most firms in this sample distribute their payout through share repurchases rather than cash dividends. The means of firm size and ROA are 6.697 and 0.009, respectively. The average book-to-market ratio is 3.818 and the average leverage is 0.219. The average firm has a sales growth of 0.084, a cash holding of 0.190, and retained earnings of -0.203. And the average logarithm of firm age is about 3.049.

[Insert Table 1 about here]

In Table 2, we report the correlations matrix of all variables used in the empirical analyses. The correlation coefficient between share repurchases and the total payout is 0.843, which is greater than that between cash dividends and the total payout. This implies that firms are more inclined to distribute cash to shareholders through share repurchases. Since other correlation coefficients are lower than 0.75, it seems that there is no multicollinearity concern in the regression models. In addition, we find a positive correlation between three measures of corporate payouts and firm size, suggesting that large firms are more willing to pay back cash to shareholders.

[Insert Table 2 about here]

4. Empirical results

4.1 The effect of the emission regulation on cash dividends

The preliminary results of Eq. (1) using cash dividend (*DVC*) as the dependent variable are exhibited in Table 3. We examine how firms adjust their payout policies through cash dividends in response to the California cap-and-trade rule. The key coefficient on the interaction term *CA*Post* captures the differential treatment effect of the enforcement of the cap-and-trade rule on payout policies. Columns (1) - (6) report the estimated results for cash dividends based on the whole sample. In column (1), we only include year fixed effect but no controls. In column (2), we add eight well-documented firm-level control variables used in the prior payout policy literature (i.e., firm size, ROA, market-to-book ratio, leverage, sales growth, cash holdings, retained earnings, and firm age). In column (3), we further add two state-level control variables, namely, state GDP growth and state unemployment rate, to control for state-level economic conditions that may affect both the implementation of the climate rule and payout policy. Columns (4) - (6) are similar to columns (1) - (3) but further control for industry fixed effect. All these firm-level and state-level controls are lagged by one year to mitigate potential endogenously. The results of all regression models show a consistently positive and significant relationship between the introduction of the cap-and-trade rule and cash dividends.

Without any control variables at the firm- and state- levels, when controlling both year and industry fixed effects, the coefficient on the interaction term *CA*Post* is 1.038, significant at 1% significant level. This suggests that cash dividends increase significantly by more than 100% following the cap-and-trade rule without controlling for any control variables. After including a set of firm-level and state-level control variables, the coefficients on *CA*Post* remain positive. But the magnitude and statistical significance of the coefficients decrease slightly. As shown in column (6), the coefficient is 0.769, which is statistically significant at 5% level. These consistently positive results indicate that the implementation of the cap-and-trade indeed exerts a positive impact on cash dividends. This finding is consistent with the conjecture that firms could increase their cash dividends in response to the cap-and-trade rule.

[Insert Table 3 about here]

4.2 The effect of the emission regulation on cash dividends for firms with heavy and light emission

To further investigate if this positive effect is more apparent for heavy emitting firms, we estimate Eq. (1) for the sample of heavy emitters and light emitters based on industry classification respectively. In addition, we run the pool regression model Eq. (2) to examine whether firms change their payout policy under the cap-and-trade rule depending on their carbon emission levels. The main coefficient of interest is the triple-interaction term *CA*Post*Emitter*, which captures how firms adjust their cash dividends under the climate policy according to their emission nature. The results are reported in Table 4 for total cash dividends. Columns (1) and (2) present results for subsample splits based on emitting level, and columns (3) show the result by using the pool regression model incorporated with the *Emitter* dummy variable.

As shown in column (1) of Table 4, the coefficient on *CA*Post* is positive but statistically insignificant. This finding is consistent with our Hypothesis 1 that heavy emitters do not change cash dividends following the cap-and-trade rule since, after the introduction of the rule, firms with higher emission prefer to retain more cash to hedge against possible higher allowance prices and financial distress. Nevertheless, due to the signalling effect of cash dividends, they would not decrease cash dividends as it gives the market a negative signal about future earnings and ultimately depresses the stock price. Therefore, heavy emitters are more likely to maintain the current level of cash dividends after implementing the rule. However, for lighter emitters, the coefficient on *CA*Post* is positive and statistically significant at 5% level in Column (2). This is consistent with our Hypothesis 2 that light emitters pay more cash dividends following the introduction of the cap-and-trade rule. This may be explained by the fact that light emitters can generate more cash inflows by selling their excess free carbon allowances. To mitigate agency problems arising from excess cash holding, they distribute more cash dividends to shareholders as a commitment to not overinvest and bust their share prices.

[Insert Table 4 about here]

Besides running separate regressions and comparing coefficients across the two models, we also run a triple-difference regression to capture this relationship. We further find a consistent result from the pooled regression model in column (3). The main coefficient on the triple interaction term *CA*Post*Emitter* is negative (-1.382) and statistically significant at 5% level, indicating that the impact of the cap-and-trade rule on the cash dividends is more pronounced for light emitters compared to heavy emitters.

5. Robustness tests

5.1 The test of parallel trend assumption

The DID model is based on the assumption that payout policies of treated and control groups should move in a similar way in the absence of the cap-and-trade rule. If this pre-treatment parallel trend assumption fails, regression results will be invalid. To test the validity of the parallel trend assumption in the dependent variable before and after initiating the cap-and-trade rule, we conduct falsification tests using the dynamic treatment model.

Following Landsman et al. (2022) and Nguyen & Phan (2020), we replace *CA*Post* dummies with new interactions between newly created time indicator variables with *CA* dummy in the Eq. (1). The newly created time dummies include $Before^{-2}$, $Before^{-1}$, $Current^{0}$, After^{+1}, After^{+2}, After^{+3}, After^{+4}, After^{+5}, After^{+6}, After^{+7}, which refer to two years before, one years before, the current year of, one year after, two years after, three years after, four years after, five years after, six years after, and seven years after the implementation of the cap-and-trade rule, respectively. The cap-and-trade rule year is 2013. The indicator variable $Before^{-3}$ (the three years before the cap-and-trade rule) is omitted, which is regarded as the benchmark year. The coefficients of the new interactions between CA and these time dummies capture the changes in payout policy of treated and control firms in the corresponding years. If the pre-treatment parallel trends assumption is valid, the coefficients on $CA{*}Before^{-2}$ and $CA{*}Before^{-1}$ will be insignificantly different from zero.

We present the key findings from this regression by graphing the coefficients of these new interactions, including the 95% confidence interval surrounding each coefficient. Figure 1 exhibits the findings of the dynamic treatment model estimation. The figure reveals that the coefficients of the interaction variables $CA{*}Before^{-2}$ and $CA{*}Before^{-1}$ are statistically insignificant, which indicates that cash dividends in the two years before the implementation year are indistinguishable. Thus, we can conclude that the treated and control firms' payout policy follows pre-treatment parallel trends. That is, the falsification test results rule out the possibility that our findings are driven by time trends or anticipation of the implementation of the cap-and-trade rule.

Furthermore, the figure reveals that after two years of the implementation of the cap-and-trade rule, the coefficients on the new interactions are positive and statistically significant. This finding confirms that cash dividends increase following the cap-and-trade rule, consistent with our baseline results.

[Insert Figure 1 about here]

5.2 Propensity-score matching and entropy balancing approaches

We use both propensity score matched and entropy balanced samples to address the concern that the results may be driven by differences in characteristics between treatment and control groups. The treatment and control groups are classified by whether or not firms have a plant in states that adopt the California cap-and-trade rule. Following Landsman et al. (2022) and Nguyen & Phan (2020), we start to construct the propensity score matched sample by retaining all observations for treated and control firms in one year before the adoption of the cap-and-trade rule. Then we use a logit regression of the CA dummy on all firm characteristics used in Eq. (1) as well as industry fixed effects (2-digit SIC industry classification) to estimate the probability of being a treated firm. After that, we calculate propensity scores for each firm by using estimated parameters. We match each treated firm in year t-1 (i.e., 2012) to control firm with the closest propensity score (without replacement) and exclude all observations that do not satisfy the common support condition.

After obtaining the propensity score matched sample, we rerun the DID regression of Eq. (1) to test the robustness of prior results. Regression results are present in Table 5. The p-values of the post-match diagnostic test in Panel A are all greater than 0.1, suggesting that the sample mean between treated and control firms for the variables used in the logit regression are not significantly different. In other words, treated and control firms in the PSM-matched sample have similar firm characteristics prior to the passage of the cap-and-trade rule. In columns (1) - (3) of Panel C, we estimate our DID model using propensity score matched sample. Consistent with the baseline results, we find that the coefficient on *CA*Post* for full sample and light emitters are still positively and statistically significant, whereas for heavy emitters are still positively and statistically insignificant. This finding further confirms that firms pay significantly higher total cash dividends after enacting the cap-and-trade rule, especially for light emitters.

Moreover, we use entropy balancing (EB) as an alternative matching approach following Dang et al. (2022). Similar to the PSM matching process discussed above, we start with all firm-level observations in one year before the adoption of the cap-and-trade rule (i.e., 2012). We then use EB to match treated firms to control firms and assign based on the first two moments (i.e., the mean and variance) of the firm-level covariates. The results on the Panel B compare the mean and variance of treated and control groups for different corporate characteristics, showing that the entropy balance has been achieved. We then estimate DID model using entropy balance sample. The result is reported in columns (4) – (6) of Panel C. The positive and statically significant coefficient on *CA*Post* for full sample and light emitters further prove our baseline finding that the adaption of the cap-and-trade rule induces increase in cash dividends for light emitters. Overall, our main regression result continues to hold after using two alternative matching methods (i.e., PSM and EB).

[Insert Table 5 about here]

5.3 A three-year window before and after the introduction of the emission regulations

To alleviate the concern that our results are driven by different sample periods, we further estimate the Eq. (1) by using a three-year window to capture the effect of the cap-and-trade rule on payout policy. Following prior DID studies (Balachandran & Nguyen, 2018; Bartram et al., 2022; Dang et al., 2022), we use a balanced sample period around the event as a robustness check. The sample period now is from 2010 to 2015, with three years before and after the enforcement of the California cap-and-trade rule in 2013.

Table 6 presents the results. All coefficients on *CA*Post* are positive and statistically significant with no control variables (in column (1)), with only firm-level control variables (in column (2)), and with both firm- and state-level controls (in column (3)). This finding is consistent with previous results using a longer sample period, although at the 10% significance level. That is, using the same event window before and after the event if introduction of the cap-and-trade rule, our results also suggest that the enactment of the cap-and-trade rule increases cash dividends.

[Insert Table 6 about here]

6. Additional analyses

6.1 The impact of emission regulations on firms' total payouts and share repurchases

Although our analysis above has indicated a robust, significant, and positive effect of the California cap-and-trade rule on cash dividends, it is of interest to extend our analysis from cash dividends to other forms of corporate payouts, such as total payouts and share repurchases. Due to the rigidity nature of cash dividends, share repurchases are a more flexible tool to adjust the payout policy without giving a negative signal to the market. Considering this property, we conjecture that the implementation of the cap-and-trade rule could lead to decreases in share repurchases, especially for heavy emitters.

To test this conjecture, we rerun Eq. (1) using share repurchases as a dependent variable based on full samples and heavy and light emitting subsamples. The share repurchases (*REP*) is the corporate annual net repurchase amount by subtracting any decrease in the value of the net number of preferred stocks outstanding from purchases of common and preferred stock, scaled by total assets. Columns (4)-(6) in Table 7 report the estimated results for share repurchases. The coefficients on *CA*Post* reveal that there is a negative and significant relationship between the cap-and-trade rule and share repurchases. Moreover, this negative impact of the climate rule on share repurchases is more apparent for heavy emitters than light emitters. This finding suggests that after the adaption of the cap-and-trade rule, heavy emitters decrease their share repurchases significantly while there is no change in light emitters' share repurchases.

For completeness, we also test the impact of the cap-and-trade rule on total payouts (*Total payout*), which is measured by the sum of cash dividends (*DVC*) and share repurchases (*REP*). Columns (1) - (3) in Table 7 report the egression results of Eq. (1) using total payouts as the dependent variable. Since all the coefficients on *CA*Post* are insignificant, implying that the cap-and-trade rule does not affect total payouts. Overall, after implementing the California cap-and-trade rule, heavy emitters decrease their share repurchases to hold more cash without fear of sending a negative signal to the market. This finding confirms the flexibility of share repurchases relative to cash dividends.

[Insert Table 7 about here]

6.2 Financial constraint and payout policies

To investigate if the impact of the California cap-and-trade rule on payout policies is related to financial constraints, we follow the method of Kaplan & Zingales (1997) and Lamont et al. (2001). We use the Kaplan-Zingales (KZ) index as an indicator to measure whether a firm is financially constrained[†]. The higher value of the KZ index indicates that firms are highly financially constrained. The main coefficient of interest is the triple-interaction term $KZ_{it}*CA_{it}*Post_{it}$ which captures whether the impact of the carbon risk on payout policies is more pronounced in companies with severe financial constraints. Table 8 reports the results of the triple-difference model concerning the financial constraints based on full sample and heavy and light emitting subsamples. From the results of full sample, as shown in columns (1), (4)

[†] $KZ = -1.001909 \times Flow + 0.2826389 \times MB + 3.139193 * LEV - 39.3678 * DVC - 1.314759 * CASH$

and (7), we find that the coefficient on $KZ_{it}*CA_{it}*Post_{it}$ or cash dividends and total payouts is positive and statistically significant at 1% level. However, the triple term coefficient is negative and significant for share repurchases. These opposing findings suggest that heavily financially constrained firms increase the total payouts and are more willing to distribute payout via cash dividends rather than share repurchases after the cap-and-trade rule. In addition, from columns (5) and (6), we find that heavy and light emitters with severe financial constraints increase their cash dividends after the cap-and-trade rule. However, for share repurchases, as shown in columns (8) and (9), we find light emitters with higher financial constrain decreases their share repurchases.

[Insert Table 8 about here]

6.3 Cash holdings and the emission regulations

In this section, we test whether the cap-and-trade rule would affect the cash balance. Following Jiang & Lie (2016) and Nyborg & Wang (2021), we control for firm size, firm age, market-to-book ratio, leverage, cash flow, sales growth, R&D, capital expenditures, and ROA in the regression model. We also include state-level controls, industry fixed effect and year fixed effect in the model. The dependent variable is cash holding, measured by the ratio of cash and cash equivalents to total assets. The detail description of variables is shown in Appendix A and the standard errors are robust to clustering by firm.

Table 9 shows the results for cash holdings based on the full sample and subsamples. The coefficients on *CA*Post* are positive and statistically significant for the full sample (column

(1)), suggesting that the enactment of the cap-and-trade rule increases cash holdings by 3%, which could explain previous findings that cash dividends increase after the cap-and-trade rule. From columns (2) and (3), we can find that the positive and significant effect of the cap-and-trade rule on cash holdings is more pronounced for light emitters, which further explains the apparent positive relationship between the rule and cash dividends of light emitters. This finding also confirmed that light emitters make a profit by selling excess free emission allowances, thus, are more willing to pay cash dividends to mitigate potential agency problems.

[Insert Table 9 about here]

6.4 Leverage and the emission regulations

To further investigate why firms distribute more cash dividends following the cap-and-trade rule, we test how the cap-and-trade rule affects firms' leverage. Following prior studies (Dang et al., 2022; Nguyen & Phan, 2020), we control for one year lagged firm size, ROA, market-to-book ratio, tangibility, cash holdings as well as state GDP growth and state unemployment rate. We also include industry fixed and year fixed effects in the model. The dependent variable is leverage, measured by the debt to total asset ratio. The detailed description of variables is shown in Appendix A and the standard errors are robust to clustering by firm.

Table 10 shows the results for leverage based on full sample and subsamples. The coefficients on *CA*Post* are all statistically insignificant, indicating that the enactment of the cap-and-trade rule does not affect leverage. That is, after the rule, firms do not obtain external financing funds.

[Insert Table 10 about here]

6.5 Innovation investment, capital expenditure and total investment

The implementation of the cap-and-trade rule aiming at curbing carbon emissions could lead to an impact on corporate innovation investment, capital expenditure, and total investment. To measure this effect, we use R&D investment, capital expenditures, and total investment as dependent variables and regress it on the interaction term *CA*Post* dummies. In this regression, we control for a set of the firm- and state-level characteristics, industry fixed effect, and year fixed effect. Regression results are reported in Table 11. We find no effect of the rule on capital expenditures since all the coefficients on *CA*Post* in columns (4)-(6) are statistically insignificant. However, for R&D investment and total investment, we can find a statistically negative relationship with the cap-and-trade rule for heavy emitters. The reduction in R&D and total investment may be caused by the increased operating costs arising from the introduction of the California cap-and-trade rule. Combining these findings, we can conclude that the implementation of the cap-and-trade rule affects corporate behaviors. Following the rule, firms hold more cash but decrease their innovation and total investments.

[Insert Table 11 about here]

7. Conclusion

In this study, we exploit the enactment of the California cap-and-trade rule as an exogenous shock and examine its impact on the corporate payout policy. We document the supportive evidence that the adoption of the cap-and-trade rule leads to an increase in firms' cash dividends for light emitters while there are no significant changes in cash dividend for heavy emitters. It may be plausible that light emitters improve their corporate profits via selling their free emission allowances and do not invest the induced additional cash inflows. Consequently, they pay more cash dividends to send a positive signal to the markets and alleviate potential agency issues. This conjecture is further supported by our finding of the increase in cash holdings of light emitters.

In addition, we find a significant and negative relationship between the cap-and-trade rule and share repurchases for heavy emitters. This may be due to the fact that share repurchases are more flexible and a reduction in share repurchases does not have a negative signalling effect on the market when heavy emitters require more cash for the increase in emission costs caused by the rule. However, for total payouts, we do not find a statistically significant impact of the rule for the full sample. This implies that the adoption of the rule does not affect total payouts when both heavy and light emitters are included as a whole.

In additional analyses, our results indicate that the introduction of the cap-and-trade rule does not affect firms' leverage and capital expenditures. There is also an insignificant relation between the cap-and-trade rule and R&D and total investments but a positive and significant relation with cash holdings for light emitters. This further provides the explanation for the increase in cash dividends for light emitters. For heavy emitters, it is intriguing to find that after the introduction of the cap-and-trade rule, those companies decrease their R&D expenditure and total investments, possibly due to the higher operating costs induced by the rule.

References

Attig, N., El Ghoul, S., Guedhami, O., & Zheng, X. (2021). Dividends and economic policy uncertainty: International evidence. *Journal of Corporate Finance*, *66*(October 2020), 101785. https://doi.org/10.1016/j.jcorpfin.2020.101785

Azar, J., Duro, M., Kadach, I., & Ormazabal, G. (2021). The Big Three and corporate carbon emissions around the world. *Journal of Financial Economics*, *142*(2), 674–696. https://doi.org/10.1016/j.jfineco.2021.05.007

Balachandran, B., & Nguyen, J. H. (2018). Does carbon risk matter in firm dividend policy? Evidence from a quasi-natural experiment in an imputation environment. *Journal of Banking and Finance*, *96*, 249–267. https://doi.org/10.1016/j.jbankfin.2018.09.015

Bartram, S. M., Hou, K., & Kim, S. (2022). Real effects of climate policy: Financial constraints and spillovers. *Journal of Financial Economics*, *143*(2), 668–696. https://doi.org/10.1016/j.jfineco.2021.06.015

Bhattacharya, S. (1979). Imperfect information, dividend policy, and" the bird in the hand" fallacy. *The Bell Journal of Economics*, 259–270.

Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk? *Journal of Financial Economics*, *142*(2), 517–549. https://doi.org/10.1016/j.jfineco.2021.05.008

Bose, S., Minnick, K., & Shams, S. (2021). Does carbon risk matter for corporate acquisition decisions? *Journal of Corporate Finance*, *70*(May), 102058. https://doi.org/10.1016/j.jcorpfin.2021.102058

Chang, Y., & Mi, L. (2021). *Climate Risk and Corporate Payout Policies around the World*. *October*.

Dang, V. A., Gao, N., & Yu, T. (2022). Climate policy risk and corporate financial decisions: Evidence from the NOx Budget Trading Program. *Management Science*, *x*, Forthcoming.

Eckstein, D., & Kreft, S. (2020). Global climate risk index 2021. Who suffers most from extreme weather events? In *Think Tank & Research* (Issue March). http://germanwatch.org/en/download/8551.pdf

Goulder, L. H., & Schein, A. R. (2013). Carbon taxes versus cap and trade: A critical review. *Climate Change Economics*, *4*(3). https://doi.org/10.1142/S2010007813500103

Grullon, G., & Michaely, R. (2002). Dividends, share repurchases, and the substitution hypothesis. *Journal of Finance*, *57*(4), 1649–1684. https://doi.org/10.1111/1540-6261.00474

Hendijani Zadeh, M. (2021). The effect of corporate social responsibility transparency on corporate payout policies. *International Journal of Managerial Finance*, *17*(5), 708–732. https://doi.org/10.1108/IJMF-07-2020-0386

Huang, H. H., Kerstein, J., & Wang, C. (2018). The impact of climate risk on firm performance and financing choices: An international comparison. *Journal of International Business Studies*, *49*(5), 633–656. https://doi.org/10.1057/s41267-017-0125-5

ICAP. (2020). ETS Detailed Information USA - California Cap-and-Trade Program. *International Carbon Action Partnership*, *91*(September), 1–5.

Ilhan, E., Sautner, Z., & Vilkov, G. (2021). Carbon Tail Risk. *Review of Financial Studies*, *34*(3), 1540–1571. https://doi.org/10.1093/rfs/hhaa071

Jagannathan, M., Stephens, C. P., & Weisbach, M. S. (2000). Financial flexibility and the choice between dividends and stock repurchases. *Journal of Financial Economics*, *57*(3), 355–384.

Jiang, Z., & Lie, E. (2016). Cash holding adjustments and managerial entrenchment. *Journal of Corporate Finance*, *36*, 190–205. https://doi.org/10.1016/j.jcorpfin.2015.12.008

Kaplan, S. N., & Zingales, L. (1997). Do investment-cash flow sensitivities provide useful measures of financing constraints? *Quarterly Journal of Economics*, *112*(1), 169–213. https://doi.org/10.1162/003355397555163

Krueger, P., Sautner, Z., & Starks, L. T. (2020). The importance of climate risks for institutional investors. *Review of Financial Studies*, *33*(3), 1067–1111. https://doi.org/10.1093/rfs/hhz137

Lamont, O., Polk, C., & Saá-Requejo, J. (2001). Financial constraints and stock returns. *Review of Financial Studies*, *14*(2), 529–554. https://doi.org/10.1093/rfs/14.2.529

Landsman, W. R., Li, C. K., & Donny Zhao, J. (2022). CDS Trading Initiation, Information Asymmetry, and Dividend Payout. *Management Science*.

Luo, Y., Chen, Y., & Lin, J. C. (2022). Does air quality affect inventor productivity? Evidence from the NOx budget program. *Journal of Corporate Finance*, *73*(July 2021), 102170. https://doi.org/10.1016/j.jcorpfin.2022.102170

Michaely, R., Rossi, S., & Weber, M. (2021). Signaling safety. *Journal of Financial Economics*, *139*(2), 405–427. https://doi.org/10.1016/j.jfineco.2020.08.013

Millerr, M. H., & Kevin, R. (1985). Dividend Policy under Asymmetric Information. *The Journal of Finance*, *40*(4), 1031–1051.

Monasterolo, I., & de Angelis, L. (2020). Blind to carbon risk? An analysis of stock market reaction to the Paris Agreement. *Ecological Economics*, *170*(December 2019), 106571. https://doi.org/10.1016/j.ecolecon.2019.106571

Nguyen, J. H., & Phan, H. V. (2020). Carbon risk and corporate capital structure. *Journal of Corporate Finance*, *64*(December 2019), 101713. https://doi.org/10.1016/j.jcorpfin.2020.101713

Ni, X., Song, W., & Yao, J. (2020). Stakeholder orientation and corporate payout policy:

Insights from state legal shocks. *Journal of Banking and Finance*, *121*, 105970. https://doi.org/10.1016/j.jbankfin.2020.105970

Nyborg, K. G., & Wang, Z. (2021). The effect of stock liquidity on cash holdings: The repurchase motive. *Journal of Financial Economics*, *142*(2), 905–927. https://doi.org/10.1016/j.jfineco.2021.05.027

Oestreich, A. M., & Tsiakas, I. (2015). Carbon emissions and stock returns: Evidence from the EU Emissions Trading Scheme. *Journal of Banking and Finance*, *58*, 294–308. https://doi.org/10.1016/j.jbankfin.2015.05.005

Stroebel, J., & Wurgler, J. (2021). What do you think about climate finance? *Journal of Financial Economics*, *142*(2), 487–498. https://doi.org/10.1016/j.jfineco.2021.08.004

Von Eije, H., & Megginson, W. L. (2008). Dividends and share repurchases in the European Union. *Journal of Financial Economics*, *89*(2), 347–374. https://doi.org/10.1016/j.jfineco.2007.11.002

Weitzman, M. L. (2009). On modeling and interpreting the economics of catastrophic climate change. *Review of Economics and Statistics*, *91*(1), 1–19. https://doi.org/10.1162/rest.91.1.1

Table 1 Summary statistics

This table presents summary statistics on key variables used in the main empirical analysis. The sample contains 17,886 observations for the whole sample period 2010–2020. For each variable, number of observations, mean, standard deviation, 25th percentile, median and 75th percentile are reported. Continuous variables, except macroeconomic ones, are winsorized at 1st and 99th percentiles to reduce the effects of outliers. Detailed definitions of all the variables are presented in Appendix A.

Variable	N	Mean	Std	25th	Median	75th
DVC	17,886	1.254	2.616	0.000	0.000	1.547
Payout	17,158	2.387	4.520	0.000	0.272	2.729
REP	17,158	3.772	5.866	0.000	1.358	4.906
Size	17,886	6.697	2.004	5.252	6.719	8.060
ROA	17,884	0.009	0.132	-0.014	0.036	0.075
MB	17,874	3.818	4.961	1.368	2.333	4.117
Lev	17,845	0.219	0.188	0.034	0.196	0.348
SALEG	17,884	0.084	0.231	-0.023	0.056	0.154
CASH	17,886	0.190	0.189	0.046	0.127	0.274
RETAIN	17,882	-0.203	1.336	-0.213	0.141	0.388
Age	17,886	3.049	0.705	2.565	3.091	3.584
GDPG	17,886	1.011	0.027	1.002	1.012	1.022
Unemplr	17,886	5.982	2.344	4.100	5.600	7.800

Table 2 Correlation matrix

This table shows correlation matrix between variables. Figures in bold indicate that the coefficient are significant at 5% level.

	DVC	Payout	REP	Size	ROA	MB	Lev	SALEG	CASH	RETAIN	Age	GDPG	Unemplr
DVC	1.000												
Payout	**0.610**	1.000											
REP	**0.121**	**0.843**	1.000										
Size	**0.083**	**0.180**	**0.203**	1.000									
ROA	**0.292**	**0.364**	**0.276**	**0.307**	1.000								
MB	**0.137**	**0.250**	**0.223**	**0.090**	**-0.031**	1.000							
Lev	**-0.082**	**-0.083**	**-0.046**	**0.370**	**-0.063**	**0.174**	1.000						
SALEG	**-0.06**	**-0.065**	**-0.044**	**0.018**	**0.146**	**0.127**	**-0.018**	1.000					
CASH	0.010	**0.081**	**0.077**	**-0.271**	**-0.182**	**0.197**	**-0.406**	**0.083**	1.000				
RETAIN	**0.173**	**0.184**	**0.140**	**0.377**	**0.574**	**-0.110**	**0.043**	**0.025**	**-0.288**	1.000			
Age	**0.206**	**0.143**	**0.068**	**0.257**	**0.224**	**-0.091**	**0.017**	**-0.160**	**-0.213**	**0.220**	1.000		
GDPG	**0.025**	**0.014**	0.005	**-0.015**	**0.046**	**-0.084**	**-0.034**	**0.042**	**-0.090**	**0.051**	**0.026**	1.000	
Unemplr	**-0.046**	**-0.026**	-0.010	**-0.076**	0.009	**-0.052**	**-0.117**	**0.054**	**0.109**	**-0.035**	**-0.075**	**-0.219**	1.000

Table 3 The effect of the California's cap-and-trade rule on cash dividends

The table reports the preliminary results of Eq. (1) using cash dividends (*DVC*) as the dependent variable. The variable, *CA*, is an indicator variable equal to one if a firm has a present located in California, and zero otherwise. *Post* is a dummy variable set to one for 2013 and later, and zero otherwise. Columns (1)-(3) only control for year fixed effect, while columns (4)-(6) control for both year and industry fixed effects. All the variables are defined in Appendix A. The standard errors are clustered by firms and t-statistics are provided in square brackets. ***, ** and *indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
CA*Post	**1.037*** **	**0.760** **	**0.767** **	**1.038*** **	**0.763** **	**0.769** **
	(0.376)	**(0.315)**	**(0.315)**	**(0.379)**	**(0.318)**	**(0.318)**
$Size_{t-1}$		-0.033	-0.032		-0.036	-0.035
		(0.032)	(0.032)		(0.032)	(0.032)
ROA_{t-1}		4.782***	4.780***		4.762***	4.760***
		(0.477)	(0.477)		(0.477)	(0.476)
MB_{t-1}		0.106***	0.105***		0.104***	0.104***
		(0.012)	(0.012)		(0.012)	(0.012)
Lev_{t-1}		-1.316***	-1.320***		-1.301***	-1.303***
		(0.225)	(0.225)		(0.227)	(0.227)
$SALEG_{t-1}$		-0.928***	-0.924***		-0.919***	-0.915***
		(0.098)	(0.098)		(0.099)	(0.098)
$CASH_{t-1}$		0.982***	1.009***		1.006***	1.033***
		(0.313)	(0.316)		(0.310)	(0.313)
$RETAIN_{t-1}$		0.111***	0.110***		0.113***	0.112***
		(0.030)	(0.029)		(0.030)	(0.030)
Age_{t-1}		0.527***	0.522***		0.530***	0.526***
		(0.053)	(0.053)		(0.054)	(0.053)
$GDPG_{t-1}$			0.811			0.813
			(0.996)			(0.989)
$Unemplr_{t-1}$			-0.031			-0.029
			(0.026)			(0.026)
Constant	1.163***	-0.398	-0.928	1.058***	-0.499**	-1.046
	(0.244)	(0.270)	(1.112)	(0.060)	(0.219)	(1.094)
Industry FE	NO	NO	NO	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	17,886	17,886	17,886	17,886	17,886	17,886
R-squared				0.006	0.147	0.147

Table 4 The effect of the California's cap-and-trade rule on cash dividends for firms with heavy and light emission

The table reports the results of Eq. (1) using cash dividends (*DVC*) as dependent variable for subsample splits based on carbon emission nature of a firm's industry. Columns (3) presents the results of Eq. (2). All the variables are defined in Appendix A. The standard errors are clustered by firms and t-statistics are provided in square brackets. ∗∗∗, ∗∗ and ∗indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) Heavy emitter	(2) Light emitter	(3) Pooled
CA*Post	**0.203**	**1.268****	1.252**
	(0.249)	**(0.499)**	(0.501)
CA*Emitter			0.195
			(0.300)
Post*Emitter			0.137
			(0.148)
CA*Post*Emitter			**-1.356****
			(0.561)
$Size_{t-1}$	0.067	-0.046	-0.036
	(0.052)	(0.036)	(0.032)
ROA_{t-1}	5.041***	4.527***	4.746***
	(0.927)	(0.511)	(0.477)
MB_{t-1}	0.170***	0.099***	0.104***
	(0.033)	(0.012)	(0.012)
Lev_{t-1}	-2.134***	-1.266***	-1.316***
	(0.569)	(0.243)	(0.226)
$SALEG_{t-1}$	-0.457**	-0.931***	-0.913***
	(0.225)	(0.108)	(0.098)
$CASH_{t-1}$	2.764***	1.144***	1.035***
	(1.052)	(0.330)	(0.312)
$RETAIN_{t-1}$	0.421***	0.105***	0.111***
	(0.104)	(0.031)	(0.030)
Age_{t-1}	-0.028	0.610***	0.524***
	(0.113)	(0.058)	(0.053)
$GDPG_{t-1}$	1.524	0.586	0.800
	(1.995)	(1.084)	(0.989)
$Unemplr_{t-1}$	0.021	-0.029	-0.029
	(0.050)	(0.028)	(0.026)
Constant	-1.058	-1.059	-1.020
	(2.121)	(1.212)	(1.094)
Industry FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	2,519	15,367	17,886
R-squared	0.198	0.149	0.148

Figure 1 Results of the dynamic treatment analysis.

This figure presents the results of the dynamic treatment analysis, which tests the parallel trend assumption between treated and control group before the introduction of the cap-and-trade rule. *Before*$^{-2}$, *Before*$^{-1}$, *Current*^{0}, After^{+1}, After^{+2}, After^{+3}, After^{+4}, After^{+5}, After^{+6}, and After^{+7} are time indicator variables that indicate two years before, one year before, the current year of, one year after, and two or more years after the implementation of the cap-and-trade rule, respectively, where the cap-and-trade rule year is 2013. We use Eq. (1) by replacing *CA*Post* by new interaction between CA and time indicator variables mentioned above to test this assumption. This figure graphs the coefficients on new interactions, including the 95% confidence interval.

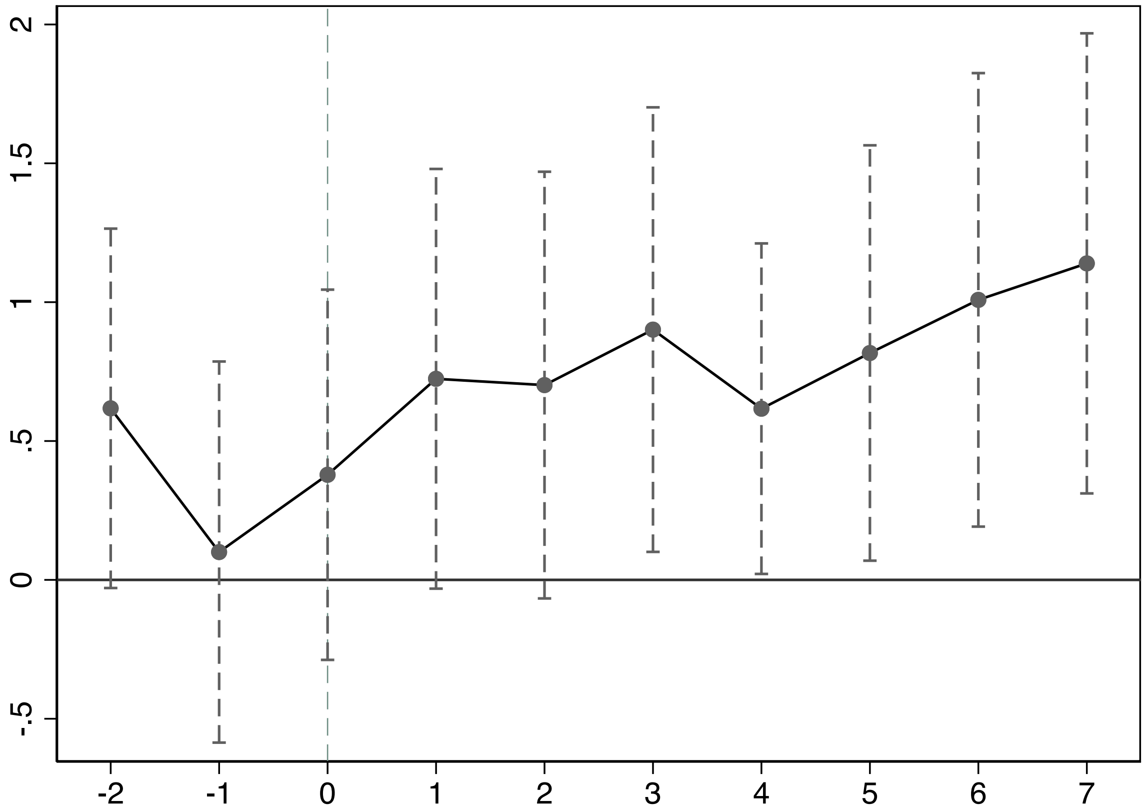

Table 5 DID Regression Using PSM-matched and Entropy Balanced Samples

The table reports the regression results of Eq. (1) using the PSM-matched and entropy balanced sample. Panel A presents the post-match diagnostic test results with p-values of mean differences between treated and control firms in 2012. During the matching procedure, we calculated the propensity scores through all control variables (e.g., $Size_{t-1}$, ROA_{t-1}, MB_{t-1}, Lev_{t-1}, $SALEG_{t-1}$, $CASH_{t-1}$, $RETAIN_{t-1}$, and Age_{t-1}) and industry fixed effects (2-digit SIC industry classification) using the logit model. Then we match each treated firms in 2012 to control firm without replacement based on the closest propensity score. Panel B tabulates the mean, variance, and skewness of firm characteristics for the treated and control firms of the entropy balanced sample. We balance treated and control firms for 2012 using the first two moments (i.e., the mean and variance) of all the firm-level control variables. Panel C shows regression results based on the propensity score matched and entropy balanced samples. In Panel C, columns (1) – (3) reports the result using PSM-matched sample and column (4) – (6) reports the result using entropy balanced sample. All the variables are defined in Appendix A. The standard errors are clustered by firms and t-statistics are provided in square brackets. ∗∗∗, ∗∗ and ∗indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Post-match diagnostic test

	(1) Treated group	(2) Control group	(3) Mean Difference	(4) p-value
$Size_{t-1}$	8.768	8.488	0.280	0.447
ROA_{t-1}	0.057	0.071	-0.014	0.544
MB_{t-1}	2.940	3.095	-0.155	0.804
Lev_{t-1}	0.217	0.180	0.037	0.330
$SALEG_{t-1}$	0.188	0.200	-0.012	0.868
$CASH_{t-1}$	0.170	0.243	-0.073	0.174
$RETAIN_{t-1}$	0.154	0.171	-0.017	0.910
Age_{t-1}	3.454	3.394	0.060	0.718

Panel B: Entropy balanced sample

	(1) Treated group		(2) Control group		(3) Difference	(4) Difference
	Mean	Variance	Mean	Variance	in Mean	in Variance
$Size_{t-1}$	9.137	2.680	9.135	3.126	0.002	-0.446
ROA_{t-1}	0.060	0.007	0.060	0.006	0.000	0.001
MB_{t-1}	3.472	11.100	3.471	10.180	0.001	0.920
Lev_{t-1}	0.247	0.030	0.246	0.025	0.001	0.005
$SALEG_{t-1}$	0.184	0.074	0.184	0.089	0.000	-0.015
$CASH_{t-1}$	0.176	0.033	0.176	0.030	0.000	0.003
$RETAIN_{t-1}$	0.127	0.281	0.127	0.858	0.000	-0.577
Age_{t-1}	3.511	0.561	3.511	0.420	0.000	0.141

Panel C: Regression results using PSM-matched and Entropy balanced samples						
	(1)	(2)	(3)	(4)	(5)	(6)
	Propensity Score matching			Entropy balancing		
	Full sample	heavy emitters	light emitters	Full sample	heavy emitters	light emitters
CA*Post	**0.678***	**0.307**	**1.024***	**0.746****	**0.136**	**1.224****
	(0.375)	**(0.323)**	**(0.523)**	**(0.335)**	**(0.288)**	**(0.492)**
$Size_{t-1}$	-0.050	0.032	-0.056	-0.045	0.074	-0.058
	(0.049)	(0.079)	(0.057)	(0.037)	(0.063)	(0.042)
ROA_{t-1}	5.991***	5.331***	5.724***	6.084***	4.904***	5.971***
	(0.752)	(1.089)	(0.837)	(0.624)	(0.945)	(0.680)
MB_{t-1}	0.154***	0.266***	0.145***	0.142***	0.219***	0.134***
	(0.023)	(0.067)	(0.024)	(0.017)	(0.038)	(0.018)
Lev_{t-1}	-1.611***	-1.883**	-1.687***	-1.490***	-2.163***	-1.457***
	(0.409)	(0.813)	(0.445)	(0.281)	(0.672)	(0.303)
$SALEG_{t-1}$	-1.320***	-0.546	-1.376***	-1.291***	-0.597**	-1.346***
	(0.159)	(0.330)	(0.180)	(0.123)	(0.264)	(0.139)
$CASH_{t-1}$	0.765	3.268**	0.867	1.182***	2.868**	1.324***
	(0.502)	(1.398)	(0.529)	(0.402)	(1.173)	(0.424)
$RETAIN_{t-1}$	0.094**	0.538***	0.079**	0.102***	0.584***	0.086**
	(0.038)	(0.171)	(0.040)	(0.037)	(0.161)	(0.038)
Age_{t-1}	0.525***	-0.164	0.682***	0.539***	-0.136	0.655***
	(0.104)	(0.165)	(0.116)	(0.077)	(0.147)	(0.085)
$GDPG_{t-1}$	2.639*	3.109	1.999	0.644	1.286	0.326
	(1.404)	(2.799)	(1.508)	(1.080)	(2.091)	(1.188)
$Unemplr_{t-1}$	-0.038	0.003	-0.037	-0.037	0.024	-0.037
	(0.038)	(0.063)	(0.043)	(0.028)	(0.054)	(0.032)
Constant	-2.768*	-2.309	-2.598	-0.929	-0.698	-0.946
	(1.527)	(2.874)	(1.690)	(1.201)	(2.242)	(1.341)
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	8,662	1,434	7,228	14,811	2,190	12,621
R-squared	0.171	0.254	0.171	0.164	0.223	0.165

Table 6 The effect of the California's cap-and-trade rule on cash dividends for period 2010-2015

The table reports the preliminary results of Eq. (1) using cash dividends (*DVC*) as dependent variable. The variable CA is an indicator variable equals to one if a firm has a present located in California, and zero otherwise. Post is a dummy variable set to one for 2013 and later, and zero otherwise. All the variables are defined in Appendix A. The standard errors are clustered by firms and t-statistics are provided in square brackets. ∗∗∗, ∗∗ and ∗indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)
CA*Post	**0.808***	**0.624***	**0.636***
	(0.416)	**(0.351)**	**(0.351)**
$Size_{t-1}$		-0.070*	-0.068*
		(0.037)	(0.037)
ROA_{t-1}		5.177***	5.169***
		(0.593)	(0.593)
MB_{t-1}		0.146***	0.146***
		(0.020)	(0.020)
Lev_{t-1}		-1.510***	-1.515***
		(0.286)	(0.286)
$SALEG_{t-1}$		-1.146***	-1.140***
		(0.148)	(0.148)
$CASH_{t-1}$		0.960***	1.001***
		(0.364)	(0.368)
$RETAIN_{t-1}$		0.138***	0.136***
		(0.036)	(0.036)
Age_{t-1}		0.512***	0.506***
		(0.065)	(0.064)
$GDPG_{t-1}$			1.691
			(1.256)
$Unemplr_{t-1}$			-0.017
			(0.026)
Constant	1.084***	-0.278	-1.775
	(0.063)	(0.256)	(1.335)
Industry FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	10,335	10,335	10,335
R-squared	0.006	0.125	0.126

Table 7 The impact the cap-and-trade rule on share repurchases and total payouts

The table reports the main results of Eq. (1) based on full sample and subsamples. The dependent variables are share repurchases (*REP*) and total payouts (*Total payouts*), respectively. The original value of these payout measures is multiplied by 100 to facilitate the interpretation of estimation results (Ni et al., 2020). All the variables are defined in Appendix A. The standard errors are clustered by firms and t-statistics are provided in square brackets. ***, ** and *indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
		Total payouts			REP	
	Full sample	heavy emitters	light emitters	Full sample	heavy emitters	light emitters
CA*Post	**0.101**	**-0.661**	**0.773**	**-0.665***	**-0.858****	**-0.443**
	(0.541)	**(0.436)**	**(0.853)**	**(0.354)**	**(0.363)**	**(0.546)**
$Size_{t-1}$	0.460***	0.489***	0.458***	0.538***	0.434***	0.551***
	(0.048)	(0.082)	(0.053)	(0.032)	(0.057)	(0.035)
ROA_{t-1}	13.732***	11.332***	13.613***	7.654***	5.564***	7.743***
	(0.800)	(1.678)	(0.857)	(0.505)	(0.881)	(0.544)
MB_{t-1}	0.290***	0.293***	0.296***	0.173***	0.116***	0.182***
	(0.023)	(0.050)	(0.025)	(0.020)	(0.034)	(0.021)
Lev_{t-1}	-4.078***	-3.750***	-4.259***	-2.750***	-1.637***	-2.949***
	(0.411)	(0.755)	(0.456)	(0.344)	(0.480)	(0.386)
$SALEG_{t-1}$	-2.493***	-1.304***	-2.673***	-1.410***	-0.926***	-1.538***
	(0.212)	(0.411)	(0.239)	(0.151)	(0.222)	(0.174)
$CASH_{t-1}$	4.160***	6.226***	4.094***	2.519***	2.650**	2.352***
	(0.547)	(1.512)	(0.576)	(0.385)	(1.029)	(0.416)
$RETAIN_{t-1}$	0.050	0.396**	0.036	-0.053	-0.033	-0.058
	(0.070)	(0.173)	(0.073)	(0.054)	(0.129)	(0.057)
Age_{t-1}	0.646***	-0.172	0.797***	0.097	-0.079	0.147*
	(0.092)	(0.174)	(0.105)	(0.069)	(0.115)	(0.079)
$GDPG_{t-1}$	-2.013	-0.638	-2.558	-2.620	-1.436	-2.974
	(1.985)	(3.323)	(2.255)	(1.688)	(2.535)	(1.931)
$Unemplr_{t-1}$	0.011	0.143*	-0.003	0.045	0.124**	0.033
	(0.044)	(0.082)	(0.048)	(0.034)	(0.057)	(0.039)
Constant	-0.772	-1.958	-0.383	-0.102	-1.884	0.360
	(2.119)	(3.784)	(2.399)	(1.757)	(2.836)	(2.003)
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	17,158	2,459	14,699	17,158	2,459	14,699
R-squared	0.228	0.228	0.230	0.163	0.147	0.165

Table 8 Financial constraints and payout policies respond to the cap-and-trade rule

The table reports results of the pooled triple-difference regressions by incorporating the measure of financial constraints (Kaplan-Zingales index). KZ index is computed following Kaplan & Zingales (1997) and Lamont et al. (2001). All the variables are defined in Appendix A. The standard errors are clustered by firms and t-statistics are provided in square brackets. ∗∗∗, ∗∗ and ∗indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Total payouts			DVC			REP	
	Full sample	heavy emitters	light emitters	Full sample	heavy emitters	light emitters	Full sample	heavy emitters	light emitters
CA*Post	-1.303***	-0.423	-1.603***	-0.057	0.081	-0.105	-1.494***	-0.592	-1.800***
	(0.388)	(0.430)	(0.605)	(0.069)	(0.125)	(0.091)	(0.371)	(0.373)	(0.597)
KZ*Post	-0.027***	-0.029***	-0.027***	-0.025***	-0.023***	-0.025***	0.001	-0.004**	0.001
	(0.001)	(0.002)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)
CA*KZ	-0.014***	0.000	-0.018***	-0.018***	-0.012***	-0.019***	0.003	0.009**	0.001
	(0.004)	(0.006)	(0.004)	(0.001)	(0.002)	(0.001)	(0.004)	(0.004)	(0.005)
CA*KZ*Post	**0.009***	**0.007**	**0.011***	**0.018***	**0.012***	**0.019***	**-0.013***	**-0.004**	**-0.013**
	(0.005)	**(0.008)**	**(0.005)**	**(0.001)**	**(0.002)**	**(0.001)**	**(0.005)**	**(0.006)**	**(0.006)**
$Size_{t-1}$	0.484***	0.426***	0.491***	-0.012	0.010	-0.014	0.531***	0.432***	0.542***
	(0.035)	(0.066)	(0.039)	(0.012)	(0.027)	(0.013)	(0.032)	(0.057)	(0.035)
ROA_{t-1}	9.382***	7.393***	9.419***	1.375***	1.904***	1.283***	7.453***	5.001***	7.579***
	(0.619)	(1.249)	(0.668)	(0.195)	(0.560)	(0.206)	(0.525)	(0.783)	(0.569)
MB_{t-1}	0.205***	0.154***	0.214***	0.031***	0.057***	0.030***	0.172***	0.097***	0.182***
	(0.022)	(0.043)	(0.024)	(0.004)	(0.016)	(0.004)	(0.021)	(0.033)	(0.022)
Lev_{t-1}	-3.133***	-2.205***	-3.339***	-0.403***	-0.841***	-0.380***	-2.793***	-1.387***	-3.016***
	(0.372)	(0.564)	(0.419)	(0.093)	(0.297)	(0.099)	(0.346)	(0.447)	(0.393)
$SALEG_{t-1}$	-1.672***	-0.898***	-1.853***	-0.232***	-0.153	-0.244***	-1.392***	-0.870***	-1.529***
	(0.185)	(0.343)	(0.212)	(0.051)	(0.161)	(0.054)	(0.155)	(0.215)	(0.181)
$CASH_{t-1}$	3.208***	3.946***	3.034***	0.385***	0.758	0.420***	2.343***	2.590**	2.151***
	(0.444)	(1.133)	(0.474)	(0.131)	(0.464)	(0.139)	(0.390)	(1.100)	(0.422)
$RETAIN_{t-1}$	0.013	0.015	0.011	0.036**	0.116**	0.035**	-0.016	-0.086	-0.017
	(0.066)	(0.145)	(0.070)	(0.014)	(0.055)	(0.015)	(0.059)	(0.126)	(0.062)
Age_{t-1}	0.187**	-0.177	0.282***	0.118***	-0.081	0.154***	0.099	-0.038	0.152*
	(0.075)	(0.134)	(0.087)	(0.022)	(0.063)	(0.024)	(0.069)	(0.113)	(0.080)
$GDPG_{t-1}$	-0.572	-2.941	-0.411	2.032***	0.416	2.299***	-2.411	-2.338	-2.660
	(1.812)	(2.884)	(2.066)	(0.606)	(1.595)	(0.659)	(1.695)	(2.468)	(1.942)
$Unemplr_{t-1}$	0.029	0.120*	0.016	-0.007	0.022	-0.010	0.041	0.102*	0.030
	(0.038)	(0.070)	(0.043)	(0.014)	(0.034)	(0.015)	(0.034)	(0.055)	(0.039)
Constant	-0.971	1.287	-1.141	-1.262**	0.797	-1.643**	-0.215	-0.874	0.139
	(1.874)	(3.123)	(2.130)	(0.596)	(1.508)	(0.653)	(1.762)	(2.766)	(2.012)
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Observations	15,921	2,404	13,517	16,588	2,463	14,125	15,921	2,404	13,517
R-squared	0.358	0.370	0.358	0.667	0.550	0.680	0.166	0.153	0.169

Table 9 The impact the cap-and-trade rule on cash holdings

The table reports the regression results based on full sample and subsamples. The dependent variable is cash holdings (CASH). Control variables contain firm size, firm age, market-to-book ratio, leverage, cash flow, sales growth, R&D, capital expenditures, ROA, state GDP growth and state unemployment rate. All the variables are defined in Appendix A. The standard errors are clustered by firms and t-statistics are provided in square brackets. ∗∗∗, ∗∗ and ∗indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)
	Full sample	heavy emitters	light emitters
CA*Post	**0.030****	**0.003**	**0.059*****
	(0.014)	**(0.011)**	**(0.020)**
Size	-0.002	-0.002	-0.002
	(0.001)	(0.002)	(0.002)
ROA	0.261***	0.122***	0.269***
	(0.027)	(0.046)	(0.029)
MB	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
LEV	-0.257***	-0.127***	-0.270***
	(0.014)	(0.030)	(0.016)
SALEG	0.019***	-0.025***	0.018***
	(0.004)	(0.008)	(0.004)
Age	-0.026***	-0.020***	-0.027***
	(0.004)	(0.006)	(0.004)
Flow	-0.427***	-0.144**	-0.440***
	(0.037)	(0.071)	(0.039)
Capex	-0.295***	-0.163**	-0.311***
	(0.049)	(0.081)	(0.059)
R&D	0.914***	1.227***	0.823***
	(0.051)	(0.231)	(0.053)
GDPG	-0.101	0.011	-0.101
	(0.066)	(0.074)	(0.075)
Unemplr	0.004***	-0.001	0.005***
	(0.001)	(0.002)	(0.002)
Constant	0.396***	0.222**	0.405***
	(0.073)	(0.093)	(0.083)
Industry FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	16,580	2,462	14,118
R-squared	0.338	0.204	0.315

Table 10 The effect of cap-and-trade rule on firm leverage

The table presents the impact of the cap-and-trade rule on leverage (LEV) controlling for one-year lagged firm size, ROA, market-to-book ratio, tangibility, cash holding, state GDP growth and state unemployment rate. All the variables are defined in Appendix A. The standard errors are clustered by firms and t-statistics are provided in square brackets. ∗∗∗, ∗∗ and ∗indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) Full sample	(2) heavy emitters	(3) light emitters
CA*Post	**0.004**	**-0.029**	**0.033**
	(0.018)	**(0.018)**	**(0.027)**
$Size_{t-1}$	0.024***	0.025***	0.024***
	(0.001)	(0.004)	(0.002)
ROA_{t-1}	-0.245***	-0.363***	-0.237***
	(0.016)	(0.056)	(0.016)
MB_{t-1}	0.008***	0.010***	0.008***
	(0.001)	(0.002)	(0.001)
$Tangibility_{t-1}$	0.105***	0.034	0.126***
	(0.023)	(0.037)	(0.027)
$CASH_{t-1}$	-0.325***	-0.334***	-0.318***
	(0.014)	(0.062)	(0.015)
$GDPG_{t-1}$	0.068	0.197	0.055
	(0.073)	(0.170)	(0.078)
$Unemplr_{t-1}$	0.000	0.003	-0.000
	(0.002)	(0.004)	(0.002)
Constant	-0.027	-0.172	-0.011
	(0.076)	(0.185)	(0.082)
Industry FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	17,833	2,514	15,319
R-squared	0.279	0.227	0.282

Table 11 The implementation of the cap-and-trade rule, innovation investment, capital expenditures and total investment

The table presents the impact of the cap-and-trade rule on innovation investment, capital expenditures and total investment controlling for firm size, ROA, market-to-book ratio, tangibility, cash holding, leverage, sales growth, retained earnings, firm age, state GDP growth and state unemployment rate. The innovation investment is proxied by the R&D investment, which is measured by R&D expenditures to total assets. All the variables are defined in Appendix A. The standard errors are clustered by firms and t-statistics are provided in square brackets. ∗∗∗, ∗∗ and ∗indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		R&D investment			capital expenditures			total investment	
	Full sample	heavy emitters	light emitters	Full sample	heavy emitters	light emitters	Full sample	heavy emitters	light emitters
CA*Post	**-0.009****	**-0.008*****	**-0.001**	**0.001**	**-0.003**	**0.002**	**-0.019**	**-0.057****	**-0.005**
	(0.004)	**(0.003)**	**(0.006)**	**(0.003)**	**(0.006)**	**(0.004)**	**(0.017)**	**(0.022)**	**(0.022)**
Size	0.002***	0.000	0.002***	-0.000	0.000	-0.000	0.004***	0.006	0.003**
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.002)	(0.006)	(0.002)
ROA	-0.134***	-0.010	-0.140***	0.008***	0.012	0.007**	-0.058**	0.031	-0.058**
	(0.013)	(0.012)	(0.013)	(0.003)	(0.013)	(0.003)	(0.025)	(0.073)	(0.025)
MB	0.000***	-0.000	0.000***	0.000	-0.000*	0.000	0.000	-0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CASH	0.131***	0.057**	0.121***	-0.026***	-0.053***	-0.022***	0.035*	0.169*	0.021
	(0.008)	(0.023)	(0.008)	(0.003)	(0.020)	(0.003)	(0.019)	(0.086)	(0.020)
LEV	-0.035***	-0.007	-0.037***	-0.003	-0.006	-0.005	0.071***	0.177***	0.072***
	(0.005)	(0.006)	(0.006)	(0.005)	(0.013)	(0.005)	(0.024)	(0.066)	(0.025)
SALEG	0.011***	0.003	0.009***	0.002**	0.012**	0.001*	0.167***	0.167***	0.166***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.006)	(0.001)	(0.043)	(0.038)	(0.044)
RETAIN	-0.006***	-0.012***	-0.006***	-0.000	0.001	0.000	-0.003	0.009	-0.003
	(0.002)	(0.004)	(0.002)	(0.000)	(0.002)	(0.000)	(0.002)	(0.007)	(0.002)
Age	-0.005***	0.003***	-0.005***	-0.005***	-0.008***	-0.005***	-0.029***	0.011	-0.030***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.005)	(0.015)	(0.005)
GDPG	-0.133***	-0.029*	-0.141***	0.035**	0.056	0.025	-0.093	-0.168	-0.100
	(0.027)	(0.017)	(0.030)	(0.018)	(0.051)	(0.019)	(0.105)	(0.299)	(0.110)
Unemplr	0.001**	0.000	0.001**	0.001***	0.001	0.001***	0.001	-0.014**	0.002
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.002)	(0.006)	(0.002)
Constant	0.143***	0.022	0.158***	0.009	0.019	0.017	0.256**	0.240	0.267**
	(0.031)	(0.019)	(0.035)	(0.019)	(0.059)	(0.020)	(0.116)	(0.308)	(0.121)
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	17,829	2,513	15,316	17,819	2,512	15,307	8,527	612	7,915
R-squared	0.367	0.251	0.341	0.039	0.077	0.034	0.087	0.129	0.085

Appendix A. Definitions of variables

Variable	Definition
Total payouts	Total payouts, the sum of cash dividends and share repurchases.
DVC	Cash dividends, the corporate annual cash dividends scaled by total assets.
REP	Share repurchases, the corporate annual net repurchase amount by subtracting any decrease in the value of the net number of preferred stocks outstanding from purchases of common and preferred stock, scaled by total assets.
CA	A dummy variable equals 1 if a firm has a plant located in California, and 0 otherwise.
Emitter	A dummy variable equals 1 if a firm belongs to one of following heavy emitting GICS industries: (1) Oil, Gas & Consumable Fuels; (2) Electric Utilities; (3) Gas Utilities; (4) Independent Power Producers & Energy Traders; (5) Multi-Utilities; (6) Chemicals; (7) Construction Materials; (8) Metals & Mining; and (9) Paper & Forest Products (CDP 2012) , and 0 otherwise.
Post	A dummy variable, which equals to 1 if firm i is observed in the post-cap-and-trade period 2013-2020, otherwise it is 0.
Size	Firm size, measured by natural logarithm of total assets.
Age	Firm age, calculated by natural logarithm of 1 plus the number of years since a firm first appeared in the Compustat.
ROA	Return on assets, the ratio of pre-tax earnings to total assets.
MB	Market-to-book ratio, measured by the market value of equity divided by book value of equity.
LEV	Leverage, measured by the debt to total asset ratio.
SALEG	Sales growth, the difference between the sales for the current fiscal year and the sales for the previous year divided by the sales for the previous year.
CASH	Cash holdings, the ratio of cash and cash equivalents to total assets.
REATIN	Retained earnings, the ratio of retained earnings to total assets.
R&D	The ratio of research and development expense to total assets. If the research and development expense is missing, then set R&D to zero.
Flow	Cash flow, measure by earnings before interest subtract interest, taxes, and common dividends, scaled by total assets.
Capex	Capital expenditure, the ratio of capital expenditures to total assets.
Invest	Total investment, the ratio of capital, research and development, advertising, and acquisition expenditures to one-year-lagged total assets.
KZ	Kaplan-Zingales index, measured following Kaplan & Zingales (1997) and Lamont et al. (2001):$KZ = -1.001909 \times Flow + 0.2826389 \times MB + 3.139193 \ * LEV - 39.3678 * DVC - 1.314759 * CASH$.
GDPG	State GDP growth, the annual GDP growth rate of a state over a fiscal year.
Unemplr	State unemployment rate, the unemployment rate of a state in a fiscal year