CARBON RISK AND DIVIDEND POLICY IN AN IMPUTATION TAX REGIME

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Justin Hung Nguyen & Balasingham Balachandran

Correspondence to: Justin Hung Nguyen
Email: justin.nguyen@vuw.ac.nz

Centre for Accounting, Governance and Taxation Research
School of Accounting and Commercial Law
Victoria University of Wellington
PO Box 600, Wellington, NEW ZEALAND

Tel: ***+ 64 4 463 5078***
Fax: ***+ 64 4 463 5076***
Website: ***http://www.victoria.ac.nz/sacl/cagtr/***

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Justin Hung Nguyen

School of Accounting and Commercial Law

Victoria University of Wellington, New Zealand

E: Justin.Nguyen@vuw.ac.nz | P: +64 4 463 5758

Balasingham Balachandran

Department of Economics and Finance

La Trobe University, Australia

E: B.Balachandran@latrobe.edu.au | P: +61 3 9479 3103

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Abstract

Australia ratified the Kyoto Protocol in December 2007, which mandates the country to reduce carbon emissions, thereby exogenously affecting firms in highest-emitting industries, or polluters. We examine the role of carbon risk in dividend policy and how this effect varies as between imputation (paying franked dividends) and classical (paying unfranked dividends) tax environments in the unique experimental setting in Australia. We find that the probability of paying dividend and dividend payout ratio are lower for polluters relative to non-polluters subsequent to the ratification. We further document that the post-Kyoto dividend reduction of polluters is driven by their relative increase in earnings uncertainty. However, the negative effect is weaker for firms that pay franked dividends than otherwise. The evidence suggests a causal influence of carbon risk on firm dividend policy, and highlights the significance of imputation tax environment on the impact of carbon risk on dividend policy

Keywords: Dividend policy; earnings uncertainty; carbon risk; imputation tax system; franked dividend

JEL classification: G35, Q51, Q58

1. Introduction

Dividend payout is among the most important corporate financial policies, through which a big fraction of a firm's generated cash flows is redistributed to shareholders, therefore being of central interests to both shareholders and managers (DeAngelo *et al.* 2009). Thus, a vast amount of the extant literature has been dedicated to identify the key determinants of dividend decisions (see e.g., (DeAngelo *et al.* 1992; La Porta *et al.* 2000; Fama & French 2001; Brav *et al.* 2005; DeAngelo *et al.* 2006; Denis & Osobov 2008; Chay & Suh 2009; John *et al.* 2011; Hoberg *et al.* 2014; Balachandran *et al.* 2017). While the effects of corporate financial and governance characteristics on dividend payments have been well documented, whether and how the increasing carbon risk faced by a firm shapes its dividend policy, and whether the tax environment moderates the possible impact are relatively less clear. In this paper, we address these important and interesting issues with an aim to extend the current understanding on the financial impact of carbon emissions that are reportedly the main cause of climate change, the global challenge of 21st century (Hoffmann & Busch 2008).

Our focus on carbon risk to explain dividend payouts is motivated by both evidence from the field and empirical research. First, Lintner (1956), Brav *et al.* (2005), and Brav *et al.* (2008) provide survey reports emphasizing that firm managers consider the stability in future earnings as the key factor to decide on dividend policy. These observations are subsequently supported by the internationally consistent evidence of Chay and Suh (2009) who demonstrate the role of cash-flow uncertainty in adversely driving dividend payments. Likewise, Hoberg *et al.* (2014) document that product market competitions negatively influence dividend payouts and attribute the effect to the relatively higher earnings uncertainty associated with firms that are more likely threatened by their product rivals. In short, an increase in earnings uncertainty is expected to lower dividend payouts.

Second, firms exposed to high levels of carbon risk are likely subject to higher earnings uncertainty. By definition, these are fossil fuel-intensive firms such as those in material, energy or utility sectors, whose future carbon performance is greatly unstable (i.e., as proxied by volatility in recorded carbon emissions), depending on various factors such as the stringency of carbon control regulations, the firms' degrees of policy compliance (Ramiah *et al.* 2013), or managers' views on the importance of carbon reduction (Busch & Hoffmann 2007; Hoffmann & Busch 2008; Oestreich & Tsiakas 2015). The uncertain future earnings for firms with high carbon risk may be attributed to their relatively higher operating and financing costs. In particular, the carbon-intensive firms likely incur more carbon-related management and accounting costs, clean-up costs, research and development (R&D) costs, compliance and litigation costs or reputation damage costs (Barth & McNichols 1994; Clarkson *et al.* 2004; Karpoff *et al.* 2005). In addition, the high-emitting firms may be subject to higher financing costs due to stricter views imposed by financing providers such as debt and equity holders (Matsumura *et al.* 2013; Jung *et al.* 2016).

It is challenging for those firms that operate in industries that in nature emit an enormous amount of carbon (e.g., metals and mining, oil and gas, chemicals, or paper and forest products) to reduce these carbon-related costs when they need to do so, such as during economic downturns. This attribute makes the carbon-related costs more fixed in nature for these firms, especially after the introduction of new stringent carbon control regulations. The increased fixed costs related to carbon risk management expose net incomes to more sources of instability such as economic conditions. The resultant carbon risk-induced earnings uncertainty may deteriorate managers' confidence in future prospects, rendering more cautious financial policies (i.e., lower dividend payouts).

The possible negative impact of carbon risk on dividend policy, however, may be attenuated for firms that follow the imputation than traditional tax systems. In the imputation tax framework, firms entitle their shareholders to a credit (also known as franking credit) for the corporate tax paid that can be subsequently offset against their own personal tax liabilities. The key benefit of this imputation tax environment is to avoid double taxation (i.e., corporate and personal income tax) on the dividend recipients (Cannavan *et al.* 2004). The recent evidence consistently shows that the imputation tax environment encourages firms to increase dividend payouts relative to the traditional tax system. For example, Pattenden and Twite (2008) document that all dividend initiations, dividend payouts and dividend reinvestment plans increase upon the introduction of dividend imputation. Furthermore, Balachandran *et al.* (2012) find that the negative market reaction to dividend reductions is stronger for firms that decrease franking credits. In addition, Balachandran *et al.* (2017) show that both the likelihood and level of dividend payouts are higher in an imputation tax environment, and that the impacts of profitability and earned/contributed capital mix on dividend decisions are weaker for firms following imputation compared to traditional tax systems. The role of tax framework in moderating the financial effect of carbon risk would, therefore, be of interests of not only policy-makers but also managers and shareholders given the rapid increase in the carbon risk for the foreseeable future.

Any attempts to investigate the financial impact of carbon risk and the possible moderating role of the tax system may be subject to at least three empirical challenges. The first challenge is endogeneity concerns because carbon risk and firm dividend policy may be jointly determined or correlated with other omitted firm characteristics (Al-Tuwaijri *et al.* 2004; Flammer 2015), which render the parameter estimates biased and inconsistent (Roberts & Whited 2012). The second challenge is the small sample bias due to a shortage of carbon risk data (e.g., greenhouse gas emissions or energy consumptions) (Konar & Cohen 2001) at the firm level, which would prevent researchers from drawing valid inference about the true nature of the population. Even if the emission data were available, they might measure current or past carbon performance, whereas carbon risk, which by definition is the uncertainty in future carbon performance, is forward-looking and, thus, hardly observable. The third challenge arises due to the fact that there are very few nations that allow both imputation and traditional tax systems to co-exist (i.e., firms are entitled to pay both franked and unfranked dividends to shareholders), which hinder examination on the moderating role of the tax environment in determining dividend policy (Cannavan *et al.* 2004; Pattenden & Twite 2008).

In this study, we propose a technique to tackle these three issues. First, to alleviate the endogeneity concerns we exploit the ratification of Kyoto Protocol in Australia as a source of experimental variation. The Protocol is an internationally binding agreement whereby participating countries commit to reduce carbon emissions to satisfy national reduction targets (UNEP 2006). In particular, following the Kyoto Protocol ratification, Australia is primarily required to restrict its average annual emissions over the 2008–2012 commitment period to eight percent above its 1990 level.[1] Moreover, the ratification was the first act of the former Prime Minister Kevin Rudd after being sworn in and widely regarded as the starting point of an era of stricter environmental regulations for Australia (Ramiah *et al.* 2013; Subramaniam *et al.* 2015). Without explicit economic objectives and political anticipations, the Kyoto ratification serves as an exogenous shock that affects firms in carbon-intensive industries, or polluters. Using this policy variation allows us to establish causal effects of carbon risk on dividend policy as well as other firm financial aspects.

Second, to address the small sample bias concern, we rely on the polluting nature of a firm's industry, that is, the relative industry-based level of carbon emissions and energy consumptions, to define polluters. Hence, any firms whose industry classifications are available

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[1] Source: http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/Browse_by_Topic/ClimateChangeold/governance/international/theKyoto

can be classified as either polluters or non-polluters. In addition, since a polluter is not defined by any of its financial characteristics including dividend policy, the use of polluter dummy variable in our analysis allows us to alleviate the concerns that a firm's dividend policy may reversely affect its carbon risk and carbon risk may be correlated with other control variables as documented by previous research (Krüger 2015). To account for a possibility that using industry-based classification of polluters and non-polluters may capture some unobserved industry characteristics, such as business risk, other than carbon risk, we control for industry fixed effects and other time-varying determinants of dividend policy in our model specifications. Collectively, this identification strategy allows us to capture carbon risk from its two main sources including the emitting nature of industries and the stringency of carbon policies (Ramiah *et al.* 2013).

Third, Australia is not only the most polluting country by greenhouse gas (GHG) emissions per capita in the Organization for Economic Co-operation and Development (OECD) group (Garnaut 2011), but also presents the unique tax setting to test our tax-related hypothesis. In particular, under the Australian imputation tax system, Australian companies pay dividends on profits that are earned and taxed in Australia (known as franked dividends) and provide shareholders resident in Australia with a credit for the corporate tax paid that can be subsequently offset against their own personal tax liabilities. Any dividends paid arising from the profits that are earned outside Australia, referred to as unfranked dividends, do not carry any tax credits and are taxed as ordinary income in the hands of investors in a similar fashion to the treatment in a traditional tax environment (Cannavan *et al.* 2004; Henry 2011; Balachandran *et al.* 2017). In sum, the novel Australian setting that has these two tax systems operating contemporaneously provide insights regarding the effect of carbon risk on dividend decisions and the possible heterogeneity in the effect between imputation (paying franked dividends) and classical (paying unfranked dividends) tax environments.

Adopting a difference-in-differences analysis framework, we document supporting evidence for our hypotheses. First, we find that, relative to control non-polluters, polluters reduce propensity to pay dividends as well as level of dividend payouts subsequent to the ratification of Kyoto Protocol in Australia. Second, we document one causal channel to explain the effect, that is earnings uncertainty. In particular, the polluters experience a relative increase in earnings uncertainty, as measured by logarithm transformation of standard deviation of annual return-on-assets ratio, while earnings uncertainty is significantly negatively associated with both decision to pay and payout ratio. Finally, we further find that the post-Kyoto relative reduction in polluters' dividend payments is weaker for firms that pay franked dividends as compared to those that do not do so.

We conduct several additional tests to address identification concerns and alternative measures of the main variables for robustness checks. First, our falsification test on the timing of Kyoto Protocol ratification suggests that the impact of carbon risk on dividend policy prevails only after the Kyoto Protocol ratification. The result is supportive of the notion that the Kyoto Protocol ratification was not fully anticipated nor our findings are driven by time trends. Second, we confirm that our main results are attributable to carbon risk rather than industry effects. In particular, we further develop two alternative measures based on firm-level carbon emissions and energy consumptions to better account for the cross-sectional variation in carbon risk, and find similar results to main ones. Third, we rule out the possibility that the Global Financial Crisis that commenced at the same time with the Australia's ratification of Kyoto Protocol may drive the main results. Finally, we replicate our analyses based on Australian data for United States (U.S.) that is the biggest nation by market capitalization but never adopted the Kyoto Protocol, and find no significant changes in the U.S. polluters' dividend policy after either 2005 or 2007. The out-of-sample test further confirms that the main results based on Australian data are driven by the nation's Kyoto Protocol ratification, rather than global trends in industry-specific attributes.

This paper contributes to the literature in several ways. First, we add to the debate on the financial effects of carbon performance/risk (Busch & Hoffmann 2007; Hoffmann & Busch 2008; Matsumura *et al.* 2013; Misani & Pogutz 2015; Oestreich & Tsiakas 2015; Nguyen 2017). Specifically, we show that the tightening in carbon controls results in a surge in firm instability about future earnings that subsequently leads to a decrease in dividend payouts. To the best of our knowledge, we are the first to relate carbon risk to this type of firm financial risk, that further unravel the channels of carbon-financial performance relations (Busch & Lewandowski 2017).

Second, the paper contributes to the broad literature on the determinants of firm dividend policy. Prior studies investigate how a firm's dividend payment can be explained by other firm financial characteristics such as size, profitability, growth opportunities (DeAngelo *et al.* 1992; Fama & French 2001; Denis & Osobov 2008), cash-flow uncertainty (Brav *et al.* 2005; Chay & Suh 2009), earned/contributed capital mix (DeAngelo *et al.* 2006), internal capital market (Gopalan *et al.* 2014), external financing conditions (Bliss *et al.* 2015), or stock liquidity (Jiang *et al.* 2017); and corporate governance attributes such as executive overconfidence/risk preference (Deshmukh *et al.* 2013; Caliskan & Doukas 2015) and incentives (De Cesari & Ozkan 2015), manager-investor information asymmetry/agency conflicts (La Porta *et al.* 2000; Hail *et al.* 2014; John *et al.* 2015), insider trading (Brockman *et al.* 2014), family control (Attig *et al.* 2016), or institutional ownership (Short *et al.* 2002).[2]

[2] Among a few exceptions, recently John *et al.* (2011) examine firm geography locations, Hoberg *et al.* (2014) investigate product market threats, and Huang *et al.* (2015) study political risk to explain dividend policy.

Our study moves forward by examining the effect of a non-financial factor that is carbon risk on corporate managers' decisions to pay dividends.

Our third contribution is to extend the line of literature on the tax clientele effects on dividend policy (Brown *et al.* 2007; Holmen *et al.* 2008; Korkeamaki *et al.* 2010; Desai & Jin 2011; Henry 2011; Alzahrani & Lasfer 2012; Hanlon & Hoopes 2014; Jacob & Michaely 2017; Li *et al.* 2017), especially the studies that look at how the imputation and traditional tax systems differ in shaping dividend policy using a unique institutional setting with both systems being concurrently present (Pattenden & Twite 2008; Balachandran *et al.* 2012; Balachandran *et al.* 2017). The prior studies document the relative importance of the imputation tax framework in encouraging firms' managers to increase dividend payouts. We are arguably the first to further show the role of imputation tax environment in attenuating the negative impact of carbon risk on dividend payments, that extend the mechanisms of the effect of imputation tax system on corporate dividend policy.

The remainder of the paper is organized as follows. Section 2 develops hypotheses. Section 3 describes data and summary statistics. Section 4 presents empirical methodology. Section 5 discusses empirical results and robustness tests. Section 6 concludes the paper.

2. Institutional background and hypothesis development

Our primary objective is to examine the effect of carbon risk on firm dividend policy, and the role of imputation tax system in moderating the effect. To capture carbon risk, we first classify sample firms into two groups, namely polluters and non-polluters, where polluters are defined to be exposed to higher carbon risk (see Section 3.1 for a detailed definition). For identification strategy, we split the sample period into two sub-periods using the ratification of Kyoto Protocol in December 2007 in Australia as the cut-off point. The policy ratification allows us to better compare the difference in dividend policy between polluters and non-polluters in the post-Kyoto relative to the pre-Kyoto periods. Australia also provide a unique tax environment where both imputation and traditional tax systems are fully permitted to co-exist. In this section, we first justify our choice of Australia over other countries and our selection of Kyoto Protocol ratification over other carbon policies, then develop testable hypotheses.

2.1. The ratification of Kyoto Protocol in Australia

Australia provides a novel setting to examine the linkage between carbon risk and corporate dividend policy for the following reasons. First, according to Climate Change Review Update 2011, Australia is the most polluting nation in the OECD group based on greenhouse gas emissions per capita (Garnaut 2011).[3] This fact gives rise to some unique characteristics of the carbon regulatory framework in Australia that have implications for Australian businesses. In particular, on the one hand, Australian policy-makers have enacted a large number of new and stringent carbon regulations with which firms have to comply. On the other hand, Australia has also been inconsistent in implementing the policies as evidenced by not only the uptake of the pollution reduction schemes but also the subsequent abolishment of some of the regulations. Secondly, Australia is among the top countries in the world with the highest awareness of carbon responsibilities by all types of market participants, such as banks, savers, investors, and business managers (Nguyen 2017).[4, 5]

[3] The Organisation for Economic Co-operation and Development (OECD) is an international organisation of countries with highly developed economies and democratic governments.

[4] The four major Australian banks (Big 4), which include the Australia and New Zealand Banking Group Limited (ANZ), the Commonwealth Bank of Australia (CBA), the National Australia Bank Limited (NAB) and Westpac Banking Corporation (Westpac) that account for more than 80% of the lending market, are signatories to the United Nations Environmental Programme (UNEP) Statement by Financial Institutions and the Equator Principles (EP) (UNEP 1997; IFC 2013).

[5] One notable recent example is the extensive protest involving the petition of over 100,000 Australians asking the CEOs of Australia's Big 4 banks to rule out financing the Abbot Point coal port expansion on the Great Barrier Reef. Financing for this project was refused by some of the world's biggest banks, such as HSBC, Deutsche Bank, The Royal Bank of Scotland, Barclays and Citibank because it is estimated that the project will triple Australia's carbon emissions, locking the country into at least 30 more years of coal-fired power.

In Australia, the ratification of Kyoto Protocol in December 2007 represents a dramatic shift in the stringency of carbon policies. It is because the Kyoto Protocol ratification was the first act of former Labor Prime Minister Kevin Rudd to fulfil his promises to protect the natural environment during his election campaign (Ramiah *et al.* 2013). The ratification marked an end to decades of Australia being criticized as a resource-based economy. Indeed, Australia and United States were the only two major industrialized countries that refused to ratify the Kyoto Protocol when it was first introduced in 1997, and Australia had not taken any decisive actions on cutting the national level of emissions prior to the Kyoto Protocol ratification (Subramaniam *et al.* 2015). By November 2007, whether Australia would ratify the Kyoto Protocol remained unclear and it all depended on which party was going to win the 2007 federal election. If the Liberal party of the then Prime Minister John Howard had won the election, the Protocol might not have been ratified and the Emission Trading Scheme would have been adopted instead.[6] Furthermore, the policy was solely aimed at reducing the Australia's GHG emission level to no more than eight percent above the 1990 levels for the commitment period 2008-2012. Without explicit economic purposes attached to the adoption of the Kyoto Protocol, the Australian government has shown its determination in joining the global efforts in protecting the environment as a top priority. The Kyoto Protocol ratification, therefore, came as an exogenous shock to firms in carbon-intensive industries, which had long been the main drivers of the Australian economy.

2.2. Carbon risk, earnings uncertainty and dividend policy

Fossil fuel-intensive firms such as those in material, energy or utility sectors are exposed to higher carbon risk that is by definition the instability in future carbon performance

[6] See the Prime Minister's address on June 3, 2007 to the Liberal Party Federal Council (source: http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22media%2Fpressrel%2FIU9N6%22).

(i.e., proxied by volatility in recorded carbon emissions) (Busch & Hoffmann 2007; Hoffmann & Busch 2008; Oestreich & Tsiakas 2015). This carbon risk is expected to be higher when new stringent carbon control regulations are introduced with a certain level of uncertainty in implementations (Ramiah *et al.* 2013).

Firms with high carbon risk may be subject to relatively higher operating and financing costs. In particular, the carbon-intensive firms likely incur more carbon-related management and accounting costs, clean-up costs, research and development (R&D) costs, compliance and litigation costs or reputation damage costs and so on (Barth & McNichols 1994; Clarkson *et al.* 2004; Karpoff *et al.* 2005). In addition, the high emitting firms may be subject to higher external financing costs due to stricter views imposed by financing providers such as debt and equity holders (Matsumura *et al.* 2013; Jung *et al.* 2016). It is challenging for the firms operating in industries that in nature emit enormous amounts of carbon to reduce carbon-related costs when they need to do so, such as during economic downturns. This attribute makes the carbon-related costs more fixed in nature for these firms, especially after the introduction of new stringent carbon policies, exposing net incomes to more sources of instability such as economic conditions. The carbon risk-induced earnings uncertainty may deteriorate managers' confidence in future prospects, rendering more cautious financial policies.

If carbon risk leads to a surge in earnings uncertainty, polluters' commitments to pay dividends are expected be weaker. The study by Lintner (1956) reports that firm managers identify future earnings stability as the main factor that influences their dividend decisions. The survey evidence in Brav *et al.* (2005); (Brav *et al.* 2008) further points out that more than two-thirds of the Chief Financial Officers perceive the stability of future incomes as a key determinant of dividend policy. Indeed, Chay and Suh (2009) provide direct empirical evidence on the negative association between cash-flow uncertainty and both propensity and level of dividend payouts. Hoberg *et al.* (2014) also imply that a firm's dividend decisions may be adversely affected by the incomes instability caused by product threats from its competitors. The managers, therefore, tend to avoid paying big amounts of dividends if future earnings are not guaranteed. We predict:

H1: Polluters decrease dividends relative to non-polluters subsequent to the Kyoto ratification.
H2: The post-Kyoto relative decrease in dividend payments of polluters is driven by their relative increase in earnings uncertainty.

2.3. Carbon risk, dividend franking and dividend policy

Under the Australian imputation tax system, Australian companies pay dividends on profits that are earned and taxed in Australia (known as franked dividends) and provide shareholders resident in Australia with a credit for the corporate tax paid that can be subsequently offset against their own personal tax liabilities. Any dividends paid arising from the profits that are earned outside Australia, referred to as unfranked dividends, do not carry any tax credits and are taxed as ordinary income in the hands of investors in a similar fashion to the treatment in a traditional tax environment (Cannavan *et al.* 2004; Henry 2011; Balachandran *et al.* 2017).

The recent evidence consistently shows that the imputation tax environment encourages firms to increase dividend payouts compared to the traditional tax system. For example, Pattenden and Twite (2008) document that all dividend initiations, dividend payouts and dividend reinvestment plans increase upon the introduction of dividend imputation. Furthermore, Balachandran *et al.* (2012) find that the negative market reaction to dividend reductions is stronger for firms that decrease franking credits. Recently, Balachandran *et al.* (2017) further show that both the likelihood and level of dividend payouts are higher in an imputation framework, and that the impacts of profitability and earned/contributed capital mix on dividend decisions are weaker for firms following imputation tax system compared to traditional tax system. We predict:

H3: The relative decrease in dividends of polluters is weaker for firms that pay franked dividends than otherwise.

3. Data and summary statistics

3.1. Polluters versus non-polluters

First, we classify a firm as either a polluter or a non-polluter based on the emitting nature of the industry in which the firm operates (Nguyen 2017). Polluters are defined as firms in those industries recognized as "carbon intensive", which include biggest greenhouse gas emitters or energy consumers. "Polluting" firms are more likely to face environmental issues (e.g., climate change) which may have negative financial effects in the form of carbon-related management and accounting costs, clean-up costs, R&D costs, compliance and litigation costs or reputation damage costs and so on (Barth & McNichols 1994; Clarkson *et al.* 2004; Karpoff *et al.* 2005). In addition, when carbon regulations become more stringent, the financial consequences are expected to be more severe for the polluters. This industry-based classification allows us to overcome the issues of measurement errors and small sample bias identified by previous studies (Konar & Cohen 2001).

The highest carbon-risk industries include those that reportedly emit the most greenhouse gas and/or consume the most energy as described by the Greenhouse Gas Protocol (GHG Protocol).[7, 8] Using a broad classification, among the 10 GICS sectors, three sectors including energy, utilities, and materials are recognized as the most GHG emitters. For

[7] Global Industry Classification Standard (GICS) is a joint Standard and Poor's and Morgan Stanley Capital International product aimed at standardising industry definition worldwide (source: http://www.asx.com.au/products/gics.htm).
[8] Source: http://www.ghgprotocol.org/

example, according to AMP Capital, energy, utility and materials are the largest contributors to ASX200 GHG emission intensity as of end of August 2015, accounting for 85% of total emissions.[9] With regard to GHG emission investment risk measured by carbon emission cost, which is equal to the estimated equity-based tonne of emissions times the assumed carbon price of AU$50/tonne CO2-e, the energy, materials and utilities sectors top the list, accounting for 33%, 21% and 19%, respectively, of the total carbon cost of the 10 GICS sectors in MSCI World Index (AMPCapital 2016).

To address a possible concern that some industries within these three sectors could be less emission intensive, we further follow the classification of the Carbon Disclosure Project to identify the most emitting industries within the energy, utilities and materials sectors.[10] To this end, firms in the following nine GICS industries are defined as polluters: (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).

3.2. Data and variables

Yearly cash dividend payments and other financial characteristics of all Australia Stock Exchange public companies from 2002 to 2013 are sourced from Morningstar DatAnalysis database. This sample period is a combination of two sub-periods including pre-Kyoto 2002-2007 and post-Kyoto 2008-2013. The post-Kyoto period is selected to correspond with the

[9] AMP Capital is a leading Australian investment house with AU$165.4 billion in funds under management. They were amongst the first to sign on to the Principles for Responsible Investment in 2007 and have broadly considered Environmental, Social and Corporate Governance issues in equity investment strategies and advices (source: https://www.ampcapital.com.au/about-us)

[10] Carbon Disclosure Project (CDP) represents US$100 trillion in assets to help reveal the risk, especially climate change risk, in their investment portfolios (source: https://www.cdp.net/en-US/Pages/About-Us.aspx). Prior studies are found to resort to CDP for data on carbon emissions, e.g., (Matsumura *et al.* 2013).

commitment period of Kyoto ratification by Australia government.[11] The pre-Kyoto is chosen to be comparable in length with the post-Kyoto period, that is six-year long each. However, for those variables that require historical data such as earnings uncertainty measures, we extend our data collection period to from 2000 to 2013.

Firms' GICS industries used to classify polluters and non-polluters are also extracted from Morningstar DatAnalysis. The main dependent variables capture dividend policy that consist of (i) probability to pay dividends (DIVDUM), and (ii) dividends-to-net-incomes ratio (DIVPAYOUT) (Chay & Suh 2009; John *et al.* 2011). Control variables are well-documented determinants of corporate dividend policy and all measured in lagged year, including lagged probability or level of dividend payouts (DIVDUML or DIVPAYOUTL) (Brav *et al.* 2008), franked dividend dummy (FRANKL) (Balachandran *et al.* 2017), log of total assets (SIZEL) (Fama & French 2001; DeAngelo *et al.* 2006), return-on-assets ratio (ROAL) (Denis & Osobov 2008), retained earnings-to-book value of equity ratio (RETAINL) (DeAngelo *et al.* 2006; Chay & Suh 2009), market-to-book value of total assets (TOBINQL) (Grullon & Michaely 2002; Hoberg *et al.* 2014), cash-to-total assets ratio (CASHL) (Fama & French 2001; DeAngelo *et al.* 2006; Brav *et al.* 2008), long-term debt-to-book value of equity ratio (LEVL), and fixed assets-to-total assets ratio (TANGL) (John *et al.* 2011). To minimize the impacts of outliers, we winsorize all continuous variables at the top and bottom one percentiles. Detailed definitions of the used variables can be found in Appendix A.

3.3. *Summary statistics and comparisons*

Table 1 reports summary statistics, *t* tests of mean differences, and Mann-Whitney (MW) tests of median differences in the main variables between polluters and non-polluters

[11] The original Kyoto commitment period in Australia is 2008-2012. We add 2013 to account for the fact that for some firms, the 2013 dividend policies are based on 2012 earnings. In an unreported analysis, we define post-Kyoto period as 2008-2012 and obtain similar results with the main findings.

for the whole sample period 2002-2013. Regarding dividend policy, only 11.4% of polluters pay dividends compared to 46.4% of non-polluters are payers. Similarly, dividend payout ratio is 6.5% for polluters while this ratio for non-polluters is 28.3%. Median values of these two dividend measures are zero since more than half of either polluters or non-polluters do not pay dividends. Moreover, 6.9% of polluters as opposed to 35.6% of non-polluters pay franked dividends in the lagged year. With regard to other characteristics, polluters are smaller in size, less profitable, have lower earned/contributed capital mix, higher growth opportunities, hold more cash, use lower financial leverage, and invest less in fixed assets. Except for the difference in mean TOBINQL that is significant at 10%, all other variables are different at less than 1% level between polluters and non-polluters.

[Insert Table 1 here]

4. Methodology

4.1. To test hypothesis 1

To examine the impact of carbon risk on dividend policy, we estimate baseline regression models are as follows:

$$Y_{it} = \alpha_0 + \alpha_1 POLLUTER_{it} + \sum_{j=2}^{n} \alpha_j CONTROL_{jit-1} + \epsilon_{it} \qquad (1)$$

$$Y_{it} = \beta_0 + \beta_1 POLLUTER_{it} + \beta_2 POST_{it} + \beta_3 POLLUTER_{it} * POST_{it} + \sum_{j=4}^{n} \beta_j CONTROL_{jit-1} + \epsilon_{it} \qquad (2)$$

$$Y_{it} = \gamma_0 + \gamma_1 POLLUTER_{it} * POST_{it} + \sum_{j=2}^{n} \gamma_j CONTROL_{jit-1} + \text{(Industry \& Year) FE} + \epsilon_{it} \qquad (3)$$

Where Y_{it} is either DIVDUM or DIVPAYOUT regarding firm i in year t. $POLLUTER_{it}$ is a dummy indicating whether firm i in year t is a polluter, $POST_{it}$ is a dummy indicating whether firm i in year t is observed in the post-Kyoto period. $POLLUTER_{it}*POST_{it}$ is an interaction term. $CONTROL_{jit-1}$ is control variable j of firm i in year t-1. For DIVDUM

(DIVPAYOUT) as the dependent variable, a list of standard control variables is specified, including DIVDUML (DIVPAYOUTL), FRANKL, SIZEL, ROAL, RETAINL, TOBINQL, CASHL, LEVL, and TANGL. All *t*-statistics use robust standard errors clustered by firm (John *et al.* 2011; Hoberg *et al.* 2014). All variables are defined in Appendix A.

In Equation 1, the coefficient of POLLUTER dummy, α_1, captures the mean difference in Y between polluters and non-polluters. For identification, we further include the POST dummy as well as the interaction term POLLUTER*POST to specify difference-in-differences models. In Equation 2, the coefficient of POLLUTER dummy, β_1, measures the mean difference in Y between polluters and non-polluters in the pre-Kyoto period, and the coefficient of POST dummy, β_2, captures the change in Y of non-polluters in the post- relative the pre-Kyoto period. Of interest in Equation 2 is the coefficient of the interaction term, β_3, which represents the change in Y of polluters relative to the change in Y of non-polluters subsequent to the ratification of Kyoto Protocol in Australia. A negative β_3 is consistent with the H1.

To control for any possibility that the POLLUTER dummy inadvertently captures industry characteristics other than carbon risk, we include GICS industry fixed effects in Equation 3. Moreover, as our sample period 2002-2013 covers a long time, we further include year fixed effects to control for macro-economic conditions that may affect the dependent variables Y. In the presence of industry and year fixed effects we do not include industry-based POLLUTER and year-based POST dummies as their explanatory powers over Y are absorbed by those fixed effects. Again, a negative γ_1 for dividend policy is consistent with the H1.

4.2. To test hypothesis 2

To identify the causal channel of the impact of carbon risk on dividend policy, we conduct the following mediating tests as in Baron and Kenny (1986) and Haveman *et al.* (2017) in two steps:

In the first step, we directly associate the carbon risk to earnings uncertainty by re-estimating Equations 1 to 3 with a measure of earnings uncertainty, ROAVOL, being the dependent variable. Control variables used in this step are similar to Equations 1 to 3 except that DIVDUML (or DIVPAYOUTL), and FRANKL are excluded when ROAVOL is the dependent variable. In the second step, we re-estimate Equations 1 to 3 with DIVDUM (or DIVPAYOUT) being the dependent variable and a further inclusion of ROAVOL as an additional independent variable.

For earnings uncertainty to be a causal channel, four conditions need to be satisfied, including (i) carbon risk upwardly drives earnings uncertainty (or coefficient of POLLUTER*POST is significantly positive in the first step), (ii) carbon risk negatively influences dividend policy (or H1 is supported), (iii) earnings uncertainty reversely affects dividend policy (or coefficient of ROAVOL is significantly negative in the second step), and (iv) the impact of carbon risk on dividend policy is significantly weaker when earnings uncertainty is further controlled for (or coefficient of POLLUTER*POST in the second step is significantly smaller (in absolute value) than that in the corresponding model that does not include ROAVOL). We will test all of these four conditions for H2.

4.3. To test hypothesis 3

To investigate the role of imputation tax system, we augment Equation 2 and 3 to specify triple-differences models as follows:[12]

[12] For H3, we opt for triple-differences models over splitting sample into franked and un-franked sub-groups due to two reasons. First, splitting sample will render the sub-samples very uneven with franked group being extremely smaller than un-franked group. Second, the franked group consists of dividend payers, that requires ordinary least square regressions, while un-franked group includes both payers and non-payers, that works well with tobit regressions. Even though in an unreported test, we find similar results when splitting sample with triple-differences analyses, the apparent differences in sample size and model type render the results relatively less meaningful.

$$Y_{it} = \beta_0 + \beta_1 POLLUTER_{it} + \beta_2 POST_{it} + \beta_3 POLLUTER_{it} * POST_{it} + \beta_4 POLLUTER_{it} * FRANKL_{it-1} + \beta_5 POST_{it} * FRANKL_{it-1} + \beta_6 POLLUTER_{it} * POST_{it} * FRANKL_{it-1} + \sum_{j=7}^{n} \beta_j CONTROL_{jit-1} + \epsilon_{it} \quad (4)$$

$$Y_{it} = \gamma_0 + \gamma_1 POLLUTER_{it} * POST_{it} + \gamma_2 POLLUTER_{it} * FRANKL_{it-1} + \gamma_3 POST_{it} * FRANKL_{it-1} + \gamma_4 POLLUTER_{it} * POST_{it} * FRANKL_{it-1} + \sum_{j=5}^{n} \gamma_j CONTROL_{jit-1} + \text{(Industry \& Year) FE} + \epsilon_{it} \quad (5)$$

Where, again Y_{it} is either DIVDUM or DIVPAYOUT regarding firm i in year t. $CONTROL_{jit-1}$ consist of the same control variables with Equations 2 and 3. The variable of interest in Equations 4 and 5 is the triple interaction term POLLUTER*POST*FRANKL that captures the difference in the impact of the double interaction term POLLUTER*POST on DIVDUM (or DIVPAYOUT) between firms that pay franked dividends and otherwise. A positive β_6 in Equation 4 (or γ_4 in Equation 5) is supportive of H3.

5. Empirical results

In this section, we report and interpret empirical results for our hypothesis tests. We start with H1 using propensity to pay dividends (DIVDUM) and dividend payout ratio (DIVPAYOUT) to proxy for dividend policy. We then test H3 by examining how the impact of carbon risk on dividend payouts differs between imputation and traditional tax systems. Next, we discuss our robustness checks. Finally, we test H2 using the log of standard deviation of five-year rolling ROA (ROAVOL) to characterize earnings uncertainty

5.1. Carbon risk and dividend policy

5.1.1. Univariate analysis results

Table 2 reports the univariate results for mean and median differences in the two main measures of dividend policy, including DIVDUM (Panel A) and DIVPAYOUT (Panel B). We observe two different trends in the dividend decisions of polluters and non-polluters following the Kyoto Protocol ratification. In particular, the results in Panel A and B shows that polluters significantly decrease both mean propensity and mean level of dividend payouts while non-polluters insignificantly change the two measures in the post-Kyoto period. For example, polluters significantly reduce the probability of paying dividends by 7.2% from 15.9% to 8.7%, and dividend payout ratio by 3.3% from 8.6% to 5.3% subsequent to the Kyoto Protocol ratification. Consequently, the gaps in both DIVDUM and DIVPAYOUT widen by 7.6% (from 30.3% to 37.9%) and 3.8% (from 19.5% to 23.3%) in absolute values after the Kyoto Protocol ratification, respectively. Similar patterns are observed using tests of median values of the two dividend payment proxies. In short, univariate analysis results are supportive of our H1 that polluters significantly decrease dividend payments relative to non-polluters subsequent to the Kyoto Protocol ratification.

[Insert Table 2 here]

5.1.2. Regression analysis results

Table 3 provides regression results using Equations 1 to 3. In Models 1 to 3 of Panel A, we estimate probit regressions since the dependent variable, DIVDUM, is a dummy variable indicating if a firm pays cash dividend in a particular year or not. In Models 1 to 3 of Panel B, we conduct tobit regressions with left limit being zero since the dependent variable, DIVPAYOUT, receives a big number of zero values associated with dividend non-paying firms. Our choice of model types are consistent with prior studies that employ the same measures of dividend policy (e.g., (Chay & Suh 2009; Balachandran *et al.* 2012).[13]

[Insert Table 3 here]

[13] We also conduct the analyses using logit or linear probability models for DIVDUM (Hoberg *et al.* 2014), and ordinary least square models for DIVPAYOUT (John *et al.* 2011) with standard errors being clustered by both firm and year. The results are qualitatively unchanged and can be provided upon request.

In Panel A, the negative coefficient of POLLUTER in Model 1 indicates that in general polluters are less likely to pay cash dividends relative to non-polluters. The difference is partially due to the lower propensity of paying dividends for polluters relative to non-polluters in the pre-Kyoto period, as shown by the negative coefficient of POLLUTER in Model 2. Even though non-polluters reduce their propensity of paying dividends subsequent to the Kyoto ratification, the reduction is significantly stronger for polluters as indicated by negative coefficients of POST and POLLUTER*POST in Model 2, respectively, leading to a bigger gap in the dividend paying probability between polluters and non-polluters in the post-Kyoto period. The observation that polluters reduce propensity to pay dividends more than non-polluters do is confirmed by the negative coefficient of POLLUTER*POST in Model 3 when both industry and year fixed effects are included. The results for the amount of dividend payments as proxied by DIVPAYOUT are quite similar as shown in Panel B, indicating that polluters pay less dividends and decrease dividend payouts at a higher pace relative to non-polluters after the ratification of the Kyoto Protocol. In sum, the observations in univariate analyses hold in the multivariate frameworks where other factors are controlled for, and that H1 is further confirmed.

Among control variables, DIVDUML (or DIVPAYOUTL), FRANKL, SIZEL, and ROAL seem to possess the most explanatory powers over DIVDUM (or DIVPAYOUT) and have predicted signs given the existing evidence. For example, the coefficients of DIVDUML (or DIVPAYOUTL) and FRANKL are highly significant and consistently positive, highlighting the importance of these two factors (historical dividends and imputation tax system) in determining dividend policy, especially in Australia context (Brav *et al.* 2008; Balachandran *et al.* 2012; Balachandran *et al.* 2017). Likewise, the coefficients of SIZEL and ROAL are positive suggesting that bigger and more profitable firms tend to pay higher dividends (Fama & French 2001; Denis & Osobov 2008).

5.2. Identification concerns and robustness checks

In this section we conduct a battery of robustness checks. First, we address the identification concerns about the possible anticipation of the Kyoto Protocol ratification in Australia and the industry-based definition of polluters may inadvertently capture industry effects. Second, we control for the possible confounding impact of the Global Financial Crisis. Finally, we conduct out-of-sample check using U.S. data.

5.2.1. Falsification test on the timing of the Kyoto Protocol ratification

The central assumption underlying our baseline difference-in-differences models is that absent the Kyoto Protocol ratification, polluters and non-polluters' dividend policy follows parallel trends, thus, there should be no significant change in the polluters' relative dividend payouts. However, this assumption might be invalid if polluters and non-polluters' dividend policies follow different trends and the polluters' relative dividend payouts still decrease even in the absence of the Kyoto Protocol ratification. Alternatively, it is possible that the ratification of Kyoto Protocol had been anticipated and firms in some industries might have adjusted their dividend policy well before the ratification.

In this section, we adopt the technique of falsification tests as suggested by Roberts and Whited (2012) to help further alleviate the possible endogeneity concerns and rule out time trends as a driver of our findings. In particular, we create three more year-based dummies, BEFORE^{-1y}, CURRENT^{0}, and AFTER^{1y+} that indicate year 2007, 2008 or 2009-onwards, respectively. We then include all the newly created dummies together with their interactions with the POLLUTER dummy and exclude the POLLUTER*POST from Equation 2. Similarly, for Equation 3 we include the three new interactions only in the specifications that control for industry and year fixed effects. If the change in the polluters' dividend payouts is due to time trend rather than the Kyoto Protocol ratification or in anticipation of the ratification, we expect significant and negative coefficients of POLLUTER*BEFORE^{-1y} interaction terms.

[Insert Table 4 here]

The results of these tests reported in Table 4 indicate that the coefficients of POLLUTER*BEFORE^{-1y}, are statistically insignificant in all regressions, suggesting that there was no trend in the relative decrease in polluters' dividend payouts before the Kyoto Protocol ratification. More importantly, the coefficients of the interactions POLLUTER*CURRENT^{0}, and POLLUTER*AFTER^{1y+} remain negative and highly significant, which indicate that the relative decrease in both propensity and level of dividend payouts of polluters only occurs after the actual Kyoto Protocol ratification. In short, the falsification test results rule out the possibility that our findings are driven by time trends or the anticipation of the Kyoto Protocol ratification.

5.2.2. Firm-based definitions of polluters and non-polluters

The use of industry-based classification of polluters and non-polluters in the main tests may raise a concern that the POLLUTER dummy variable simply captures the effects of industry characteristics rather than carbon risk in explaining dividend policy. Thus far, we have controlled for industry fixed effects in the regression models to validate this industry-level identification of polluters. Nonetheless, firm-based classifications of polluters and non-polluters may better account for the variation in the firm carbon risk. Therefore, in this section, we construct two additional firm-specific polluter dummy variables for this purpose.

The two dummy variables are based on firms' self-reported carbon emissions and energy consumptions following the standard literature in this field. The relevant data are published by the National Greenhouse and Energy Reporting (NGER) from 2008 onwards for a number of Australian organizations that meet a certain threshold of GHG emissions or energy consumptions, which are reset on a yearly basis.[14] Corporations or corporate groups listed by NGER are among the highest carbon emitting institutions in Australia (Subramaniam *et al.* 2015).

We match NGER data with other firm data from DatAnalysis database. The matching identifier is either a corporate name or Australia Business Number, depending on which one produces better matches. Because there is only a small group of sample firms published by NGER and a large portion of these organizations are not listed firms, this data search yields only 446 firm-year observations for the period 2008-2014 over which NGER data are available. We then compute the ratios of total emissions (scope 1 and scope 2) to sales and energy consumptions to sales, and create two new dummy variables including emission-based EMIPOLLUTER and energy-based ENEPOLLUTER. EMIPOLLUTER (ENEPOLLUTER) takes a value of 1 if a firm's emissions-to-sales (energy consumptions-to-sales) ratio in a given year is greater than respective sample median, and 0 otherwise.

[Insert Table 5 about here]

Table 5 reports the results of probit regressions of DIVDUM (Panel A) and tobit regressions of DIVPAYOUT (Panel B) on firm-based polluter dummy variables and other controls. Here we augment Equation 1 with POLLUTER being replaced by either EMIPOLLUTER (Model 1 without controls, and Model 2 with full controls) or ENEPOLLUTER (Model 4 without controls, and Model 5 with full controls). Furthermore, we also interact each of these two newly created polluter dummy variables with lagged franking dummy, FRANKL, and report regression results in Models 3 and 6. Since the data used to construct these two new dummy variables are only available from 2008, the regressions do not

[14] Source: http://www.cleanenergyregulator.gov.au/NGER

include the POST dummy variable. Moreover, we do not incorporate lagged dividend variables due to the fact the almost all sample firms have consistent dividend policy over a short sample period 2008-2014. Also, we do not control for industry fixed effects because a big number of firms are consistently classified as either polluters or non-polluters over time. However, we do include year fixed effects to control for time-varying macroeconomic conditions. Overall, the coefficients of these two firm-based polluter dummies are negative and significant (except for EMIPOLLUTER in Model 2 of Panel A after including all control variables), while the coefficients on the interaction terms are positive and significant, which are consistent with main results using industry-based definition of polluters.

5.2.3. Control for the Global Financial Crisis

We control for the Global Financial Crisis (GFC) time since a large number of firms adjust their dividend policy due to the changes in macro-economic as well as financing conditions during this period (Bliss *et al.* 2015). Australia also ratified the Kyoto Protocol at the onset of this crisis, that poses concerns about the possible contamination effect of the crisis on the actual effect of the policy change. In particular, we re-estimate Equations 2 and 3 with a further inclusion of an indicator GFC that indicates the crisis time, and an interaction POLLUTER*GFC. Since there is no consensus on the definition of the GFC period, especially in Australia, we adopt the two most generally accepted timespans including 2008-2009 (as indicated by GFC0809 dummy variable) and 2007-2009 (as indicated by GFC0709 dummy variable) to characterize the crisis.

We report the results of these tests in Table 6 for DIVDUM (Models 1 and 2) and DIVPAYOUT (Models 3 and 4) using GFC0809 in Panel A and GFC0709 in Panel B. The regression results show neither of GFC nor POLLUTER*GFC has statistically significant explanatory powers over dividend policy in all models. In other words, polluters do not significantly change their dividend policy relative to non-polluters during the Global Financial Crisis. Overall, these results rule out the possibility that potential confounding effects of the crisis that occurred in the post-Kyoto period explain our findings

[Insert Table 6 about here]

5.2.4. Out-of-sample test: U.S. polluters

We further address the possible concerns that the main results are simply driven by industry-specific trends or unique Australian institutional settings rather than a true effect of the Kyoto Protocol ratification on dividend policy. To do so, we need to identify an opposite case that satisfies two conditions, including (i) the underlying nation never adopted Kyoto Protocol, and (ii) the sample is large enough to draw statistically and economically meaning inferences. U.S. stands out as the best candidate for this exercise. First, U.S. is a major economy with the biggest number of public firms available for empirical research, hence having attracted an enormous amount of prior studies on corporate dividend policy (see DeAngelo *et al.* (2009) for a survey). Second, U.S. governments never ratified the Kyoto Protocol and in fact was together with Australia to be the only two developed economies that refused to adopt the Kyoto Protocol when it was first introduced in 1997 (Subramaniam *et al.* 2015). If the baseline results in Australia are due to global trends at industry level or some unique Australian institutional attributes other than carbon risk, then we should observe the same patterns in other countries such as U.S.

In this section, we employ U.S. data for our out-of-sample test. Specifically, we apply similar sample selection and methodology that we have used for Australian firms to the U.S. counterparts. We download necessary data on firm financial characteristics and GICS industry classifications for U.S. sample from Compustat database. We restrict the sample period to 2002 to 2013 to be consistent with that of Australia. We also define an U.S. firm-year as a polluter if it belongs to one of nine following GICS industries in that year: (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). Next, we create a dummy variable, POST07, for our analysis based on U.S. firms, that is exactly the same with the POST dummy used for Australia. In addition, we create another dummy variable, POST05, to indicate the period 2006-2013 over which the Kyoto Protocol has been internationally effective.

We then re-estimate Equations 2 and 3 for U.S. firms with POST being replaced by either POST05 or POST07. To be consistent with Australia-based analyses, we follow John *et al.* (2011) to define DIVDUM dummy variable as taking the value of one if a firm-year has positive cash dividends on common stock, and zero otherwise. Also, we define DIVPAYOUT variable as the ratio of cash dividends on common stock over net income, and set this ratio to one for payers with negative net incomes, or dividend payments greater than net incomes, to be comprable with that used for Australian firms. Note that for U.S. sample, we follow Hoberg *et al.* (2014) to exclude firms with book value of equity below 250,000 dollars or total assets below 500,000 dollars, and only include firms incorporated in the U.S. Moreover, variable FRANKL is omitted in these regressions due the fact that U.S. does not allow imputation tax system.

[Insert Table 7 here]

Table 7 reports results for this out-of-sample test. Similar to Australia-based analyses, Panel A presents probit regression results with DIVDUM being the dependent variable, and Panel B documents tobit regression results with DIVPAYOUT being the dependent variable. The variables of interest here are the interaction terms POLLUTER*POST05 and POLLUTER*POST07, that capture the relative change in the probability of paying dividend

(DIVDUM) and the change in dividend payout ratio (DIVPAYOUT) of U.S. polluters after year 2005 or 2007 compared to the previous periods, respectively. The statistically insignificant coefficients on these interaction terms across all estimated models suggest that there were no significant changes in the U.S. polluters' dividend policy relative to the U.S. control non-polluters after the Kyoto Protocol came into effect both internationally and in Australia. This evidence strengthens our conclusion that the main results observed in Australia are indeed attributed to its ratification of Kyoto Protocol in December 2007, other than a pure industry effect or simply an effect of the unique Australian settings.

5.3. Channel analysis: earnings uncertainty

Table 8 displays results of testing H2. Here, we measure earnings uncertainty, ROAVOL, by taking the logarithm transformation of the standard deviation of annual ROAs over five-year rolling window.[15] In Models 1 to 3 of Panel A, we estimate OLS regressions with ROAVOL being the dependent variable. In Models 4 and 5, we adopt probit regressions of DIVDUM using Equations 2 and 3 with an additional independent variable, ROAVOL, respectively. Similarly, in Models 6 and 7, we employ tobit regressions of DIVPAYOUT using Equations 2 and 3 with ROAVOL being further included, respectively. Panel B reports the chi-squared test of the difference in the coefficient of the interaction term POLLUTER*POST between each of Models 4 to 7 in Table 8 and its corresponding model reported in Table 3. The objective of these tests reported in Panel B is to compare the explanatory power of carbon risk on dividend policy between with and without controlling for earnings uncertainty.

[Insert Table 8 here]

[15] We take logarithm transformation to minimize the impact of skewness of standard deviation of annual ROAs. We also conduct analyses using alternative rolling windows of three and four years, and found similar results.

Overall, the evidence is supportive of H2 with four required conditions being satisfied. First, Models 1 to 3 in Table 8 show that in general polluters present higher earnings uncertainty, and relatively increase the level of earnings uncertainty after the Kyoto Protocol ratification compared to non-polluters, as evident in the positive coefficients of POLLUTER in Model 1, and POLLUTER*POST and Models 2 and 3, respectively. Second, as discussed above, the results reported in Table 3 suggest polluters significantly decrease both propensity and level of dividend payouts relative non-polluters in the post-Kyoto period. Third, Models 4 to 7 in Table 8 consistently show that ROAVOL is significantly negatively related to both propensity and level of dividend payments. Finally, chi-squared test results in Panel B in Table 8 indicate that the coefficient of POLLUTER*POST is significantly smaller (in absolute value) than that documented in Table 3 (without the inclusion of ROAVOL). In sum, the channel analyses reported in Table 8 are consistent with our hypotheses that carbon risk upwardly drives firm earnings uncertainty, which in turn renders managers adopting more caution financial policy, i.e. decrease in both probability to pay dividend and dividend payout ratio.

6. Conclusion

In this paper, we present evidence on the causal effect of carbon risk on firm dividend policy and the role of the tax system in moderating the effect. We do so by utilizing the unique Australia tax setting. First, Australia ratified the Kyoto Protocol in December 2007 that serves as a quasi-natural experiment for our identification strategy. The Protocol mandates Australia to reduce its greenhouse emissions to no greater than eight percent above the 1990 level over the 2008-2012 commitment period, therefore exogenously affecting firms in carbon intensive industries, or polluters. Second, Australia is among a few nations that has fully legalized a dual tax framework where imputation and tradition tax systems coexist. By classifying firms as franked dividend payers and otherwise, we are able to examine how the effect of carbon risk on dividend differs across tax systems. Finally, Australia is among the developed economies with highest level of carbon intensity as measured by greenhouse gas emissions per capita. This fact has attracted great attentions from both policy makers, companies and investors.

Using difference-in-differences specifications, we find the polluters decrease both propensity and level of dividend payouts relative to non-polluters subsequent to the Kyoto Protocol ratification. We further find that polluters relatively increase earnings uncertainty, and the post-Kyoto relative reduction in polluters' dividend payouts is driven by their relatively higher earnings uncertainty. These results provide evidence on the causal negative impact of carbon risk on earnings stability, which in turn leads to a decrease in dividend payouts.

Adopting a triple-differences framework, we further document that the post-Kyoto relative decrease in polluters' dividend payouts is weaker for firms that pay franked dividends as compared to otherwise. This evidence suggests that the negative effect of carbon risk on dividend policy is alleviated for firms that follow the imputation tax system as opposed to the traditional tax system. Overall, the study adds to the strands of literature on (i) the financial impact of carbon risk; (ii) the determinants of dividend policy, and (iii) effect of imputation tax environment on dividend policy.

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Appendix A
Variable Definitions

Variable abbreviation	Variable name	Definition
Main dependent variables		
DIVDUM	Current dividend dummy	Dummy variable that takes a value of 1 if the firm pays cash dividend in year t, and zero otherwise.
DIVPAYOUT	Current dividend payout ratio	Ratio of paid cash dividends over after-tax earnings in year t. Consistent with Holmen et al. (2008) and Balachandran et al. (2017), the payout ratio is set to one if (i) dividends are paid but after-tax earnings are negative, or (ii) dividends are larger than after-tax earnings.
Main independent variables		
POLLUTER	Current polluter dummy	Dummy variable that takes a value of 1 if the firm is classified into one of these nine 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). in year t, and zero otherwise.
POST	Post-Kyoto dummy	Dummy variable that takes a value of 1 if the firm is observed in year 2008 onwards, and zero otherwise.
POLLUTER*POST	Interaction term	Interaction term between POLLUTER dummy and POST dummy
Control variables		
DIVDUML	Lagged dividend dummy	Dummy variable that takes a value of 1 if the firm pays cash dividend in year t-1, and zero otherwise.
DIVPAYOUTL	Lagged dividend payout ratio	Payout ratio in year t-1
FRANKL	Lagged franked dividend dummy	Dummy variable that takes value of unity if the firm pays franked dividends in year t − 1, and zero otherwise.
SIZEL	Lagged firm size	Logarithm transformation of total assets in year t-1
ROAL	Lagged profitability	Ratio of pre-tax earnings over total assets in year t-1
RETAINL	Lagged retained/capital mix	Ratio of retained earnings over book value of equity in year t-1
TOBINQL	Lagged growth opportunities	Tobin's Q = (Total assets + market value of equity - book value of equity)/total assets in year t-1
CASHL	Lagged cash holdings	Ratio of cash balance over total assets in year t-1
LEVL	Lagged leverage	Ratio of long-term debt over book value of equity in year t-1
TANGL	Lagged tangibility	Ratio of net value of property, plant, and equipment over total assets in year t-1
ROAVOL	Earnings volatility	Logarithm transformation of standard diviation of yearly ROA (pre-tax earnings over total assets) over a five-year rolling window covering year t-4 to t
Other variables		
EMIPOLLUTER	Current carbon emission-based polluter dummy	Dummy variable that takes a value of 1 if the ratio of scope1&2 emissions over sales is greater than its sample median value, and 0 otherwise. Data of firms' emissions and energy consumptions are collected from NGER website for the period 2008-2014
EMIPOLLUTER	Current energy consumption-based polluter dummy	Dummy variable that takes a value of 1 if the ratio of energy consumption over sales is greater than its sample median value, and 0 otherwise. Data of firms' emissions and energy consumptions are collected from NGER website for the period 2008-2014

$BEFORE^{-1y}$	Year 2007 dummy	Dummy variable that takes a value of 1 if the firm is observed in year 2007, and zero otherwise.
$CURRENT^{0}$	Year 2008 dummy	Dummy variable that takes a value of 1 if the firm is observed in year 2008, and zero otherwise.
$AFTER^{1y+}$	Post-2008 dummy	Dummy variable that takes a value of 1 if the firm is observed in year 2009 onwards, and zero otherwise.
POST05	Post-2005 dummy	Dummy variable that takes a value of 1 if the firm is observed in year 2006 onwards, and zero otherwise.
POST07	Post-2007 dummy	Dummy variable that takes a value of 1 if the firm is observed in year 2008 onwards, and zero otherwise.
GFC0809	GFC 2008-09 dummy	Dummy variable that takes a value of 1 if the firm is observed in the Global Financial Crisis time 2008-09, and zero otherwise.
GFC0709	GFC 2007-09 dummy	Dummy variable that takes a value of 1 if the firm is observed in the Global Financial Crisis time 2007-09, and zero otherwise.

Table 1
Summary Statistics

This table presents descriptive statistics on key variables for polluters and non-polluters for the whole sample period 2002-2013. All data are sourced from Morningstar DatAnalysis database. An observation is required to be available for all variables reported in this table to be included in the sample. For each variable, we report mean and median, and t test of mean difference and Mann-Whitney (MW) test of median difference between polluters and non-polluters. Continuous variables are winsorized at 1st and 99th percentiles. We report detailed definitions of all variables in Appendix A. * and *** indicate significance at 10% and 1%, respectively.

Variable	Polluter (N=8,539)		Non-polluter (N=8,305)		*t* test	MW test
	Mean (1)	Median (2)	Mean (3)	Median (4)	(1) - (3)	(2) - (4)
DIVDUM	0.114	0.000	0.464	0.000	-54.40***	-50.17***
DIVPAYOUT	0.065	0.000	0.283	0.000	-47.75***	-49.82***
FRANKL	0.069	0.000	0.356	0.000	-48.81***	-45.69***
SIZEL	16.807	16.369	17.724	17.476	-26.74***	-29.41***
ROAL	-0.332	-0.115	-0.195	0.024	-11.43***	-36.92***
RETAINL	-0.375	-0.120	-0.258	0.015	-5.97***	-31.79***
TOBINQL	2.426	1.496	2.325	1.354	1.93*	5.26***
CASHL	0.309	0.216	0.210	0.102	24.34***	26.97***
LEVL	0.111	0.000	0.262	0.027	-19.66***	-40.11***
TANGL	0.168	0.028	0.178	0.092	-2.90***	-22.03***

Table 2
Univariate Analysis of Dividend Policy

This table presents descriptive statistics on key measures of dividend policy (DIVDUM in Panel A, and DIVPAYOUT in panel B) for polluters and non-polluters in the pre-Kyoto (2002-2007) and post-Kyoto (2008-2013) periods. All data are sourced from Morningstar DatAnalysis database. An observation is required to be available for all variables reported in Table 1 to be included in the sample. For each variable, we report mean and median, and t test of mean difference and Mann-Whitney (MW) test of median difference between polluters and non-polluters in the pre- and post-Kyoto periods. Continuous variables are winsorized at 1st and 99th percentiles. We report detailed definitions of all variables in Appendix A. *** indicates significance at 1%.

	Polluter		Non-polluter		*t* test (1) - (3)		MW test (2) - (4)	
	N_{pre} =3,225; N_{post}=5,314		N_{pre} =4,103; N_{post}= 4,202					
	Mean (1)	Median (2)	Mean (3)	Median (4)	Diff.	t stat.	Diff.	z stat.
Panel A: DIVDUM								
Pre-Kyoto	0.159	0.000	0.462	0.000	-0.303	-28.95***	0.000	-27.42***
Post-Kyoto	0.087	0.000	0.466	0.000	-0.379	-46.69***	0.000	-42.11***
Diff. (Post-Pre)	-0.072	0.000	0.004	0.000				
t (or z) stat.	-10.15***	-10.09***	0.35	0.35				
Panel B: DIVPAYOUT								
Pre-Kyoto	0.086	0.000	0.281	0.000	-0.195	-26.70***	0.000	-27.63***
Post-Kyoto	0.053	0.000	0.286	0.000	-0.233	-39.64***	0.000	-41.55***
Diff. (Post-Pre)	-0.033	0.000	0.004	0.000				
t (or z) stat.	-6.95***	-9.87***	0.55	0.48				

Table 3
Carbon Risk and Dividend Policy: Main Results

This table reports the results on the impact of carbon risk on dividend policy. Panel A presents the probit regression results on the impact of carbon risk on decision to pay. Panel B presents the tobit regression results on the impact of carbon risk on the determinants of dividend payout ratio. The t-statistics based on robust standard errors clustered by firm are reported in square brackets. Continuous variables are winsorized at 1st and 99th percentiles. We report detailed definitions of all variables in Appendix A. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	Panel A - Decision to Pay (Dep. Var. = DIVDUM)						
	1	2	3	4	5	6	7
POLLUTER	-0.596***	-0.470***		-0.479***		-0.472***	
	[-11.71]	[-7.44]		[-6.87]		[-7.51]	
POST		-0.168***		-0.130**		-0.166***	
		[-3.23]		[-2.21]		[-3.23]	
POLLUTER*POST		**-0.214*****	**-0.211*****	**-0.250*****	**-0.252*****	**-0.232*****	**-0.224*****
		[-2.73]	[-2.59]	[-2.85]	[-2.76]	[-2.88]	[-2.66]
POLLUTER*FRANKL				0.105	0.029		
				[0.45]	[0.13]		
POST*FRANKL				-0.145	-0.172		
				[-0.97]	[-1.23]		
POLLUTER*POST*FRANKL				**0.148**	**0.174**	**0.166**	**0.107**
				[0.48]	[0.59]	[0.80]	[0.55]
DIVDUML	1.594***	1.585***	1.458***	1.586***	1.458***	1.586***	1.458***
	[23.43]	[23.14]	[22.55]	[23.13]	[22.56]	[23.15]	[22.56]
FRANKL	1.471***	1.471***	1.508***	1.511***	1.571***	1.451***	1.494***
	[19.91]	[19.85]	[20.29]	[12.68]	[13.98]	[18.72]	[19.26]
SIZEL	0.228***	0.242***	0.274***	0.241***	0.273***	0.241***	0.274***
	[14.37]	[14.56]	[15.99]	[14.40]	[15.87]	[14.46]	[15.90]
ROAL	1.371***	1.357***	1.137***	1.355***	1.132***	1.358***	1.136***
	[3.34]	[3.30]	[3.08]	[3.30]	[3.07]	[3.30]	[3.08]
RETAINL	0.138	0.128	0.121	0.128	0.121	0.129	0.121
	[1.60]	[1.47]	[1.51]	[1.49]	[1.52]	[1.49]	[1.53]
TOBINQL	0.019*	0.019*	0.027***	0.020*	0.027***	0.020*	0.027***
	[1.85]	[1.89]	[2.77]	[1.91]	[2.79]	[1.91]	[2.81]
CASHL	0.097	0.126	0.225**	0.125	0.225**	0.121	0.222**
	[0.95]	[1.24]	[2.21]	[1.22]	[2.20]	[1.19]	[2.18]
LEVL	0.023	0.013	-0.062	0.014	-0.061	0.014	-0.061
	[0.54]	[0.28]	[-1.24]	[0.31]	[-1.23]	[0.31]	[-1.23]
TANGL	0.242**	0.199*	0.249**	0.200*	0.254**	0.198*	0.250**
	[2.37]	[1.93]	[2.35]	[1.95]	[2.39]	[1.93]	[2.35]
Constant	-5.359***	-5.525***	-6.555***	-5.513***	-6.552***	-5.505***	-6.545***
	[-19.08]	[-18.87]	[-16.91]	[-18.62]	[-16.87]	[-18.72]	[-16.84]
Industry FE	No	No	Yes	No	Yes	No	Yes
Year FE	No	No	Yes	No	Yes	No	Yes
Firm Cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,855	16,855	16,688	16,855	16,688	16,855	16,688
Pseudo R-squared	0.76	0.76	0.77	0.76	0.77	0.76	0.77

Panel B - Determinants of Payout ratio (Dep. Var. = DIVPAYOUT)							
	1	2	3	4	5	6	7
POLLUTER	-0.226***	-0.193***		-0.229***		-0.196***	
	[-11.25]	[-9.10]		[-7.40]		[-9.37]	
POST		-0.026**		-0.018		-0.025**	
		[-2.21]		[-0.80]		[-2.16]	
POLLUTER*POST		**-0.060****	**-0.058****	**-0.080****	**-0.083****	**-0.102*****	**-0.099*****
		[-2.44]	[-2.34]	[-2.19]	[-2.27]	[-3.55]	[-3.39]
POLLUTER*FRANKL				0.095**	0.075*		
				[2.33]	[1.68]		
POST*FRANKL				-0.012	-0.009		
				[-0.47]	[-0.34]		
POLLUTER*POST*FRANKL				**0.091****	**0.096****	**0.164*****	**0.149*****
				[1.96]	[1.99]	[4.23]	[3.57]
DIVPAYOUTL	0.638***	0.636***	0.566***	0.638***	0.568***	0.637***	0.567***
	[21.83]	[21.75]	[20.47]	[21.75]	[20.58]	[21.74]	[20.54]
FRANKL	0.403***	0.401***	0.409***	0.375***	0.385***	0.382***	0.392***
	[12.37]	[12.38]	[13.21]	[10.60]	[11.41]	[11.91]	[12.80]
SIZEL	0.064***	0.066***	0.073***	0.063***	0.071***	0.064***	0.071***
	[12.93]	[13.07]	[12.98]	[12.55]	[12.46]	[12.73]	[12.64]
ROAL	0.628***	0.625***	0.584***	0.625***	0.583***	0.625***	0.583***
	[2.96]	[2.95]	[2.89]	[2.99]	[2.91]	[2.97]	[2.90]
RETAINL	0.047	0.045	0.042	0.047	0.044	0.047	0.044
	[1.48]	[1.45]	[1.35]	[1.55]	[1.44]	[1.52]	[1.41]
TOBINQL	-0.004	-0.004	-0.004	-0.004	-0.003	-0.004	-0.003
	[-0.63]	[-0.62]	[-0.50]	[-0.59]	[-0.41]	[-0.59]	[-0.43]
CASHL	0.020	0.029	0.071**	0.027	0.070**	0.026	0.068**
	[0.61]	[0.88]	[2.15]	[0.83]	[2.11]	[0.78]	[2.07]
LEVL	0.013	0.012	-0.026*	0.014	-0.024	0.014	-0.024*
	[0.79]	[0.73]	[-1.76]	[0.88]	[-1.61]	[0.83]	[-1.65]
TANGL	0.134***	0.126***	0.148***	0.116***	0.138***	0.120***	0.142***
	[3.92]	[3.67]	[4.12]	[3.39]	[3.81]	[3.49]	[3.92]
Constant	-1.485***	-1.497***	-1.675***	-1.441***	-1.645***	-1.459***	-1.652***
	[-14.64]	[-14.53]	[-8.64]	[-13.62]	[-8.43]	[-14.05]	[-8.51]
Industry FE	No	No	Yes	No	Yes	No	Yes
Year FE	No	No	Yes	No	Yes	No	Yes
Firm Cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,833	16,833	16,795	16,833	16,795	16,834	16,796
Pseudo R-squared	0.61	0.61	0.63	0.62	0.63	0.62	0.63

Table 4
Falsification Test on the Timing of Australia's Ratification of Kyoto Protocol

This table presents falsification tests on the timing of the Kyoto Protocol ratification. $BEFORE^{-1y}$, $CURRENT^{0}$, and $AFTER^{1y+}$ are year dummy variables indicating year 2007 on not, 2008 or not, and 2009 onwards or not. Models 1 and 2 use probit regressions, while Models 3 and 4 use tobit regressions. Industry and year fixed effects are included in Models 2 and 4. The t-statistics based on robust standard errors clustered by firm are reported in square brackets. Continuous variables are winsorized at 1st and 99th percentiles. We report detailed definitions of all variables in Appendix A. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	Decision to Pay (Dep. Var. = DIVDUM)		Determinants of Payout ratio (Dep. Var. = DIVPAYOUT)	
	1	2	3	4
POLLUTER	-0.460***		-0.190***	
	[-7.09]		[-8.86]	
$BEFORE^{-1y}$	0.016		-0.018	
	[0.16]		[-0.93]	
$CURRENT^{0}$	-0.034		0.021	
	[-0.34]		[1.01]	
$AFTER^{1y+}$	-0.194***		-0.040***	
	[-3.40]		[-3.07]	
POLLUTER*$BEFORE^{-1y}$	**-0.056**	**-0.021**	**-0.013**	**-0.006**
	[-0.38]	[-0.14]	[-0.36]	[-0.17]
POLLUTER*$CURRENT^{0}$	**-0.292****	**-0.274****	**-0.093****	**-0.088****
	[-2.17]	[-1.98]	[-2.48]	[-2.34]
POLLUTER*$AFTER^{1y+}$	**-0.207****	**-0.203****	**-0.056****	**-0.054****
	[-2.40]	[-2.24]	[-2.08]	[-1.96]
DIVDUML	1.584***	1.458***		
	[23.08]	[22.53]		
DIVPAYOUTL			0.637***	0.566***
			[21.77]	[20.47]
FRANKL	1.472***	1.508***	0.400***	0.409***
	[19.81]	[20.27]	[12.40]	[13.21]
SIZEL	0.243***	0.274***	0.066***	0.073***
	[14.45]	[15.97]	[13.07]	[12.97]
ROAL	1.357***	1.137***	0.626***	0.584***
	[3.30]	[3.09]	[2.96]	[2.89]
RETAINL	0.128	0.121	0.046	0.043
	[1.47]	[1.52]	[1.45]	[1.36]
TOBINQL	0.017	0.027***	-0.005	-0.004
	[1.63]	[2.80]	[-0.76]	[-0.50]
CASHL	0.125	0.225**	0.031	0.071**
	[1.23]	[2.21]	[0.94]	[2.16]
LEVL	0.011	-0.062	0.011	-0.026*
	[0.24]	[-1.24]	[0.69]	[-1.75]
TANGL	0.197*	0.248**	0.125***	0.148***
	[1.91]	[2.34]	[3.63]	[4.11]
Constant	-5.535***	-6.558***	-1.494***	-1.675***
	[-18.83]	[-16.86]	[-14.52]	[-8.63]
Industry FE	No	Yes	No	Yes
Year FE	No	Yes	No	Yes
Firm Cluster	Yes	Yes	Yes	Yes
Observations	16,855	16,688	16,834	16,796
Pseudo R-squared	0.76	0.77	0.61	0.63

Table 5
Firm-based Definitions of Polluters

This table reports the results on the impact of carbon risk on dividend policy, using firm-based definitions of polluters. Panel A presents the probit regression results on the impact of carbon risk on decision to pay. Panel B presents the tobit regression results on the impact of carbon risk on the determinants of dividend payout ratio. The t-statistics based on robust standard errors are reported in square brackets. Continuous variables are winsorized at 1st and 99th percentiles. We report detailed definitions of all variables in Appendix A. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Panel A - Decision to Pay (Dep. Var. = DIVDUM)						
	1	2	3	4	5	6
EMIPOLLUTER	**-0.810*****	**-0.072**	**-0.345**			
	[-5.77]	[-0.32]	[-1.42]			
EMIPOLLUTER*FRANKL			**1.022****			
			[2.33]			
ENEPOLLUTER				**-0.838*****	**-0.468****	**-0.747*****
				[-5.92]	[-2.11]	[-3.28]
ENEPOLLUTER*FRANKL						**1.041****
						[2.25]
FRANKL		1.517***	1.022***		1.528***	0.915***
		[5.82]	[3.05]		[5.47]	[2.64]
SIZEL		0.539***	0.573***		0.529***	0.554***
		[5.77]	[6.27]		[5.71]	[5.84]
ROAL		3.916**	3.825**		3.534**	3.499**
		[2.23]	[2.16]		[2.24]	[2.10]
RETAINL		-0.123	-0.131		-0.129	-0.142
		[-0.97]	[-1.04]		[-1.10]	[-1.18]
TOBINQL		-0.011	0		0.002	0.027
		[-0.09]	[0.00]		[0.02]	[0.24]
CASHL		-2.109**	-2.249**		-1.559*	-1.598*
		[-2.45]	[-2.56]		[-1.75]	[-1.76]
LEVL		0.046	0.043		0.004	-0.019
		[0.33]	[0.31]		[0.03]	[-0.14]
TANGL		-1.697***	-1.742***		-1.561***	-1.654***
		[-3.55]	[-3.56]		[-3.34]	[-3.45]
Constant	1.136***	-10.304***	-10.821***	1.142***	-9.968***	-10.281***
	[6.01]	[-5.19]	[-5.47]	[6.05]	[-5.09]	[-5.04]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	456	446	446	454	444	444
Pseudo R-squared	0.076	0.53	0.54	0.08	0.54	0.55

Panel B - Determinants of Payout ratio (Dep. Var. = DIVPAYOUT)						
	7	8	9	10	11	12
EMIPOLLUTER	**-0.229*** **	**-0.074* **	**-0.217*** **			
	[-5.82]	[-1.77]	[-2.83]			
EMIPOLLUTER*FRANKL			**0.223*** **			
			[2.64]			
ENEPOLLUTER				**-0.258*** **	**-0.146*** **	**-0.332*** **
				[-6.65]	[-3.73]	[-4.67]
ENEPOLLUTER*FRANKL						**0.295*** **
						[3.71]
FRANKL		0.270***	0.151**		0.277***	0.126**
		[6.05]	[2.41]		[6.39]	[2.23]
SIZEL		0.048***	0.046***		0.047***	0.046***
		[3.75]	[3.65]		[3.67]	[3.65]
ROAL		1.022**	0.964**		0.914**	0.875**
		[2.37]	[2.19]		[2.15]	[1.98]
RETAINL		-0.043	-0.042		-0.044	-0.052
		[-0.65]	[-0.64]		[-0.70]	[-0.83]
TOBINQL		-0.096***	-0.090***		-0.095***	-0.082***
		[-3.49]	[-3.26]		[-3.49]	[-2.99]
CASHL		-0.239	-0.261		-0.133	-0.121
		[-1.26]	[-1.39]		[-0.71]	[-0.67]
LEVL		0.048	0.059		0.03	0.027
		[1.12]	[1.35]		[0.74]	[0.72]
TANGL		-0.223**	-0.230**		-0.166*	-0.186*
		[-2.34]	[-2.43]		[-1.75]	[-1.95]
Constant	0.509***	-0.594**	-0.470	0.519***	-0.571**	-0.435
	[9.53]	[-2.10]	[-1.62]	[9.81]	[-2.00]	[-1.52]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	456	446	446	454	444	444
Pseudo R-squared	0.07	0.30	0.32	0.08	0.32	0.35

Table 6
Control for the Global Financial Crisis

This table reports the results on the impact of carbon risk on dividend policy, after controlling for the Global Financial Crisis (GFC) period. We adopt two definitions of GFC time, including 2008-2009 period (Panel A) or 2007-2009 period (Panel B). Models 1 and 2 use probit and Models 3 and 4 use tobit regressions. Industry and year fixed effects are included in Models 2 and 4. The t-statistics based on robust standard errors clustered by firm are reported in square brackets. Continuous variables are winsorized at 1st and 99th percentiles. We report detailed definitions of all variables in Appendix A. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Panel A - Global Financial Crisis 2008-2009				
	Decision to Pay (Dep. Var. = DIVDUM)		Determinants of Payout ratio (Dep. Var. = DIVPAYOUT)	
	1	2	3	4
POLLUTER	-0.470***		-0.193***	
	[-7.44]		[-9.10]	
POST	-0.165***		-0.033**	
	[-2.93]		[-2.55]	
POLLUTER*POST	**-0.211****	**-0.210****	**-0.061****	**-0.060****
	[-2.45]	[-2.32]	[-2.25]	[-2.15]
POLLUTER*GFC0809	**-0.009**	**-0.003**	**0.004**	**0.004**
	[-0.08]	[-0.02]	[0.15]	[0.13]
GFC0809	-0.008		0.018	
	[-0.10]		[1.25]	
DIVDUML	1.586***	1.458***		
	[23.10]	[22.54]		
DIVPAYOUTL			0.636***	0.566***
			[21.76]	[20.48]
FRANKL	1.471***	1.508***	0.400***	0.409***
	[19.86]	[20.31]	[12.39]	[13.21]
SIZEL	0.242***	0.274***	0.066***	0.073***
	[14.52]	[15.99]	[13.06]	[12.98]
ROAL	1.357***	1.137***	0.625***	0.584***
	[3.30]	[3.08]	[2.95]	[2.89]
RETAINL	0.128	0.121	0.045	0.042
	[1.48]	[1.51]	[1.44]	[1.35]
TOBINQL	0.020*	0.027***	-0.005	-0.004
	[1.90]	[2.77]	[-0.68]	[-0.50]
CASHL	0.126	0.225**	0.030	0.071**
	[1.24]	[2.21]	[0.89]	[2.15]
LEVL	0.013	-0.062	0.011	-0.026*
	[0.30]	[-1.24]	[0.68]	[-1.76]
TANGL	0.198*	0.249**	0.127***	0.148***
	[1.93]	[2.36]	[3.68]	[4.12]
Constant	-5.524***	-6.555***	-1.498***	-1.675***
	[-18.85]	[-16.91]	[-14.54]	[-8.64]
Industry FE	No	Yes	No	Yes
Year FE	No	Yes	No	Yes
Firm Cluster	Yes	Yes	Yes	Yes
Observations	16,855	16,688	16,834	16,796
Pseudo R-squared	0.76	0.77	0.61	0.63

Panel B - Global Financial Crisis 2007-2009				
	Decision to Pay (Dep. Var. = DIVDUM)		Determinants of Payout ratio (Dep. Var. = DIVPAYOUT)	
	1	2	3	4
POLLUTER	-0.465***		-0.193***	
	[-7.24]		[-9.04]	
POST	-0.168***		-0.027**	
	[-3.18]		[-2.27]	
POLLUTER*POST	**-0.210*****	**-0.210****	**-0.060****	**-0.058****
	[-2.64]	[-2.54]	[-2.41]	[-2.30]
POLLUTER*GFC0709	**-0.027**	**-0.010**	**-0.002**	**0.000**
	[-0.30]	[-0.11]	[-0.07]	[0.01]
GFC0709	0.001		0.004	
	[0.01]		[0.36]	
DIVDUML	1.586***	1.458***		
	[23.15]	[22.55]		
DIVPAYOUTL			0.636***	0.566***
			[21.77]	[20.48]
FRANKL	1.471***	1.508***	0.401***	0.409***
	[19.86]	[20.30]	[12.39]	[13.21]
SIZEL	0.242***	0.274***	0.066***	0.073***
	[14.56]	[15.98]	[13.06]	[12.98]
ROAL	1.356***	1.137***	0.625***	0.584***
	[3.30]	[3.08]	[2.95]	[2.89]
RETAINL	0.128	0.121	0.045	0.042
	[1.48]	[1.51]	[1.45]	[1.35]
TOBINQL	0.020*	0.027***	-0.005	-0.004
	[1.93]	[2.79]	[-0.64]	[-0.50]
CASHL	0.126	0.225**	0.029	0.071**
	[1.24]	[2.21]	[0.88]	[2.15]
LEVL	0.013	-0.062	0.012	-0.026*
	[0.30]	[-1.24]	[0.71]	[-1.76]
TANGL	0.198*	0.249**	0.126***	0.148***
	[1.93]	[2.36]	[3.67]	[4.12]
Constant	-5.526***	-6.556***	-1.498***	-1.675***
	[-18.86]	[-16.88]	[-14.50]	[-8.63]
Industry FE	No	Yes	No	Yes
Year FE	No	Yes	No	Yes
Firm Cluster	Yes	Yes	Yes	Yes
Observations	16,855	16,688	16,834	16,796
Pseudo R-squared	0.76	0.77	0.61	0.63

Table 7
Out of Sample Test: U.S. Polluters

This table reports the results on the impact of carbon risk on dividend policy, using U.S. data. Panel A presents the probit regression results on the impact of carbon risk on decision to pay. Panel B presents the tobit regression results on the impact of carbon risk on the determinants of dividend payout ratio. The t-statistics based on robust standard errors clustered by firm are reported in square brackets. Continuous variables are winsorized at 1st and 99th percentiles. We report detailed definitions of all variables in Appendix A. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Panel A - Decision to Pay (Dep. Var. = DIVDUM)				
	1	2	3	4
POLLUTER	0.106**		0.142***	
	[2.21]		[3.63]	
POST05	-0.108***			
	[-6.22]			
POLLUTER*POST05	**0.066**	**0.070**		
	[1.16]	[1.23]		
POST07			-0.113***	
			[-6.58]	
POLLUTER*POST07			**0.014**	**0.028**
			[0.29]	[0.57]
DIVDUML	3.047***	2.982***	3.046***	2.982***
	[134.36]	[121.09]	[134.44]	[121.13]
SIZEL	0.132***	0.139***	0.133***	0.139***
	[25.78]	[23.42]	[25.76]	[23.41]
ROAL	0.625***	0.554***	0.622***	0.554***
	[3.66]	[3.09]	[3.65]	[3.09]
RETAINL	0.006***	0.005***	0.006***	0.005***
	[4.21]	[3.21]	[4.20]	[3.22]
TOBINQL	0.007**	0.009***	0.007**	0.009***
	[2.31]	[3.37]	[2.11]	[3.37]
CASHL	-0.232***	0.289***	-0.222***	0.290***
	[-3.47]	[4.03]	[-3.30]	[4.04]
LEVL	-0.012**	-0.021***	-0.012**	-0.021***
	[-2.12]	[-3.61]	[-2.11]	[-3.62]
TANGL	-0.234***	-0.033	-0.229***	-0.032
	[-5.53]	[-0.57]	[-5.41]	[-0.56]
Constant	-2.354***	-2.951***	-2.376***	-2.956***
	[-63.79]	[-33.29]	[-65.31]	[-33.32]
Industry FE	No	Yes	No	Yes
Year FE	No	Yes	No	Yes
Firm Cluster	Yes	Yes	Yes	Yes
Observations	68,744	68,744	68,744	68,744
Pseudo R-squared	0.74	0.75	0.74	0.75

Panel B - Determinants of Payout ratio (Dep. Var. = DIVPAYOUT)				
	1	2	3	4
POLLUTER	0.062***		0.054***	
	[4.74]		[4.61]	
POST05	0.010**			
	[2.04]			
POLLUTER*POST05	**-0.004**	**-0.017**		
	[-0.30]	[-1.38]		
POST07			-0.009*	
			[-1.87]	
POLLUTER*POST07			**0.013**	**0.004**
			[1.17]	[0.37]
DIVPAYOUTL	1.109***	1.015***	1.111***	1.016***
	[105.87]	[92.73]	[105.89]	[92.91]
SIZEL	0.064***	0.062***	0.065***	0.062***
	[28.24]	[25.14]	[28.18]	[25.11]
ROAL	0.445***	0.451***	0.446***	0.451***
	[3.65]	[3.38]	[3.65]	[3.38]
RETAINL	0.004***	0.003***	0.004***	0.003***
	[7.79]	[5.37]	[7.74]	[5.37]
TOBINQL	0.003	0.005***	0.003	0.005***
	[1.55]	[3.66]	[1.53]	[3.64]
CASHL	-0.335***	0.081***	-0.330***	0.081***
	[-11.63]	[2.89]	[-11.44]	[2.88]
LEVL	-0.002	-0.009***	-0.003	-0.009***
	[-1.52]	[-5.26]	[-1.58]	[-5.25]
TANGL	-0.172***	0.010	-0.173***	0.009
	[-9.64]	[0.45]	[-9.69]	[0.42]
Constant	-0.700***	-0.936***	-0.693***	-0.933***
	[-39.17]	[-23.54]	[-39.40]	[-23.48]
Industry FE	No	Yes	No	Yes
Year FE	No	Yes	No	Yes
Firm Cluster	Yes	Yes	Yes	Yes
Observations	68,483	68,483	68,483	68,483
Pseudo R-squared	0.47	0.51	0.47	0.51

Table 8
Channel Analysis: Earnings Uncertainty

Panel A of the table displays the results on the impact of carbon risk on earnings uncertainty, and the impact of carbon risk on dividend policy after controlling for earnings uncertainty. Models 1 to 3 use OLS regressions, Models 4 and 5 use probit regressions, and Models 6 and 7 use tobit regressions. The t-statistics based on robust standard errors clustered by firm are reported in square brackets. Panel B of the table reports chi-squared tests of differences in coefficients of POLLUTER*POST between each of Models 4 and 5 in Table 8 and Models 2 and 3 in Panel A of Table 3; and between each of Models 6 and 7 in Table 8 and Models 2 and 3 in Panel B of Table 3. We report detailed definitions of all variables in Appendix A. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Panel A - Channel Analysis: Earnings Uncertainty							
	Earnings Uncertainty (Dep. Var = ROAVOL)			Decision to Pay (Dep. Var. = DIVDUM)		Determinants of Payout ratio (Dep. Var. = DIVPAYOUT)	
	1	2	3	4	5	6	7
POLLUTER	0.178***	0.082*		-0.475***		-0.189***	
	[4.95]	[1.73]		[-7.58]		[-8.94]	
POST		0.176***		-0.178***		-0.023*	
		[5.36]		[-3.43]		[-1.95]	
POLLUTER*POST		**0.121****	**0.122****	**-0.153****	**-0.186****	**-0.058****	**-0.057****
		[2.35]	[2.35]	[-1.99]	[-2.27]	[-2.35]	[-2.27]
ROAVOL				**-0.094*****	**-0.093*****	**-0.018*****	**-0.013****
				[-5.07]	[-4.91]	[-3.02]	[-2.15]
DIVDUML				1.508***	1.450***		
				[21.28]	[22.20]		
DIVPAYOUTL						0.632***	0.564***
						[21.67]	[20.38]
FRANKL				1.363***	1.494***	0.393***	0.404***
				[19.19]	[19.84]	[12.08]	[13.06]
SIZEL	-0.285***	-0.293***	-0.282***	0.221***	0.255***	0.062***	0.070***
	[-29.86]	[-30.34]	[-27.16]	[13.43]	[14.78]	[12.04]	[12.34]
ROAL	-0.483***	-0.474***	-0.473***	1.538***	1.089***	0.621***	0.579***
	[-23.69]	[-23.53]	[-23.64]	[3.38]	[2.88]	[2.90]	[2.84]
RETAINL	-0.073***	-0.071***	-0.064***	0.105	0.118	0.044	0.042
	[-8.04]	[-7.95]	[-7.39]	[1.09]	[1.41]	[1.36]	[1.30]
TOBINQL	0.034***	0.034***	0.031***	0.020*	0.033***	-0.003	-0.002
	[7.12]	[7.08]	[6.35]	[1.79]	[3.52]	[-0.37]	[-0.33]
CASHL	0.130**	0.098*	0.013	0.101	0.240**	0.035	0.073**
	[2.20]	[1.68]	[0.22]	[1.00]	[2.37]	[1.05]	[2.22]
LEVL	-0.126***	-0.118***	-0.061**	-0.002	-0.071	0.008	-0.028*
	[-3.68]	[-3.46]	[-1.97]	[-0.05]	[-1.41]	[0.52]	[-1.88]
TANGL	0.018	0.068	0.167**	0.155	0.254**	0.124***	0.149***
	[0.23]	[0.84]	[2.03]	[1.52]	[2.39]	[3.62]	[4.13]
Constant	2.455***	2.506***	2.450***	-5.340***	-6.490***	-1.478***	-1.663***
	[13.83]	[14.07]	[8.38]	[-18.55]	[-15.79]	[-14.46]	[-8.50]
Industry FE	No	No	Yes	No	Yes	No	Yes
Year FE	No	No	Yes	No	Yes	No	Yes
Firm Cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,608	17,608	17,566	16,852	16,685	16,834	16,796
Adjusted (Pseudo) R-squared	0.43	0.43	0.45	0.76	0.77	0.61	0.63

Panel B - Test of Difference in the Coefficients of POLLUTER*POST between Table 8 and Table 3							
Chi-squared				42.68	12.55	5.10	4.30

P-value	0.00***	0.00***	0.02**	0.04**