Effect of Mandatory Climate-related Disclosure Regulation on Firms' Cost of Capital - International Evidence.

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Abstract

This study examines the impact of mandatory climate-related disclosure regulations on the cost of equity capital in New Zealand, the U.K., and Japan, using firm-level and portfolio-level approaches. Our findings reveal a significant reduction in the cost of capital for regulated firms in New Zealand and the U.K. when full compliance is achieved, whereas a significant increase is observed for regulated firms in Japan. The comply-or-explain regulation, which lacks stringent enforcement, shows insignificant impact on the cost of capital, highlighting the importance of robust implementation. Additionally, for unregulated firms, the cost-of-capital effect is insignificant in New Zealand but significantly negative in the U.K., suggesting that financial resources, expertise, and disclosure incentives influence voluntary disclosures of unregulated firms and hence, cost of capital. Overall, our results indicate that mandatory climate-related disclosure regulations enhance the corporate information environment and yield positive capital market effects, advocating for regulatory adoption in countries without such mandates.

Keywords: sustainability, climate-related disclosure, climate finance, climate change, cost of equity capital, environmental issues.

JEL Codes: Q50, Q56, Q58, G38, M41, G32.

1. Introduction

Environmental, social, and governance (ESG) considerations have become increasingly important for investment decisions. Yet, investors frequently complain that the availability and quality of firm-level ESG disclosures are insufficient to make informed investment decisions (Ilhan et al., 2023). Policymakers worldwide have increasingly recognized the importance of environmental, social, and governance (ESG) considerations in corporate reporting (Grewal et al., 2019). Along with the growing interest in sustainable investments, the demand for information about corporate social responsibility (CSR) as well as firms' environmental, social, and governance (ESG) activities and policies has steadily risen (Amel-Zadeh, 2018). Of all the categories in ESG or CSR disclosures, climate-related disclosure attracts more and more attention from investors, firms, and policymakers. In response to the gap between the demand for climate-related information by investors and the supply of such information by firms, in June 2017, the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) released its final recommendations (2017 report), which provide a framework for companies and other organizations to develop more effective climate-related financial disclosures through their existing reporting processes. At country level, recently, several countries have initiated *mandatory* climate-related disclosure regulations based on TCFD framework to force firms to disclose high-quality information on climate issues either jointly with traditional financial disclosures or in specialized standalone reports. In addition to these country-level initiatives, there are significant efforts at the global level to design, harmonize, and eventually mandate international climate-related disclosure standards.[1]New Zealand is the first country in the world passed this regulation with full compliance in October 2021.

We choose to investigate impact of mandatory disclosure regulation on firms' cost of equity capital because of two reasons. First, the relationship between mandatory regulations and the cost of capital is probably better supported by extant theory than the link between the cost of capital and voluntary ones (Hail & Leuz, 2006). Second, empirical evidence on the effects of CSR regulation (climate-related regulation in particular) is limited and still developing (Christensen et al., 2021). Third, the impact of mandatory disclosure regulation on cost of capital is still an open issue. Mandatory disclosure regulations have positive effect on equity market as well as cost of equity because a clear commitment to disclosure effectively reduces uncertainty and information asymmetries between the firm and its investors, as well as among investors themselves (Verrecchia, 2001) and since then, it reduces risk premium required by the investors. Additionally, in a Capital Asset Pricing Model (CAPM) world, better disclosure regulation has the effect of decreasing firms' cost of capital by generally lowering the covariance between a firm's future cash flows and the future

[1] For instance, in June 2023 the International Sustainability Standards Board (ISSB) issued its first two IFRS® Sustainability Disclosure Standards, IFRS S1 *General Requirements for Disclosure of Sustainability-related Financial Information* and IFRS S2 *Climate-related Disclosures.) IFRS S1 and IFRS* S2 are effective for annual reporting periods beginning on or after 1 January 2024.

cash flows of the other firms in the economy. However, impact of both mandatory financial (IFRS) or nonfinancial disclosure regulations (for example: ESG, CSR) on firms' cost of capital shows mixed results because this effect can be different across the countries due to the way the countries implement their regulation (Krueger, 2021), regulated firms can comply disclosure regulation voluntarily before the introduction of the mandate disclosure (Li, 2010; Krueger, 2021) and the global integration of equity market (Hail & Leuz, 2006). These factors can affect the pure impact of mandatory disclosure regulations on cost of capital, making it insignificant or even positive. Fourth, currently, there are few papers investigating the impact of climate-related disclosure regulation on firms' economic outcomes.

In this paper, we investigate the impact of mandatory climate-related disclosure regulations in 3 countries including New Zealand, U.K., and Japan – the first countries in the world passed the mandatory climate-related disclosure regulations on firms' cost of equity capital.[2] While New Zealand has only one full compliance climate-related disclosure regulation, the U.K. and Japan have two related regulations with different levels of compliance (comply-or-explain basis and full compliance).

To examine the effect of climate-related disclosure regulation on firms' cost of capital, following Chen et al. (2010). First, we use two models to estimate implied cost of equity in each calendar quarter during the research period for each country. The first model is the GLS (generalized least squares) model developed by Gebhardt et al. (2001) to estimate cost of capital at firm level. This method produces a panel (firm-quarter) dataset of cost of capital for each sample. The second one is residual income valuation model developed by Easton and Sommers (2007) using realized earnings as proxies for investors' expected earnings to simultaneously estimate the cost of equity and long-term growth. This method produces a time-series dataset of cost of capital for each sample.

Second, we create 2 indicator variables as the proxies for the climate-related disclosure regulations based on the context of each country. The indicator variables will take the value one if the observation in the quarter after the regulation was passed and zero otherwise.

Third, with the panel dataset, to control for the time-varying firm's characteristics which affect implied cost of capital, based on prior literature, we include 12 control variables defined in Table 19 in Appendix. To control for time-invariant firm's characteristics which potentially affect cost of implied capital, we add firm fixed effects in the regression model. To control for potential macroeconomic conditions which can have potential impact on cost of capital over time, we add time trend variable in the regression model. Moreover, for Japan and U.K., to examine the different effect of the regulations across regulated firms and unregulated firms, we create an indicator variable Reg1 (or/and Reg2), taking the value 1 if the firm is regulated by the

[2] In this paper, cost of equity, cost of equity capital and cost of capital are used alternatively.

regulation and 0 otherwise and add some interactions between the indicator variable standing for the regulation and indicator standing for regulated firms. To make the results more robust and reliable, we use a method suggested by Petersen (2009) to adjust standard error for clustering at both firm level and time level.

With the time-series dataset, we only run the regression with two dummy variables as proxies for the regulations because cost of capital is estimated for a portfolio thus, we cannot add control variables. We consider each quarter corresponding to a portfolio and use a cross-sectional sample to estimate COC. Thus, each quarter, we get one value of estimated COC for one portfolio. We use Newey and West (1987) to compute t-statistics and adjust standard errors which correct for the potential time-series correlation.

After analysing the advantages and disadvantages of the two approaches (panel regression and time-series regression), we consider the results from the panel regression as the main results, and the results from the time-series regression as robustness checks.

Consistent with prior literature, we find that the full compliance regulation reduces cost of capital for regulated firms in NZ and U.K. and while it doesn't significantly impact cost of capital for unregulated firms in NZ, it still decreases cost of capital for unregulated firms in the U.K. It is possible because the unregulated firms in NZ are dominated by SMEs with a lack of both expertise and financial resources (Hon & Hon, 2020) to comply with this regulation while non-financial disclosures are so complicated (Krueger, 2021). Otherwise, the unregulated firms in the U.K. which are listed in the AIM market on London Stock Exchange with better resources can totally comply with this regulation voluntarily due to spill-over effect. In contrast, the regulated firms in Japan experience an increase in cost of capital after the introduction of full compliance climate-related disclosure regulation. This result can be found in some papers investigating impact of IFRS mandate or ESG mandate on cost of capital and is explained with two reasons including pre-mandate voluntary disclosures and anticipatory effect. In Japan, a lot of firms voluntarily disclose climate-related information based on the TCFD framework before its official adoption date and thus, the decreased effect can occur in a prior period. Moreover, we find little evidence on impact of comply-or-explain regulation on cost of capital for all firms in both the U.K. and Japan owing to both U.K and Japan are the most global integrated equity market which reduce the effect of disclosure regulation (Hail & Leuz, 2006) and the effect of comply-or-explain regulation is weaker than a full compliance one or even insignificant (Krueger, 2021).

Our paper follows the methods of Chen et al. (2010) to examine the effect of climate-related disclosure regulation on firms' cost of capital. Chen et al. (2010) investigate the impact of Fair Disclosure regulation on cost of capital for the US-listed firms while we investigate the impact of climate-related disclosure regulation on cost of capital for both regulated and unregulated firms in three countries including New Zealand, U.K.

and Japan. Moreover, while Chen et al. (2010) do not control for time-invariant firm characteristics that can affect implied cost of capital in panel regression models, we add firm fixed effects to control for those factors.

Our study makes several significant contributions to the literature on disclosure regulations and their impact on the cost of capital.

First, it fills a critical gap in the literature by examining the impact of climate-related disclosure regulations on the cost of capital, an area that has had limited number of studies despite the growing importance of environmental sustainability in financial markets. Prior literature has only studied impact of mandatory disclosure regulation including Fair Disclosure (Chen et al., 2010; Duarte et al., 2008; Gomes et al., 2007), ESG (Krueger, 2015; Krueger et al., 2021), CSR (Dhaliwal et al., 2011; Chen et al., 2018), securities regulation (Core et al., 2015; Hail & Leuz, 2006), IFRS (Daske et al., 2008; Li, 2010; Christensen et al., 2013). We add to those papers by investigating influence of another new disclosure regulation – climate-related disclosure regulation on cost of capital which is not investigated by any papers while this regulation has been proposing and issuing by many countries in the world[3]. We document a decrease in firms' cost of equity capital which is consistent with the rare evidence on the cost-of-capital effect of mandatory disclosure.

Second, it provides a comprehensive analysis across three diverse regulatory environments—New Zealand, the U.K., and Japan—highlighting the varying effects of disclosure mandates in different national contexts. The findings reveal that full compliance with disclosure mandates significantly reduces the cost of capital for regulated firms in New Zealand and the U.K., while paradoxically increasing it for regulated firms in Japan. This suggests that the impact of mandatory climate-related disclosure regulation is not uniform and can be influenced by country-specific factors such as market integration (Hail & Leuz, 2006) and pre-mandate voluntary disclosure practices when assessing the effectiveness of regulatory interventions. These findings are consistent with the impact of some other mandatory disclosure regulations such as IFRS or ESG mandates.[4] The prior literature shows the effects of IFRS, ESG mandates on COC can vary across the countries. We contribute to the literature by adding the impact of mandatory climate-related disclosure on COC across the countries. This insight is crucial for policymakers and regulators aiming to design effective disclosure frameworks.

Third, the research contributes to the ongoing debate on the efficacy of "comply-or-explain" regulations, showing that such frameworks have no significant impact on the cost of capital in Japan and the

[3] Currently, companies in 14 jurisdictions are subject to TCFD-aligned disclosure requirements, and companies in another two jurisdictions will be subject to such requirements by 2025. In addition, three jurisdictions have proposed disclosure requirements that incorporate or draw from the TCFD recommendations. These 19 jurisdictions account for close to 60% of global 2022 gross domestic product. (TCFD, 2023)

[4] Daske et al. (2008) and Ball (2006) agree that IFRS implementation is likely to be heterogeneous across countries with the idea that firms' reporting incentives, which are shaped by markets and countries' institutional environments, play a crucial role for reporting outcomes. Krueger et al., (2021) find effects of ESG mandates on stock liquidity are different across countries due to regulatory implementation and market equity's integration.

U.K. Under an implementation of comply-or-explain basis, the firms have the option to deviate from a default case, because the disclosure rules are weaker if the firms opt out of compliance by providing explanations for why they choose not to disclose (Krueger et al., 2021). This suggests that mandatory disclosure with full compliance may be more effective in enhancing the information environment and reducing capital costs. This insight is also crucial for policymakers and regulators aiming to design effective disclosure frameworks. This finding is consistent with the findings of Krueger et al. (2021)[5].

2. Literature Review and Hypothesis Development

2.1 Climate -related disclosure, ESG, CSR and sustainability-related disclosures.

ESG, CSR or sustainability disclosures are the issues that have close meaning with climate-related information, but they cover a broader disclosure category. First, the similarity among all the definition is that all types of disclosures aim to enhance transparency and accountability in corporate practices, focusing on sustainability and ethical impacts. ESG disclosure is a broader and more comprehensive form of reporting that includes a company's environmental, social, and governance practices. Environmental pillar in ESG includes climate-related issues (which overlap with climate-related disclosures) but also extends to broader environmental concerns such as biodiversity, waste management, and water usage. CSR disclosure refers to the reporting by companies on their broader social, ethical, and environmental responsibilities. Climate-Related Disclosure concentrates on environmental impacts, particularly those related to climate change and focused on providing detailed climate risk information to investors, regulators, and other stakeholders concerned with environmental sustainability.

Related to the relationship between CSR disclosure and cost of capital, Han B. Christensen et al. (2021) in a review paper about mandatory CSR and sustainability reporting stress that the links between CSR and the cost of capital—whether conceptual or empirical—are for the underlying CSR activities and exposures, not for CSR reporting or regulation. Studies focusing on reporting provide evidence of a negative relation between voluntary CSR disclosures and firms' implied cost of capital (e.g., El Ghoul et al., 2011; Plumlee et al., 2015; Matsumura et al., 2017).

2.2 Impact of mandatory disclosure regulation on cost of capital

There are many papers investigating the impact of disclosure regulation on different firms' economic factors[6] including stock liquidity, firm performance, the real effect of the disclosure regulation and cost of capital and while some studies investigate the impact of voluntary disclosure regulation, there are a very

[5] Krueger et al. (2021) investigate impact of ESG mandate on stock liquidity in different countries and they find that the effects are strongest if the disclosure requirements are implemented by government institutions, not on a comply-or-explain basis, and coupled with strong enforcement by informal institutions.

[6] stock liquidity (Krueger, 2024) firm value (Krueger, 2015; Jinji, 2023), firm performance (Chen et al., 2018), the real effect of the disclosure regulation (Fiechter et al., 2022; Christensen et al., 2017) and cost of capital (Li, 2010; Hail, & Leuz, 2006; Chen et al. 2010; Core et al., 2015; Duarte et al. 2008; Gomes et al., 2007; Jinji, 2023).

limited number of papers investigating the influence of mandatory one. The mandatory disclosure regulations investigated can be financial (for example: IFRS 2005) or non-financial including ESG, CSR, security regulation. The number of papers investigating impact of mandatory climate-related disclosure (CSR-related) on cost of capital is not only limited, but they mainly focus on impact of disclosures instead of the regulation (Christensen et al., 2021). ESG or CSR disclosure rules in general, or climate-related disclosure may affect various firm-level outcomes, but our focus on cost of capital is motivated by some primary considerations. First, cost of capital is an extremely important factor for investors, firms, and regulators because it affects firms' real and financial outcomes, the investment decision of investors and efficiency of the capital market and financial market in general. Second, as stressed by Christensen et al. (2021) in their review of the CSR disclosure, empirical evidence on the effects of CSR regulation is limited and still developing. Third, the relationship between mandatory regulations and the cost of capital is probably better supported by extant theory than the link between the cost of capital and voluntary ones (Hail & Leuz, 2006).

Studies on mandatory disclosure regulations show the positive effect on the capital market as well as cost of equity. Krueger et al. (2021) find the positive effect of ESG disclosure mandates on the stock liquidity. Krueger (2015) finds firms regulated by mandatory GHG emissions disclosure regulation experience significantly positive valuation effects for firms listed on the Main Market of the London Stock Exchange. Meanwhile, Fiechter et al. (2022) find the mandatory CSR regulation has real effect on CSR activities and increases CSR transparency when investigating CSR Directive for EU firms in 2014. Similarly, the mandatory disclosure regulations also yield positive effects in cost of capital. Investigating the impact of Fair Disclosure regulation in the US for the US firms, Chen et al. (2010) find some evidence that the cost of capital declines in the post-period of Fair Disclosure regulation relative to the pre-period for the medium and large firms. Dhaliwal et al. (2011) find that initiating CSR reporting leads to a reduction in cost of equity for firms with superior social performance. With a broader research scope, some papers find similar results. Li (2010) examines whether the mandatory adoption IFRS 2005 in 18 countries in the European Union reduces the cost of equity capital or not and he finds that mandatory adopters (firms who did not comply IFRS voluntarily before mandatory introduction) experience a significant reduction in the cost of equity after the mandatory introduction of IFRS 2005, and voluntary adopters (firms already complied IFRS voluntarily before mandatory introduction) experience no significant change in the cost of capital after 2005. Likewise, Core et al. (2015) show that mandatory disclosure regulation in securities offering is negatively related to implied cost of equity capital for 35 countries all over the world while Hail & Leuz (2006) show that securities regulations can reduce cost of equity significantly in the countries with more extensive disclosure requirements, stronger securities regulation, and stricter enforcement mechanisms.

It is straightforward to show that a credible commitment to disclosure reduces uncertainty and information asymmetries between the firm and its investors or among investors (Verrecchia, 2001). In capital markets with incomplete information, disclosure can enhance investor recognition, thereby enlarging the investor base and improving risk sharing (Merton 1987) and hence reducing cost of equity capital. More recently, Leuz et al. (2005) show that, even in the Capital Asset Pricing Model (CAPM) world, better disclosure regulation has the effect of decreasing firms' cost of capital by generally lowering the covariance between a firm's future cash flows and the future cash flows of the other firms in the economy. Thus, we develop hypothesis 1 as following:

H1: Mandatory climate-related disclosure regulations reduce cost of equity capital for regulated firms in the post-regulation period compared to the pre-regulation period.

While all these explanations predict that more disclosure is associated with a lower cost of capital, the empirical magnitude of these effects is still an open issue. Mandating some firms to disclose more while leaving other firms disclosing voluntarily is less effective in improving and may even harm the overall information environment when firms' disclosures are endogenous. Although the regulated firms' increased disclosure directly reduces all firms' cost of capital, it crowds out the unregulated firms' voluntary disclosure and thus increases all firms' cost of capital indirectly (Jinji, 2023). Thus, the impact of disclosure regulation on regulated firms and unregulated firms can be different depending on firms' characteristics such as firm size (Chen et al., 2010) or inside ownership (Core et al., 2015). Investigating Fair Disclosure Regulation in the US, while Chen et al. (2010) find the decrease in the cost of capital post Fair Disclosure Regulation is mainly for medium and large firms but is insignificant for small firms, Gomes et al. (2007) find that the cost of capital has increased for small as well as medium firms post Fair Disclosure regulation but remained unchanged for large firms. The reason is while medium and large firms compensate for the loss of information flow from the ''selective disclosure'' channel by attracting more analyst following and making more earnings pre-announcements after Fair Disclosure regulation, small firms are unable to do so and thus face a deteriorated information environment post Reg FD and an increase in cost of capital. For most countries, the initially adopted firms are the largest firms in the market and New Zealand, U.K. and Japan are no exception.
Thus, we develop the second hypothesis as following:

H2: Mandatory climate-related disclosure regulations do not impact cost of equity capital significantly for unregulated firms.

Moreover, impact of disclosure regulation on cost of capital can be different across the countries due to equity market's global integration (Hail & Leuz, 2006) or regulation implementation (Krueger et al., 2021). Daske et al. (2008) and Ball (2006) agree that IFRS implementation is likely to be heterogeneous across countries and with the idea that firms' reporting incentives, which are shaped by markets and countries' institutional environments, play a crucial role for reporting outcomes. Krueger et al., (2021) find effects of ESG mandates on stock liquidity are different across countries due to regulatory implementation. It means how countries implement the disclosure mandate (i) whether the mandates are issued by a government institution or a stock exchange and (ii) whether they are implemented on a full compliance or a comply-or-explain basis. They find that the effects are strongest if the disclosure requirements are implemented by government institutions, not on a comply-or-explain basis. Because the mandates are issued by government institutions rather than stock exchanges, because governments tend to have more credible implementation mandates, are less affected by regulatory capture, and have more resources to implement and enforce the rules effectively. Likewise, the regulation has stronger effects in countries requiring full compliance without the option to deviate from a default case, because disclosure rules are stricter if firms cannot opt out of compliance by providing explanations for why they choose not to disclose. For our analysis, while New Zealand has only one full compliance climate-related disclosure regulation, both Japan and U.K. have two mandatory climate-related disclosure regulations. The first one is comply-or-explain regulation issued by Tokyo Stock Exchange-Japan (Financial Conduct Authority-U.K.) and the second one is full compliance regulation issued by Financial Stability Authority-Japan (U.K. Parliament- U.K.). Thus, we develop the third hypothesis as following:

H3: Impact of full compliance climate-related disclosure regulation on cost of capital is larger than that of comply-or-explain one in both Japan and U.K.

3. Data and Methodology

3.1 Methods to estimate cost of equity capital.

Recently there have been numerous methods for estimating the expected rate of return or the implied cost of equity capital. Chen et al. (2010) summarize and categorize them into 2 broad categories: (1) firm-specific estimation of the implied cost of capital assuming long-term growth. This method can be found in the studies of Dhaliwal et al. (2011), Daske et al. (2008), Li (2010), Hail & Leuz (2006), Core et al. (2015), and (2) portfolio-specific simultaneous estimation of the implied cost of capital and long-term growth using realized earnings. Additionally, there are some papers using monthly return as the cost of capital of each stock (Duarte et al., 2008) or monthly returns on the value-weighted size-based portfolios as the cost of capital at portfolio level (Gomes et al., 2007).

Both firm-specific and portfolio-specific estimation methods have some advantages and disadvantages. The first category (firm-specific implied COC estimation method) has some advantages. First, it generates a firm-quarter (panel) dataset big enough that improves the power of statistical tests. Second, we can add control variables in the regression model to control for firm characteristics which affect implied cost of capital. However, it has a weakness that simplifying assumptions about long-term growth rates of future earnings which leads to measuring the investors' long-term growth expectations with errors and using analysts' earnings forecasts (optimistic), as proxies for investors' expected earnings which produce biased cost of capital estimates. In my paper, following Chen et al. (2010), to improve the weaknesses of firm-specific estimation (errors in investors' long-term growth expectations and optimistic analysts' earnings forecasts), we add three control variables (analyst forecast errors, the analyst consensus forecast of long-term earnings growth rates, standard deviation of analyst earnings forecasts) in regression model to capture the errors of long-term growth rate and analyst earnings forecast in estimating implied cost of capital.

The second category (portfolio-specific implied COC estimation) can overcome the weakness of the first category by (1) estimating the cost of capital and long-term growth rate simultaneously rather than assumed and (2) using realized earnings, instead of analysts' earnings forecasts as proxies for investors' expected earnings. Moreover, by grouping firms into portfolios, we increase the precision of our estimates of the systematic cost of capital (Francis & Yu, 2015). However, portfolio-specific estimation has 2 weaknesses. First, due to the need to estimate the long-term growth rate and implied cost of capital simultaneously, these models can only estimate a portfolio-specific, rather than firm-specific, cost of capital at a particular point in time (Chen et al., 2010). It is the difficulty in controlling for other firm-specific factors that may affect cost of capital (Easton, 2006). Second, it can only generate a small number of cost of capital estimates (16-21 cost of capital estimates for our time-series regression during 16-21-quarter research period) which limits the power of statistical tests.

After analysing the advantages and disadvantages of both methods, following Chen et al. (2010), we use both methods to estimate implied COC at firm level and portfolio level. However, we consider the results from the firm-specific approach as the main one and results from the portfolio-specific approach as robustness tests. The basic idea of both approaches is to substitute price and analyst forecasts into a valuation equation and to back out the cost of capital as the internal rate of return that equates current stock price with the expected future sequence of residual incomes or abnormal earnings.

3.1.1 Estimating cost of capital at firm level.

To estimate implied COC at the firm level, we follow the method used in the paper of Chen et al. (2010) using the GLS (generalized least squares) model developed by Gebhardt et al. (2001). This method has been widely used in accounting and finance research to examine various factors affecting expected returns (for example, Dhaliwal et al., 2011; Daske et al., 2008; Li, 2010; Hail & Leuz, 2006; Chen et al., 2010; Francis et al., 2015). The firm-specific cost of capital estimates are the internal rates of return (IRR) that equate current stock prices to the present values of future earnings or dividends. This model estimates a firm-specific cost of capital at a particular point in time and is derived from the dividend discount model. R_{GLS} is the firm-specific cost of capital estimate based on the GLS model.

$$P_t = \sum_{\tau=1}^{\infty} \frac{E_t[DPS_{t+\tau}]}{(1+R_{GLS})^{\tau}} \qquad (1)$$

Under the "clean surplus" assumption, that is $B_{t+\tau} = B_{t+\tau-1} + EPS_{t+\tau} - DPS_{t+\tau}$, the equation 8 can be rewritten as

$$P_t = B_t + \sum_{\tau=1}^{T-1} \frac{E_t[EPS_{t+\tau} - R\ x\ B_{t+1-\tau}]}{(1+R)^{\tau}} + \sum_{\tau=T}^{\infty} \frac{E_t[EPS_{t+\tau} - R\ x\ B_{t+1-\tau}]}{(1+R)^{\tau}} \quad (2)$$

Assuming that the abnormal earnings at time T, that is, $[ROE_{t+T} - R_{GLS}]\ x\ B_{t+T-1}$ becomes a perpetuity from T onward and $ROE_{t+\tau}$ is the return on equity at time (t+τ), the equation 9 can be rewritten as:

$$P_t = B_t + \sum_{\tau=1}^{T-1} \frac{E_t[EPS_{t+\tau} - R_{GLS}\ x\ B_{t+1-\tau}]}{(1+R_{GLS})^{\tau}} + \frac{E_t[ROE_{t+T} - R_{GLS}]\ x\ B_{t+T-1}}{(1+R_{GLS})^{T-1}\ R_{GLS}} \qquad (3)$$

Where P_t is the stock price of a firm's common share at time t. $E_t[.]$ is the expectation based on information at time t. $DPS_{t+\tau}$ is the future dividends per share for time (t+τ). B_t is the book value of equity per share from the most recent available financial statement at time t. $EPS_{t+\tau}$ is the median earnings forecast per share from Workspace or derived earnings forecasts per share for time (t+ τ). POUT is the dividend payout ratio. The author uses a firm's previous fiscal year's dividend payout ratio to measure for the forecasted payout ratio.

To estimate equation 3, the author used the method of Gebhardt et al. (2001) that uses the analyst earnings forecasts for the next two years as expected earnings from year t+1 to year t+2. To calculate the analyst earnings forecast for year t+3, the author uses the long-term growth rate to compute the three-year-ahead earnings forecast by multiplying 2-year-ahead analyst earnings forecast by (1+long term growth rate). Then we measure the expected earnings by assuming that the future return on equity declines linearly to an equilibrium return on equity from year t+4 to year t+T. This equilibrium return on equity is a moving median return on equity for all firms in the same industry in the past 10 years. The return on equity is collected from Workspace (London Stock Exchange). We classify all firms into 12 industries defined by Fama and French (1997). Firm-year observations with a negative return on equity are eliminated in the calculation. The future book value of equity is estimated by assuming the clean surplus relation, that is $B_{t+\tau} = B_{t+\tau-1} + EPS_{t+\tau} - DPS_{t+\tau}$. The future dividend, $DPS_{t+\tau}$ is calculated by multiplying $EPS_{t+\tau}$ by the payout ratio POUT. Following Gebhardt et al. (2001), we set T=12.

Estimating COC at the firm level generates a panel dataset (firm-quarter) for each sample.

3.1.2 Estimating cost of capital at portfolio level.

The portfolio-specific cost of capital using the residual income valuation model developed by Easton and Sommers (2007) uses realized earnings as proxies for investors' expected earnings to simultaneously estimate the cost of equity and long-term growth.

$$P_t = B_t + \sum_{\tau=1}^{\infty} \frac{E_t[EPS_{t+\tau} - R\ x\ B_{t+1-\tau}]}{(1+R)^{\tau}} \qquad (4)$$

where P_t = stock price of a firm at time t; B_t = book value of equity per share at time t; Et [.] = expectation based on information at time t; EPS_t = earnings per share at time t; R = the cost of capital of a firm.

Estimating COC at the portfolio level generates a time-series dataset (quarterly) for each sample.

(1) Using current realized earnings as expected earnings.

Easton and Sommers (2007) assume that the current year's residual income, $EPS_t - R^0_{ES}\ x\ B_{t-1}$ where R^0_{ES} = the cost of capital estimated based on current earnings, grows at a rate g_{ES} per year in perpetuity. Then year (t+1)'s residual income is equal to $[EPS_t - R^0_{ES}\ x\ B_{t-1}]\ x\ (1 + g_{ES})$. Easton and Sommers (2007) show that equation above can be rewritten as:

$$P_t = B_t + \frac{[EPS_t - R^0_{ES}\ x\ B_{t-1}] x\ (1 + g_{ES})}{R^0_{ES} - g_{ES}} \qquad (5)$$

Rearranging equation 2, Easton and Sommers (2007) obtain the following empirical model:

$$\frac{EPS_t}{B_{t-1}} = \delta_0 + \delta_1 \frac{P_t - B_t}{B_{t-1}} + \varepsilon_t \qquad (6)$$

Where $\delta_0 = R^0_{ES}$ and $\delta_1 = \frac{R^0_{ES} - g_{ES}}{1 + g_{ES}}$

Equation 6 can be estimated for a portfolio of firms at time t to obtain δ_0 and δ_1. The implied cost of capital, R^0_{ES}, and implied long-term growth rate, g_{ES}, can be calculated as follows:

$$R^0_{ES} = \delta_0 \qquad (7a)$$

$$g_{ES} = \frac{\delta_0 - \delta_1}{1 + \delta_1} \qquad (7b)$$

(2) Using future realized earnings as expected earnings

Easton and Sommers (2007) assumes perfect foresight for expected residual income in year t + 1, that is, $E_t[EPS_{t+1} - R\ x\ B_{t+1-\tau}]$ = $EPS_{t+1} - R^1_{ES}\ x\ B_t$ where R^1_{ES} = the cost of capital estimated based on future earnings. Further assumption that year (t+1)'s residual income, $EPS_{t+1} - R^1_{ES}\ x\ B_t$ grows at a rate G_{ES} per year in perpetuity. Easton and Sommers (2007) show that equation 1 can be rewritten as

$$P_t = B_t + \frac{EPS_{t+1} - R^1_{ES}\, x\, B_t}{R^1_{ES} - G_{ES}} \qquad (8)$$

Rearranging equation 5, Easton and Sommers (2007) obtain the following empirical model:

$$\frac{EPS_{t+1}}{B_t} = \gamma_0 + \gamma_1 \frac{P_t}{B_t} + \mu_t \qquad (9)$$

Where $\gamma_0 = G_{ES}$ and $\gamma_1 = R^1_{ES} - G_{ES}$. Equation 9 can be estimated for a portfolio of firms at time t to obtain γ_0 and γ_1. The implied cost of capital, R^1_{ES}, and implied long-term growth rate, G_{ES}, can be calculated as follows:

$$R^1_{ES} = \gamma_0 + \gamma_1 \qquad (10a)$$

$$G_{ES} = \gamma_0 \qquad (10b)$$

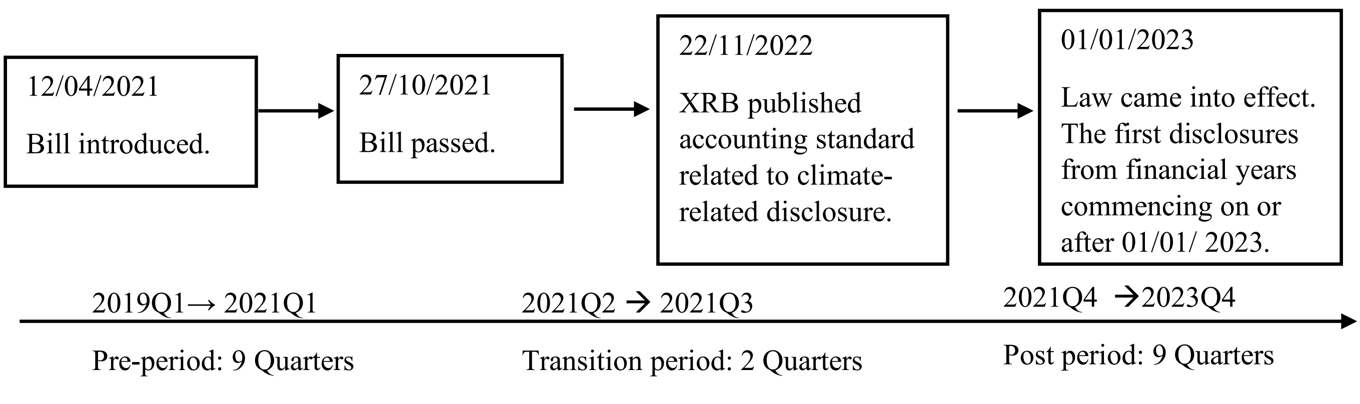
3.2 Context of the countries, research period and sample selection.

3.2.1 New Zealand

Context.

New Zealand mandatory climate-related disclosure regulation or The Financial Sector (Climate-related Disclosures and Other Matters) Amendment Act 2021 amended the Financial Markets Conduct Act 2013 (FMC Act), the Financial Reporting Act 2013, and the Public Audit Act 2001. The Bill was proposed to Parliament on April 12th, 2021, approved on October 27th, 2021, and came into effect on January 1st, 2023. The new law requires regulated firms to prepare an annual climate-related statement in accordance with climate standards published by the External Reporting Board (XRB) which is based on the TCFD framework. Affected organisations are required to publish first statements from financial years commencing on or after 1 January 2023. It is a full compliance regulation.

Figure 1. Timeline of climate-related disclosure regulation in New Zealand



Research period.

Following the studies by Chen et al. (2010) and Gomes et al. (2007) when investigating the impact of the U.S Fair Disclosure Regulation 2010 on firms' cost of equity capital, we define research period including 3 periods. The pre-period is the period before the regulation was proposed, transition period is from the quarter when the regulation was proposed until the quarter right before it was approved because during this period, the behaviours of firms and the market could potentially be affected by the expectation of climate-related disclosure regulation's implementation (Chen et al., 2010) and, it is particularly challenging to predict the responses of firms and the market to the impending regulation (Gomes et al., 2007). Post-period starts from the quarter when the regulation was approved until December 2023. The pre-period is set equal in length to the post-period (Dhaliwal, D. S., 1979).

For New Zealand, the research period is from March 2019 to December 2023 (20 quarters). We define March 2019 to March 2021 (9 quarters) as the pre-period, June 2021 to September 2021 (2 quarters) as the transition period and December 2021 to December 2023 (9 quarters) as the post-period.

Sample selection.

We construct 2 samples of regulated firms and unregulated firms. The first sample includes 95 regulated firms which are the largest listed firms (market capitalization is larger than $60million) on NZX and the other includes 49 unregulated firms (market capitalization is lower than $60million). The list of 95 regulated firms is from the New Zealand Companies Office[7] and the list of 49 unregulated firms and all the data are from Compustat Global.

Next, we use these samples to estimate COC at portfolio level and firm level. The process estimating portfolio-specific COC for regulated firms and unregulated firms generate the R^0_{ES} and R^1_{ES} samples with the number of firms as shown in table 1. We consider each quarter as a portfolio and use cross-sectional data to estimate equation 6 (and 9). After this process, we get one observation for each quarter (sample). Thus, the process produces a time-series dataset with 20 R^0_{ES} (16 R^1_{ES}) quarterly observations for each sample of regulated or unregulated firms. The process estimating firm-specific COC (R_{GLS}) and requirement of availability of 12 control variables excluding all unregulated firms due to unavailability of data and create a sample of only 50 regulated firms. After this process, we get a firm-quarter dataset of regulated sample with 50 firms and 782 observations.

3.2.2 The United Kingdom

[7] Until 2/2024, there are 174 climate reporting entities regulated by this regulation including a listed issuer, registered bank, licensed insurer, credit union, building society. Our research only focuses on equity listed firms. Then, we get the list of 95 equity listed firms. This regulation regulated Website of New Zealand Companies Office: Climate-related Disclosures | Companies Office on February 28th, 2024.

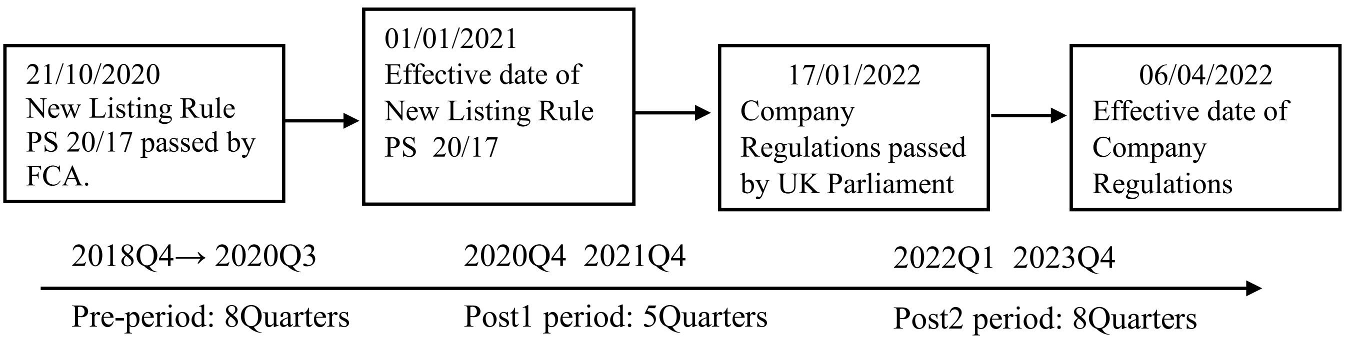
Context

There are two mandatory climate-related disclosure regulations in the U.K. applied for specific firms listed on London Stock Exchange. The first one is the New Listing Rule - Policy Statement 20/17 (PS20/17) which was proposed by Financial Conduct Authority (FCA) for commercial companies with a UK premium listing, on a "comply or explain" basis in March 2020 and approved on December 21st, 2020, and came into effect for accounting periods beginning on or after 1 January 2021. The new listing rule requires that the in-scope firms must include a statement in their annual financial report which sets out whether they have made disclosures consistent with the TCFD's framework. "Comply and explain" means where disclosures have not been made, there must be an explanation of why and a description of any steps they are taking or plan to take to make consistent disclosures in future. The second one is The Companies (Strategic Report) (Climate-related Financial Disclosure) Regulations 2022 which was proposed in December 2021 and approved by the U.K. Parliament on January 17th, 2022, and came into force on 6th April 2022. This requires all in-scope companies to provide climate-related information in accordance with the TCFD in a strategic report. Instead of disclosing on a comply-or-explain basis, it is the full compliance for specific publicly quoted companies and large private companies.

Research period.

We define the research period is from December 2018 to December 2023 (21 quarters) with pre-period from December 2018 to September 2020 (8 quarters), the post1-period from December 2020 to December 2021 (5 quarters) and post2-period from March 2022 to December 2023 (8 quarters).

Figure 2. Timeline of climate-related disclosure regulation in the U.K.



Sample selection.

The research only focuses on equity listed firms, thus, based on the criteria of regulated firms in each regulation, we construct 3 samples: the first one includes the firms regulated by both The New Listing Rule PS 20/17 and the Company Regulations 2022, the second one includes the firms regulated by only Company Regulations 2022 and the last one includes the firms unregulated by both regulations.

First, we collect the list of all the equity listed firms in all market segments on the London Stock Exchange from the website of London Stock Exchange.

Second, based on the criteria for regulated firms by each regulation, for the first sample: we sort the firms meeting 3 requirements: (1) the firms with UK Premium listing; (2) being UK companies; and have more than 500 employees and we get a sample of 321 firms (called as Premium sample). The second sample includes the firms meeting two requirements: (1) firms listed on Alternative Investment Market (AIM) segment and (2) have more than 500 employees (called regulated AIM sample) and we get 148 firms. The last one includes the remaining firms listed on the AIM market segment which are not regulated by both regulations, and we get 586 firms (called non-regulated AIM sample).

Third, we use these samples to estimate COC at portfolio level and firm level. The process estimating COC at portfolio-specific level for regulated firms and unregulated firms generates the R^0_{ES} and R^1_{ES} samples with the number of firms as shown in table 7. The process estimating COC at firm-specific level for all regulated firms and unregulated firms generates a firm-quarter dataset of 445 firms and 3365 observations (231 firms regulated by both regulations, 98 firms regulated by only 2nd regulation and 116 firms unregulated by any regulations).

3.2.3 Japan

Context

Like the U.K., there are 2 mandatory climate-related disclosure regulations in Japan. The first one is Corporate Governance Code Revision 2021 which includes some climate-related disclosure principles only applying for listed firms in the Prime market segment, proposed in April 2021[8] and approved on June 11th, 2021, by Tokyo Stock Exchange (TSE). This Revision 2021 requires the firms in the Prime market to collect and analyse the necessary data on the impact of climate change-related risks and earning opportunities on their business activities in corporate governance reports on a "comply-or-explain" basis. In April 2022, TSE restructured the stock market and began operating a new market segment that clarified the concept and listing criteria for each market, including Prime Market, Standard Market and Growth Market. The Prime market is tailored for large, global companies that must meet strict requirements. These firms are expected to adhere to high corporate governance standards, making them attractive to institutional investors both in Japan and internationally. The Standard market caters to medium-sized companies that may not meet the size and governance criteria of the Prime market. Meanwhile, the Growth market focuses on emerging companies with significant growth potential, though they may have less established track records.

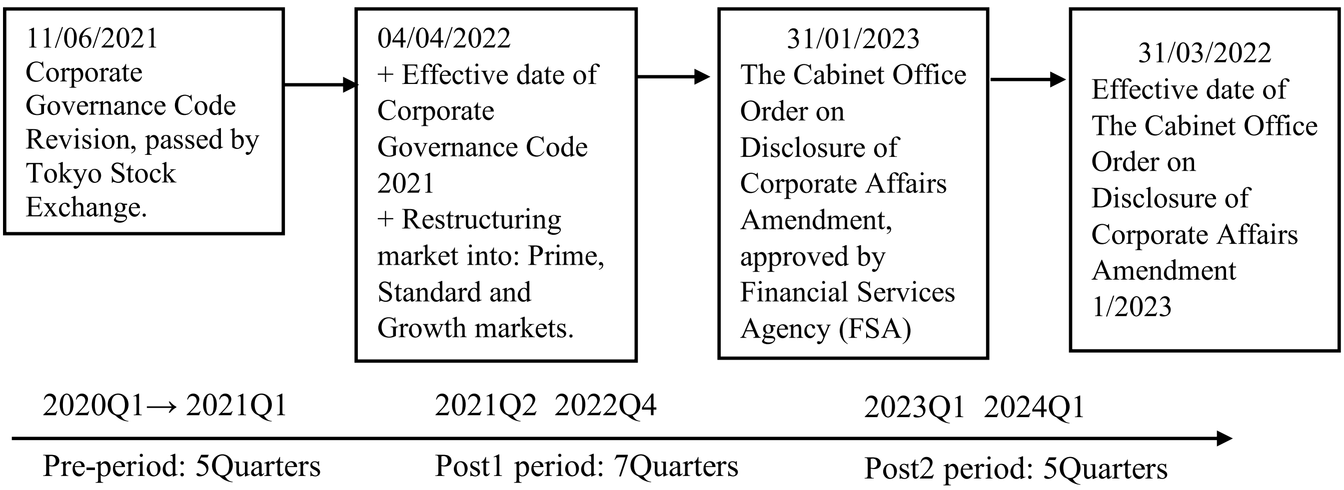
[8] https://www.jpx.co.jp/english/equities/improvements/market-structure/index.html

The second one is The Cabinet Office Order on Disclosure of Corporate Affairs Amendment which was proposed in April 2022 by Financial Services Agency (FSA)- a government organization, being approved on January 31st, 2023, and has applied to Disclosure Statements for fiscal years ending on or after 31 March 2023. It is a mandatory full compliance regulation applied for all companies listed on the Japanese stock market, including those in the Prime, Standard, and Growth market segments. Thus, the listed companies in the Prime segment are regulated by both regulations while the firms in the Standard segment and Growth segment are only regulated by the second one.

Research period.

The research period is from March 2020 to March 2024 (17 quarters). We define March 2020 to March 2021 (5 quarters) as the pre-period, June 2021 to December 2022 (7 quarters) as the post1-period and March 2023 to March 2024 as the post2-period (5 quarters).

Figure 3. Timeline of climate-related disclosure regulation in Japan.



Sample selection.

We construct 2 samples as follows. The first one includes the firms regulated by Corporate Governance Code Revision 2021: the firms in the Prime market segment. The second one includes the remaining firms which are regulated by only The Cabinet Office Order on Disclosure of Corporate Affairs Amendment: the firms in the Standard and Growth market.

First, we get the list of firms in each market segment from the website of Tokyo Stock Exchange from April 2022 to March 2024. During this period, some firms change their market segments. Thus, Second, for the first sample, we choose the firms that are listed on the Prime market during the period from April 2022 to March 2024. For the second sample, we choose the firms that are listed on the Standard and Growth market during the period from April 2022 to March 2024.

Third, we use these samples to estimate COC at portfolio level and firm level. The process estimating COC at portfolio level for 2 samples generates the R^0_{ES} samples with the number of firms as shown in table 14. The process estimating COC at firm level and requiring the data availability of twelve control generate a firm-quarter dataset of 1477 firms with 18808 observations (1205 firms in the Prime market, regulated by both regulations and 272 firms in Standard and Growth market, regulated by only 2nd regulation).

3.3 Empirical design

3.3.1 Firm-specific COC estimation

We employ a firm-quarter analysis to examine the effect of mandatory climate-related disclosure regulations on the firms' cost of capital in 3 countries: New Zealand, the United Kingdom and Japan separately.

Following Chen et al. (2010), our dependent variable is the excess return which is calculated by subtracting the risk-free interest rate measured as the yield on the 10-year government (New Zealand, United Kingdom, Japan) Treasury bonds in quarter t from the implied cost of equity capital estimated at quarter t.

Our variables of primary interest are $POST_t$ (New Zealand), the proxy for the mandatory climate-related disclosure regulation and $POST1_t$ and $POST2_t$ (Japan and the U.K.), the proxy for the comply-or-explain and full compliance climate-related disclosure regulations respectively.

We include 12 control variables in the regression model to control for time-varying firm-specific characteristics that have been shown to be associated with implied cost of capital. Table 19 shows the definitions of control variables.

We include firm fixed effects and a time trend variable to account for time-invariant firm characteristics potentially linked to the implied cost of capital, as well as the potential influence of macroeconomic conditions on the implied cost of capital.

New Zealand

Due to the data processing to estimate implied cost of capital, all unregulated firms in NZ are excluded. Thus, we only run a firm-quarter regression model for a sample of regulated firms.

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_1 TRANS_t + \alpha_2 POST1_t + \beta_j X_{it} + \varepsilon_{it} \quad (10a)$$

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_{i+} \alpha_1 TRANS_t + \alpha_2 POST1_t + \beta_j X_{it} + \varepsilon_{it} \quad (10b)$$

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_{i+} \alpha_1 TRANS_t + \alpha_2 POST1_t + \beta_j X_{it} + Ttrend_t + \varepsilon_{it} \quad (10c)$$

Where:

R_{GLSit} is the implied cost of equity measured using GLS model (Gebhardt et al., 2001), for firm i in quarter t.

$TRANS_t$ ($POST_t$) is an indicator variable set to one if an observation is in the transition (post) period and zero otherwise.

R_{Ft} is the risk-free interest rate measured as the yield on the 10-year New Zealand government Treasury bonds in quarter t.

$\beta_j X_{it}$: variables control for time-varying firm-specific characteristics which are associated with implied cost of equity capital, shown in Table 19- appendix.

α_i: control for firms fixed effect

$Ttrend_t$: time trend variable which takes the value from 20 to 1 over 20 quarters for New Zealand, 21 to 1 over 21 quarters for U.K., and from 1 to 17 over 17 quarters for Japan.

U.K.

Unlike New Zealand, the U.K. has 2 mandatory climate-related disclosure regulations. Thus, the variable of primary interest is $POST1_t$($POST2_t$), an indicator variable set to 1 if an observation is observed in or after the quarter The New Listing Rule PS 20/17 (Company Regulations 2022) passed and zero otherwise.

To capture the differences in the cost of capital between regulated and unregulated firms after each regulation, we include two interactions: POST1*Reg1 and POST2*Reg2 in the regression model. Reg1(Reg2) is an indicator variable, set to 1 if the firms are regulated by the New Listing Rule PS 20/17 (Company Regulations 2022) and zero otherwise.

To examine the impact of mandatory climate-related disclosure regulations on the firms' COC in Japan, we run the following regression model.

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_1 POST1_t + \gamma_1 POST1_t \times Reg1_i + \alpha_2 POST2_t + \gamma_2 POST2_t \times Reg2_i + \beta_j X_{it} + \varepsilon_{it} \quad (11a)$$

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_i + \alpha_1 POST1_t + \gamma_1 POST1_t \times Reg1_i + \alpha_2 POST2_t + \gamma_2 POST2_t \times Reg2_i + \beta_j X_{it} + \varepsilon_{it} \quad (11b)$$

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_i + \alpha_1 POST1_t + \gamma_1 POST1_t \times Reg1_i + \alpha_2 POST2_t + \gamma_2 POST2_t \times Reg2_i + \beta_j X_{it} + Ttrend_t + \varepsilon_{it} \quad (11c)$$

Japan

Like the U.K., Japan has 2 mandatory climate-related disclosure regulations. Thus, the variable of primary interest is $POST1_t$($POST2_t$), an indicator variable set to 1 if an observation is observed in or after the quarter the Governance Code 2021 (The Cabinet Office Order on Disclosure of Corporate Affairs Amendment 2023) passed and zero otherwise.

To capture the difference in the cost of capital between the firms in the 2 samples after the Corporate Governance Code 2021 (comply-or-explain regulation), we include an interaction POST1*Reg1 in the regression model. Reg1 is an indicator variable set to 1 if the firm is regulated by the Corporate Governance Code 2021 and zero otherwise.

To examine the impact of mandatory climate-related disclosure regulations on the firms' COC in Japan, we run the following regression model.

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_1 POST1_t + \gamma_1 POST1_t \times Reg1_i + \alpha_2 Post2_t + \beta_j X_{it} + \varepsilon_{it} \quad (12a)$$

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_i + \alpha_1 POST1_t + \gamma_1 POST1_t \times Reg1_i + \alpha_2 Post2_t + \beta_j X_{it} + \varepsilon_{it} \quad (12b)$$

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_i + \alpha_1 POST1_t + \gamma_1 POST1_t \times Reg1_i + \alpha_2 Post2_t + \beta_j X_{it} + Ttrend_t + \varepsilon_{it} \quad (12c)$$

For panel regression, since the firms enter the sample more than once, we use robust standard errors (Petersen 2009) corrected for heteroscedasticity and clustering at firm level to make statistical inferences[9].

3.3.2 Portfolio-specific COC estimation

First, for each country, we select samples of both regulated firms and unregulated firms based on the criteria for regulated firms of each country, mentioned in section 3.2.1, 3.2.2, 3.2.3 respectively for New Zealand, the U.K. and Japan. Second, we define the research period based on the context of each country. Third, we partition each sample into many portfolios. Each portfolio corresponds to a quarter in the research period. Fourth, we estimate equation 6 (R^0_{ES}) or equation 9 (R^1_{ES}) for each portfolio and obtain quarterly cost of capital estimates. Finally, we use the following equations to estimate the impact of climate-related disclosure regulations on the cost of equity capital. Because this approach only produces time-series portfolio-specific COC estimates, this makes it difficult to control for other factors that may affect cost of capital.

For New Zealand, with only one mandatory full compliance climate-related disclosure regulation.

$$R_{ESt} - R_{Ft} = \alpha + \beta_1 TRANS_t + \beta_2 POST_t + \varepsilon_t \quad (13a)$$

$$R_{ESt} - R_{Ft} = \alpha + \beta_1 POST_t + \varepsilon_t \quad (13b)$$

For Japan and the U.K., with 2 mandatory climate related disclosure regulations, the first regulation is implemented on comply-or-explain basis and the second one is implemented with a full compliance.

$$R_{ESt} - R_{Ft} = \alpha + \beta_1 POST1_t + \beta_2 POST2_t + \varepsilon_t \quad (14a)$$

$$R_{ESt} - R_{Ft} = \alpha + \beta_1 POST2_t + \varepsilon_t \quad (14b)$$

[9] Our findings in table 9,13,19 are qualitatively unchanged when we adjust standard errors for clustering at both firm level and time level (Petersen 2009).

Where R_{ESt} is the cost of equity capital based on future earnings (R^1_{ES}) or current earnings (R^0_{ES}) at quarter t. $TRANS_t$ ($POST_t$) is an indicator variable set to one if an estimation portfolio is in the transition (post) period and zero otherwise.

$POST1_t$ is an indicator variable set to 1 if the portfolio is in or after the quarter that the "comply-or-explain" regulation was passed and zero otherwise. $POST1_t$ captures the impact of the comply-or-explain regulation.

$POST2_t$ is an indicator variable set to 1 if the portfolio is in or after the quarter that the 2nd or full compliance regulation was passed and zero otherwise. $POST2_t$ captures the impact of the full compliance regulation.

R_{Ft} is the risk-free rate measured as the yield on the 10-year government (New Zealand, United Kingdom, Japan) Treasury bonds in quarter t.[10]

After that, to account for potential serial correlations in residuals over time, we use Newey and West (1987) to compute t-statistics and adjust standard errors which correct for this potential time series correlation.

3.4 Data collection and data sources.

3.4.1 Firm-specific cost of capital estimation

After getting the sample mentioned in section 3.2.1, 3.2.2, 3.2.3, to estimate COC at the firm level, we follow the method of Chen et al. (2010). First, we require the stock price at the end of the current quarter, one-year-ahead and two-year-ahead annual earnings forecasts, positive beginning-of-year book value of equity, and a long-term growth forecast. We estimate the implied cost of capital at the end of each calendar quarter during the research period. Our estimation algorithms require the cost of capital estimates to be positive and less than 100%. We delete cost of capital estimates that do not converge or are greater than 50%. Second, after obtaining COC estimates, we further require the availability of 12 control variables (described in Table 19-appendix) for an observation to be included in our sample. This selection process results in a final sample for each country as following: New Zealand with 50 regulated firms and 782 observations from March 2019 to December 2023, U.K with 445 firms and 3365 observations (231 firms regulated by both regulations, 98 firms regulated by only 2nd regulation and 116 firms unregulated by any regulations) from December 2018 to December 2023, and Japan with 1477 firms and 18808 observations (1205 firms in the Prime market, regulated by both regulations and 272 firms in Standard and Growth market, regulated by only 2nd regulation) from March 2020 to March 2024.

All data is collected from the Workspace database of the London Stock Exchange, except the list of unregulated firms in New Zealand collected from Compustat Global.

[10] The residuals in Equation 13a, 13b, 14a, 14b may exhibit serial correlation. To address this issue, we compute t-statistics using Newey and West (1987) adjusted standard errors, which correct for this potential time series correlation.

3.4.2 Portfolio-specific cost of capital estimation

The sample selection processes are slightly different depending on which equation is used to estimate the cost of equity capital. To calculate the cost of capital based on current earnings (R^0_{ES}) using equation 6, it requires the availability of the following data items: (1) stock price (P_t) at the end of the calendar quarter t; (2) book value of equity at the end of the fiscal quarter ending in the calendar quarter t (B_t) and in year t - 1 (B_{t-1}), scaled by the number of shares outstanding at the end of quarter t and quarter t - 4, respectively; (3) realized earnings for the current year (EPS_t) starting from quarter t - 3, calculated as the sum of the next four quarterly earnings (that is, quarter t - 3 to quarter t) before extraordinary items scaled by the number of shares outstanding at the end of quarter t. We delete the top and bottom 2.5% of each variable in equation 3 in a quarter to reduce the undue influence of outliers and require EPS_t and B_{t-1} to be positive.

On the other hand, to calculate the cost of capital based on future realized earnings (R^1_{ES}) using equation 6, we require the availability of the following data items: (1) stock price (P_t) at the end of the calendar quarter t; (2) book value of equity (B_t) at the end of the fiscal quarter ending in the calendar quarter t scaled by the number of shares outstanding (quarterly data) at the end of quarter t; and (3) realized earnings for the next year (EPS_{t+1}) starting from quarter t +1, calculated as the sum of the next four quarterly earnings (that is, quarter t + 1 to quarter t + 4) before extraordinary items (quarterly data) scaled by the number of shares outstanding at the end of quarter t. We delete the top and bottom 2.5% of each variable in equation 9 in a quarter to reduce the undue influence of outliers and further require EPS_{t+1} and B_t to be positive. After these processes, we get the different samples to estimate R^0_{ES} and $R^1_{ES.}$

All data is collected from the Workspace database of the London Stock Exchange.

4. Results and Discussion

As analysed above, we consider the results from the panel regression as the main results, and the results from the time series regression as robustness checks.

4.1 Descriptive Statistics and correlation matrix

4.1.1 New Zealand

Table 5 presents an overview of the primary variables used in this research, including the number of observations, mean, standard deviation, 1st, 25th percentile, median, 75th percentile, 99th percentile, minimum value, and maximum value. R_{GLS} has a mean of 8.425%, and a standard deviation of 4.483%. The excess return has a mean of 5.778%, and a standard deviation of 4.65%. Table 5 presents the correlation matrix of the variables used in this study. Both TRANS and POST are negatively correlated with excess return. The correlation between the independent (TRANS and POST) and the dependent variables (excess return) is consistent with the expected relationship. The coefficient of the correlation between excess return and TRANS is -0.034 while that of excess return and POST is -0.228. This reveals a weaker impact of proposed Bill on cost of capital and stronger impact of the official law on cost of capital of the firms.

4.1.2 The U.K.

Table 10 presents an overview of the primary variables used in this research, including the number of observations, mean, standard deviation, 1st, 25th percentile, median, 75th percentile, 99th percentile, minimum value, and maximum value. R_{GLS} has a mean of 3.751%, and a standard deviation of 4.815%. The excess return ($R_{GLS} - R_F$) has a mean of 1.845%, and a standard deviation of 4.94%. Table 11 presents the correlation matrix of the variables used in this study. Both POST1 and POST2 are negatively correlated with excess return. The correlation between the independent (POST1 and POST2) and the dependent variables (excess return) is consistent with the expected relationship. The coefficient of the correlation between excess return and POST1 is -0.184 while that of excess return and POST2 is -0.204. This reveals that the full compliance regulation has stronger relationship with cost of capital.

The coefficients of interaction POST1*Reg1 and POST2*Reg2 are negative shows that cost of capital of regulated firms is lower than that of unregulated firms.

4.1.3 Japan.

Table 16 presents an overview of the primary variables used in this research, including the number of observations, mean, standard deviation, 1st, 25th percentile, median, 75th percentile, 99th percentile, minimum value, and maximum value. R_{GLS} has a mean of 7.39%, and a standard deviation of 3.787%. The excess return ($R_{GLS} - R_F$) has a mean of 7.137%, and a standard deviation of 3.809%. Table 17 presents the correlation matrix of the variables used in this study. Both POST1 and POST2 are negatively correlated with excess return. The correlation between the independent (POST1 and POST2) and the dependent variables (excess return) is consistent with the expected relationship. The coefficient of the correlation between excess return and POST1 is -0.044 while that of excess return and POST2 is -0.091. This reveals the weaker impact of both regulations on cost of capital and the full compliance regulation has stronger relationship with cost of capital than the comply-or-explain regulation. The coefficients of interaction POST1*Reg1 is negative shows that cost of capital of the firms regulated by the comply-or-explain regulation is lower than that of the firms unregulated by the comply-or-explain regulation.

4.2 Impact of mandatory climate-related disclosure regulations firms' cost of capital.

4.2.1 New Zealand

Table 6 presents the results of the firm-quarter regressions using different models, including Pooled OLS, firm fixed effects, and firm fixed effects with a time trend, based on equations 10a, 10b, and 10c. These regressions are conducted using the sample of 50 regulated firms described in Section 3.2.1. The coefficients for TRANS and POST are relatively consistent across all models. While the coefficients for TRANS are negative (-0.282%, -0.779%, and -0.521%), they are statistically insignificant, indicating that the Bill did not have a significant impact on the cost of capital for regulated firms during the transitional period.

The coefficient on POST is significant and negative (-1.225%, -1.920%, and -1.415%), indicating that, on average, the cost of capital for regulated firms decreases by 1.225%, 1.92%, or 1.415%, respectively, across the three models in the post-regulation period compared to the pre-regulation period, after accounting for other factors influencing the implied cost of capital. This finding supports Hypothesis 1. There are two reasons why this regulation benefits significantly New Zealand market capital. First, the effects of regulatory changes likely depend on existing regulation and institutions. New disclosure regulation or reporting standards need to be enforced and hence are unlikely to be effective without reliable auditing, supervisory agencies, and/or legal remedies (Leuz & Wysocki, 2016). New Zealand has very good supervisory agencies, and/or legal remedies to implement this regulation.[11] Second, firms with weaker information environments benefit more from ESG disclosure mandates (Krueger et al., 2021).[12]

The coefficient of the time trend variable is very small and insignificant (0.001), suggesting no evidence of a time trend in the cost of capital during the research period.

The coefficients of POST in table 3 for unregulated firms when we estimate the equation 13a and 13b are negative (-2.884 and -1.760) but insignificant, showing that after this regulation the cost of capital of unregulated firms does not change significantly, consistent with Hypothesis 2. According to Hon and Hon (2020), investors are aware that unregulated firms in New Zealand are SMEs that lack the financial and expertise resources to voluntarily comply with mandatory climate disclosures, which are more complex than financial information (Krueger et al., 2021) and hence, risk premium for unregulated firms keeps unchanged.

The coefficients on control variables are generally consistent with prior literature. Consistent with Chen et al. (2010) and Dhaliwal et al. (2005, 2007), coefficients of β_{MKT}, β_{SMB}, β_{HML} are positive but all are insignificant. Consistent with Gebhardt et al. (2001) and Gode and Mohanram (2003), and Chen et al. (2010), we find a negative significant coefficient on LogMV (-0.016), positive significant coefficient on Growth

[11] See the document that outlines the FMA's implementation approach for the CRD regime over a period of approximately 4 years, through to 2025/26. It sets out the roles and responsibilities of the various government agencies, to help industry understand 'who is doing what' with regard to CRD. Climate-related disclosures regime implementation approach | Financial Markets Authority (fma.govt.nz), more information in Mandatory climate-related disclosures | Ministry of Business, Innovation & Employment (mbie.govt.nz)

[12] Based on the proposal of Hon James Shaw and Hon Kris Faafoi, Ministers of MBEI, 2020: (1) Investor and business awareness about climate change: There is very little high quality climate related reporting in NZ, resulting from and contributing to, what the Reserve Bank Governor has call a "thin" awareness of climate change in the financial system in NZ. (2) There are no express express statutory requirements on NZ entities to consider and report on how climate change impact the long-term strategy and viability of a company. (3) NZ financial markt: NZ is also dominated by SMEs, NZ companies are reluctant to list, with concerns including compliance, continuous disclosure standards. (4) Until 7/2020, there is little information available on company-level emissions or climate risks. climate-related-financial-disclosures-regulatory-impact-assessment.pdf (environment.govt.nz)

(0.008) and IndRP (0.567) but negative and insignificant coefficient on LogBM and Ferr. Consistent with Gebhardt et al. (2001), Dhaliwal et al. (2005, 2007) and Chen et al. (2010), we find a negative and significant coefficient on LogDisp (0.027).

4.2.2 United Kingdom

Table 12 presents the results of the firm-quarter regressions using different models, including Pooled OLS, firm fixed effects, and firm fixed effects with a time trend, based on equations 11a, 11b, and 11c. These regressions are conducted using the sample of 445 regulated firms described in Section 3.2.2. While the coefficient on POST1 in Pool OLS and firm fixed effect model is negative, it in firm fixed effect and time trend model is positive, but all are insignificant. It shows that the comply-or-explain regulation does not have a significant impact on both regulated and unregulated firms in the U.K. The coefficients of POST1*Reg1 across the models are small and insignificant, showing that there are no significant differences in the impact of this regulation on cost of capital between regulated and unregulated firms.

The comply-or-explain regulation in the U.K. has little impact on the cost of equity capital due to the combination of two factors. First, the comply-or-explain basis has less enforcement than a full compliance one because a full compliance without the option to deviate from a default case makes disclosure rules stricter and rigid because firms cannot opt out of compliance by providing explanations for why they choose not to disclose. Krueger et al. (2021) find that there is heterogeneity in the impact of ESG disclosure mandates on firms' economic (liquidity) and the liquidity effect of ESG mandate is strongest if the disclosure requirements are implemented by government institutions, not on a comply-or-explain basis. Thus, a comply-or-explain basis can weaken the impact of climate-related disclosure regulation on cost of capital.[13] Second, U.K. is the most globally integrated equity market in the world and in a more globally integrated market where investors can invest freely in stocks around the world, it is easier to find close substitutes in other countries, which is likely to reduce the effects of securities regulation and other legal institutions (Hail & Leuz, 2006). Hail & Leuz (2006) investigating the impact of security regulations on the cost of equity capital across 40 countries

[13] Krueger et al. (2021) states "*We consider two forms of cross-country variations. The first heterogeneity exploits that ESG disclosure mandates are implemented by different institutions around the world. Government institutions, such as ministries and securities regulators, implement the rules in some countries, whereas local stock exchanges take the lead in others. Governments should have more credible implementation mandates, be less affected by regulatory capture, and have more resources to implement (and eventually enforce) the rules effectively. Thus, we expect larger liquidity benefits if the mandates are issued by governments rather than exchanges. The second heterogeneity exploits the practice of some countries to adopt "comply-or-explain" rules under which firms can provide the ESG disclosures or explain why they do not. The rationale is that a one-size fits- all approach may not be suitable for all firms, because of high information production or proprietary disclosure costs. Other countries require full compliance without the option to deviate from a uniform default case; thus, the rules are more rigid as firms cannot opt out. Liquidity should improve more if mandatory ESG disclosure is introduced on a binding, rather than comply-or-explain, basis, because more information is released to all market participants*". In our setting, cost-of-capital effect of mandatory climate disclosure regulation can be explained in the similar channels.

in the world including the U.K find the cost-of-capital effect of securities regulations becomes statistically insignificant as capital markets become more globally integrated.[14]

The coefficient of POST2 is strongly significant and negative (-1.019% and -1.363%) in Pool OLS and firm fixed effect models, describing that the cost of capital of unregulated firms experiences a decrease more than 1% in the period after the full compliance regulation was passed compared to the pre-period. The coefficients of POST2*Reg2 across 2 models are very small and insignificant, showing that there are not any significant differences in the COC between regulated firms and unregulated firms caused by this regulation. In conclusion, cost of capital of all the regulated and unregulated firms in UK decreases more than 1% after the passage of the full compliance regulation. The consistency across Pooled OLS and firm fixed effects models strengthens this conclusion since firm-specific effects are accounted for in the fixed effects model.

In the model 11c with firm fixed effect and time trend, coefficient on POST2 is negative but insignificant and the coefficient on time trend is very small but significant (0.001). This suggests that the observed reduction in cost of capital may partly coincide with an underlying time trend unrelated to the policy. To make the results more robust, we use alternative specifications which adds interaction between the policy variables (POST1 and POST2) and time trend variable to explore whether the policy impact evolves differently over time. The results are shown in the column 5,6,7 table 12 with an addition of POST1*Ttrend, POST2*Ttrend and both POST1*Ttrend and POST2*Ttrend respectively. The coefficients of POST1 are consistent and negative but only significant in specification I and the coefficients of POST2 are negative across 3 specifications and significant in specifications II and III. It indicates that the comply-or-explain regulation initially shows some impact in reducing the cost of capital over time, its effect is weak and disappears in more complex specifications with both interaction terms, suggesting that this policy's impact is either small or not sustained over time. In contrast, the full compliance regulation has significant and consistently negative effect on the cost of capital, especially when accounting for the interaction with the time trend. This suggests that the full compliance regulation has stronger and more persistent effect in reducing the cost of capital over time, potentially due to factors such as improved investor confidence, market stability, or long-term benefits. The interactions POST1*Ttrend and POST2*Ttrend are significant positive across 3 specifications, indicating that the effects of these policies increase as time progresses.

There is one argument that regulated firms' mandatory disclosures crowd out unregulated firms' voluntary disclosures and unregulated firms reduce their own disclosures in the presence of regulated firms' disclosures (Breuer et al., 2022). Thus, it increases the cost of capital for unregulated firms. However, Jinji

[14] In the Hail, L., & Leuz, C. (2006)' paper: United Kingdom's equity market is considered as integrated equity market with two dummy variables (DEV and FLOW) standing for the market's integration taking value 1.

(2023) investigating impact of mandatory disclosure regulation on cost of capital for regulated firms and unregulated firms shows that the mandatory disclosure regulation reduces cost of capital for regulated firms directly and indirectly reduces cost of capital for unregulated firms when the cash flows of regulated firms and unregulated firms are mildly negative correlated, there is disclosure complementarity between them- following an increase in regulated firms' disclosure, unregulated firms' disclosure move endogenously in the same direction. This is because, when regulated firms increase their disclosures, it increases unregulated firms' marginal benefit of disclosure when their cash flows are mildly negatively correlated and hence increases unregulated firms' disclosure. It leads to a decrease in cost of capital for unregulated firms and for all firms. Another explanation is that different from unregulated firms in New Zealand, unregulated firms in AIM market on London Stock Exchange are larger in size and better in both financial and expertise resources, hence they have enough resources to comply with mandatory climate-related regulation voluntarily, increasing their climate-related disclosure and reducing their cost of capital.

Some of the coefficients of control variables are consistent with prior literature. Consistent with Gebhardt et al. (2001) and Gode and Mohanram (2003) and Chen et al. (2010), we find positive and significant coefficients on Growth (0.002), and IndRP (0.319). Consistent with Hail and Leuz (2006) and Chen et al. (2010), we find a positive coefficient on Ferr (5.518%). The coefficients of β_{MKT}, β_{HML}, LogMV, Lev are positive but insignificant.

4.2.3 Japan

Table 18 presents the results of the firm-quarter regressions using different models, including Pooled OLS, firm fixed effects, and firm fixed effects with a time trend, based on equations 12a, 12b, and 12c. These regressions are conducted using the sample of 1477 firms mentioned in the section 3.2.3.

The coefficient of POST1 is inconsistent across 3 models. It is significantly positive in Pool OLS model (0.527%), insignificantly positive in firm fixed effect model (0.12) but turns to insignificantly negative in the model with firm fixed effect and time trend (-0.021%). This suggests that the policy might initially seem to have a direct positive association with the cost of capital. When firm-specific fixed effects are controlled for, the policy's impact on the cost of capital becomes statistically insignificant, although the direction remains positive. The fixed effects model removes firm-specific time-invariant characteristics might confound the policy's effect. This suggests that the initial significant result in Pooled OLS might partly reflect such confounding factors. The remaining positive (but insignificant) coefficient indicates a weaker or less consistent association between the policy and the cost of capital. When a time trend is added, the policy's coefficient turns negative and becomes insignificant, implying that any remaining association is small and potentially spurious. The time trend might capture broader temporal patterns (e.g., market-wide changes in the cost of capital) that were previously attributed to the policy. In conclusion, the evidence does not strongly support a significant and consistent impact of the comply-or-explain regulation on the cost of capital of regulated firms in the Prime market. The coefficient of interaction POST1*Reg1 across 3 models is insignificant, showing that there is no significant difference in the COC between regulated and unregulated firms by this regulation. In conclusion, the comply-or-explain regulation does not impact significantly on the cost of capital of all firms in Japan.

It is possible because Corporate Governance Code Revision 2021 focuses on 4 new components (Enhancing Board Independence, Promoting Diversity in senior management, Attention to Sustainability and ESG, specifically, climate disclosure based on TCFD framework and others), not only attention to climate-related disclosure. Thus, the impact of this regulation on COC is not the pure impact of climate-related disclosure regulation. Moreover, like the case of U.K., there is possibility that equity market in Japan[15] is globally integrated (Hail & Leuz, 2006) and the regulation on a comply-or-explain basis can lead to the statistically insignificant cost of capital impact.

The coefficient of POST2 are positive across 3 models (0.317%, 0.545% and 0.437%) but only significant in firm fixed effect model showing that across all specifications, the full compliance regulation is associated with an increase in the cost of capital, the direction of the impact is robust and the full compliance regulation likely exerts upward pressure on the cost of capital. In the Pool OLS model, it does not control for firm-specific unobserved factors, so the effect of the regulation might be diluted by omitted variable bias or noise from heterogeneity in the sample. In the firm fixed effects model, the effect becomes statistically significant, suggesting that the regulation's impact on the cost of capital is more clearly observable when firm-specific confounding factors are accounted for. Adding a time trend might absorb part of the variation in the cost of capital attributed to the regulation, especially if the time trend captures broader market-wide or economic changes coinciding with the regulation. The reduced significance may also indicate that the regulation's effect is not distinct from these broader trends.

The interaction POST2*Reg1 is consistently negative but insignificant across 3 models (-0.246%, -0.389%; -0.004%), showing that on average, after the full compliance regulation, cost of capital of the firms in the Prime market decreases less than 0.5% compared to that of firms in the Standard and Growth market although the difference is insignificant.

Our finding is consistent with Daske et al. (2008). The increased effect in COC caused by the full compliance regulation can be explained by two reasons including pre-mandate voluntary disclosures and

[15] In the Hail, L., & Leuz, C. (2006)' paper: Japan equity market is considered as an integrated equity market with two dummy variables (DEV and FLOW) standing for the market's integration taking value 1, Table 1 Panel C.

anticipatory effect. First, pre-mandate voluntary disclosures mean firms can disclose voluntarily before the official mandatory adoption date of the regulation while more public disclosures after mandatory regulation could even have negative information effects. Balakrishnan et al. (2022) argue that if more public disclosure incentivizes only sophisticated investors to produce private information, this could exacerbate the information asymmetry among investors. Thus, it leads to an increase in the cost of capital. The situation of pre-mandate voluntary disclosures is quite popular for other mandatory disclosure regulations.[16] Second, anticipatory effect is that market participants anticipate some effects of the disclosure mandate, in which case including observations of firms that already disclosed climate information voluntarily before the introduction of disclosure mandate likely works against finding a decrease in the cost of capital (Daske et al., 2008). Daske et al. (2008) document that cost of capital decreased one year before the official adoption date for regulated firms and increased after the official adoption date for all firms while Krueger et al. (2021) find the effect of ESG mandate on liquidity occurs 2 years before the adoption date. Additionally, Li (2010) also finds the similar results on the impact of IFRS mandate on cost of equity capital for the countries in EU. His findings show that before the IFRS mandate, firms which voluntarily complied IFRS experienced a lower cost of equity than the firms that did not comply, and this difference becomes insignificant after the mandatory adoption. Similarly, Leuz and Wysocki (2016) agree that capital markets often anticipate regulatory changes, even before the first firms adopt the new rules. It means the regulation is "priced in" from the time of the announcement, if not earlier, which, in turn, implies that a staggered design will not work with economic outcome variables that are anticipatory in nature. Thus, estimated treatment effects are biased when firms can anticipate regulatory changes and hence adjust ahead of the mandate.

Some following reasons explain why the decreased effect can occur before the full compliance mandatory adoption in Japan. First, there is the possibility that a lot of firms voluntarily disclosed climate information before that official adoption date. Second, there are a lot of TCFD initiatives or TCFD guidance established/issued by Japanese government institutions[17] before full compliance mandatory regulation was passed.

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[16] Fiechter, Hitz, and Lehmann (2022) show that firms started reporting on CSR issues before the entry-into-force of the EU directive on CSR reporting. In a similar spirit, analysis in Krueger (2015) also suggests anticipatory effects for the UK's mandatory disclosure rules on greenhouse gas emissions and Krueger et al. (2021) suggest that some firms may have already reported ESG information voluntarily prior to the introduction of ESG disclosure rules, thus, additional disclosure requirements may not have effects. As analysed above, climate-related disclosure is overlapped but narrower than environmental (E) pillar in ESG, thus, impact of climate-related disclosure mandate can be considered quite similar with that of ESG mandate.

[17] Japan is the country that most supports TCFD in the world with the greatest number of TCFD support during the first TCFD report in 2027 and a lot of TCFD initiatives.

6/2017: TCFD published its final report.

8/2018: the Ministry of Economy, Trade and Industry convened the "Study Group on Implementing TCFD Recommendations for Mobilizing Green Finance through Proactive Corporate Disclosure

8/2018: The Ministry of Environment MOE) started the support program for companies to analyze their own climate risks and opportunities in line with the TCFD recommendations and MOE released "the *practical guide for scenario analysis in line with TCFD recommendations"*.

8/2018: Ministry of Economy, Trade and Industry established the TCFD Study Group.

Some of the coefficients of control variables are consistent with prior literature. Consistent with Guay et al. (2003) and Chen et al. (2010), the coefficient on MMT is significantly negative (-0.034). Consistent with Gebhardt et al. (2001), Gode and Mohanram (2003) and Chen et al. (2010), we find a significantly positive coefficient on Growth (0.006). We also find a significantly negative coefficient on LogDisp (0.042) while Gebhardt et al. (2001), Dhaliwal et al. (2005, 2007) and Chen et al. (2010) find a positive coefficient on it.

5. Robustness Tests

5.1 Use another proxy for cost of capital.

Concerning about the weaknesses of firm-specific cost of capital estimation and following Chen et al. (2010), we use residual income valuation model developed by Easton and Sommers (2007) and, to estimate implied portfolio-specific cost of capital and estimate equation 13a and 13b (New Zealand) and 14a and 14b (U.K. and Japan) to examine the impact of climate-related disclosure regulation on cost of capital.

Consistent with the firm-specific COC estimation approach, for New Zealand and U.K., we find that, the impact of the full compliance climate-regulated disclosure regulation on cost of capital of on both regulated firms (NZ&U.K.) and unregulated firms (U.K.) are significantly negative. The results are shown in table 3 (NZ) and table 9 (U.K.).

We don't find significant and consistent results for the impact of comply-or-explain regulation between the portfolio-specific and firm-specific COC estimation approach in the U.K., and the impact of the regulations in Japan.

5.2 Test anticipatory effect for Japan.

Concerning that the decreased effect of climate-related disclosure regulation in Japan can occur in the time prior to the regulation's passage, following Daske et al. (2008) and Krueger et al. (2021), we address this issue by (1) excluding firm-year observations immediately before mandatory climate-related adoption (model 12) and (2) by moving the mandatory climate related disclosure regulation indicator variables by some quarters, that is, we start coding them as one in the year before the official climate-related disclosure adoption date (model 12).

We will collect more data from 2015 to 2019 because the decreased effect can occur from 2018 or 2019 when TCFD was first introduced and guided in Japan.

12/2018: Ministry of Economy, Trade and Industry published the *"Guidance on Climate-related Financial Disclosures (TCFD Guidance*)" to provide explanations and useful examples, as well as to provide "viewpoints" that show the initiatives undertaken by companies in various industries.
5/2019: The TCFD Consortium was established by the Ministry of Economy, Trade and Industry to discuss effective corporate information disclosure.
2019-2022: The Ministry of Economy, Trade and Industry has hosted the TCFD summit
As of 3/2021, there are at least 259 companies reporting their climate disclosures because they are official TCFD supporters, and this number is 1125 as of 10/2022 (before the adoption date of full compliance mandatory climate-related disclosure regulation). About TCFD | TCFD Consortium (tcfd-consortium.jp)

6. Conclusion

We use two approaches estimating implied cost of equity capital at firm level and portfolio level to analyse the cost-of-capital effect of mandatory climate-related disclosure regulation in New Zealand, U.K. and Japan. We document a significant negative effect of mandatory climate-related disclosure mandates on cost of capital if regulation is implemented with full compliance basis for regulated firms in New Zealand and U.K, while significant positive effect for regulated firms in Japan. We also find little evidence on the cost-of-capital effect of comply-or-explain regulation which has less enforcement on implementation, indicating that the regulation implementation can affect the effectiveness of the regulation. Moreover, cost-of-capital effect of mandatory climate-related disclosure regulation with full compliance for unregulated firms is insignificant in New Zealand while it is significant negative in the U.K., showing that the differences in financial and expertise resources as well as the disclosure incentives can affect voluntary disclosures of unregulated firms and hence cost of capital. Our results support the notion that mandatory climate-related disclosure regulations improve the corporate information environment with beneficial capital market effects. These findings encourage and support regulatory changes for countries that have yet to adopt mandatory climate-related disclosure requirements.

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Appendix

Table 1: Distribution of R^1_{ES} and R^0_{ES} samples of regulated and unregulated firms in New Zealand – portfolio-specific estimation.

		Regulated firms		**Unregulated firms**	
	Quarter	R^0_{ES}	R^1_{ES}	R^0_{ES}	R^1_{ES}
Pre-period	2019Q1	73	66	12	15
	2019Q2	77	64	16	15
	2019Q3	73	72	17	16
	2019Q4	68	70	17	15
	2020Q1	66	76	15	15
	2020Q2	64	76	15	15
	2020Q3	67	75	16	16
	2020Q4	70	77	14	12
	2021Q1	75	75	14	15
Transition	2021Q2	76	73	14	16
	2021Q3	75	73	14	16
Post-period	2021Q4	77	74	11	16
	2022Q1	75	73	15	15
	2022Q2	72	73	16	15
	2022Q3	71	73	16	14
	2022Q4	73	73	16	14
	2023Q1	73		15	
	2023Q2	73		15	
	2023Q3	73		14	
	2023Q4	73		14	

Table 2: Descriptive Statistics – portfolio-specific cost of capital estimation-New Zealand

	Regulated firms				Regulated firms				
Variable (%)	R^0_{ES}	R^1_{ES}	Excess return R^0_{ES}	Excess return R^1_{ES}	R^0_{ES}	R^1_{ES}	Excess return (R^0_{ES})	Excess return (R^1_{ES})	R_{Ft}
Mean	8.675	9.322	6.121	7.278	9.444	9.923	6.891	7.805	2.554
SD	1.276	2.188	2.378	3.190	3.802	1.802	3.992	2.026	1.482
Min	6.162	6.471	1.193	2.625	0.880	5.703	-0.347	3.937	0.655
Max	10.87	13.64	9.102	12.79	16.62	13.62	15.45	12.44	4.989
Obs	20	16	20	16	20	16	20	16	20

Table 3: Impact of climate-related disclosure regulation on firms' cost of capital in New Zealand - portfolio-specific estimation.

$$R_{ESt} - R_{Ft} = \alpha + \beta_1 TRANS_t + \beta_2 POST_t + \varepsilon_t \quad (13a) \qquad R_{ESt} - R_{Ft} = \alpha + \beta_1 POST_t + \varepsilon_t \quad (13b)$$

	Regulated firms- Excess return R^0_{ES}		Unregulated firms- Excess return R^0_{ES}	
(%)	**(13a)**	**(13b)**	**(13a)**	**(13b)**
Intercept	7.391***	7.696***	8.807***	7.682***
	(0.313)	(0.374)	(2.124)	(1.972)
TRANS	1.677***		-6.186**	
	(0.318)		(2.204)	
POST	-3.194***	-3.499***	-2.884	-1.760
	(0.964)	(0.931)	(2.143)	(1.967)
Observations	20	20	20	20
R-Adjusted	0.561	0.540	0.170	-0.002[18]

*, **, *** indicate significance levels at 0.10, 0.05, and 0.01 respectively in a two-tail test. The t-statistics are based on Newey and West (1987) adjusted standard errors.

[18] The negative adjusted R^2 (-0.0021) for unregulated firms in New Zealand using R^0_{ES} in equation 8b is due to an implicit constraint in equation 8b that the coefficient on R_{Ft} be equal to one. When we estimate a modified equation 8b where R_{Ft} is moved to the right-hand side, the adjusted R^2 for unregulated firms is -0.0953, and the coefficient on R_{Ft} is still insignificantly different from zero.

Table 4. Descriptive Statistics – firm-specific cost of capital estimation – New Zealand.

Variable	N	Mean	SD	Min	Max	Percentile				
						1%	25%	Median	75%	99%
R_{GLS} (%)	783	8.425	4.483	0.431	35.40	1.872	5.088	8.198	10.701	25.260
R_F(%)	783	2.625	1.429	0.654	4.988	0.655	1.444	2.100	4.278	4.989
$R_{GLS} - R_F$ (%)	783	5.778	4.650	-4.277	33.65	-1.636	2.109	5.701	7.897	23.323
β_{MKT}	783	0.725	0.466	-0.372	2.347	-0.038	0.349	0.655	1.020	1.794
β_{SMB}	783	0.551	0.754	-0.893	3.314	-0.586	-0.014	0.415	0.895	3.039
β_{HML}	783	-0.171	0.582	-3.557	1.349	-1.589	-0.488	-0.157	0.192	1.090
LogMV	783	8.979	0.669	7.800	11.012	7.800	8.459	8.872	9.444	10.985
LogBM	783	-0.186	0.329	-1.718	0.527	-1.385	-0.346	-0.151	0.036	0.465
MMT	783	0.014	0.151	-0.603	1.013	-0.432	-0.070	0.011	0.099	0.393
Lev	762	0.139	0.113	0.000	0.560	0.000	0.051	0.117	0.193	0.505
Ferr (%)	783	0.613	5.229	-41.155	73.265	-9.625	-0.466	0.143	1.053	13.036
Growth	783	0.011	0.848	-8.947	3.706	-4.063	-0.014	0.085	0.200	2.172
LogDisp	783	0.033	0.132	-1.125	1.162	-0.341	0.005	0.022	0.059	0.487
Less2	783	0.124	0.330	0.000	1.000	0.000	0.000	0.000	0.000	1.000
IndRP	783	0.049	0.031	-0.215	0.171	-0.001	0.027	0.046	0.068	0.119

Table 5: Correlation matrix - NZ

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
$R_{GLS} - R_F$ (1)	1														
TRANS (2)	-0.034	1.000													
POST (3)	-0.228	-0.323	1.000												
β_{MKT} (4)	0.000	0.111	0.173	1.000											
β_{SMB} (5)	0.106	-0.026	0.404	0.566	1.000										
β_{HML}(6)	0.145	-0.121	0.210	0.203	0.463	1.000									
LogMV (7)	-0.316	-0.009	-0.025	-0.170	-0.269	-0.115	1.000								
LogBM (8)	0.322	-0.008	-0.030	0.065	0.147	0.451	-0.127	1.000							
MMT (9)	-0.213	0.337	-0.087	0.024	-0.047	-0.126	0.012	-0.185	1.000						
Lev (10)	0.239	0.004	-0.023	0.021	0.091	0.255	0.145	0.464	-0.065	1.000					
Ferr (11)	0.066	-0.012	-0.046	-0.056	-0.019	-0.023	-0.132	0.067	-0.040	-0.078	1.000				
Growth (12)	0.212	-0.011	-0.047	-0.175	-0.145	-0.023	0.106	0.001	0.020	0.048	-0.054	1.000			
LogDisp (13)	0.125	-0.004	-0.097	-0.152	-0.117	-0.058	0.116	0.003	0.026	0.037	-0.034	0.247	1.000		
Less2 (14)	0.021	0.041	0.096	0.170	0.235	0.119	-0.368	0.045	0.020	0.011	0.150	-0.127	-0.096	1.000	
IndRP (15)	0.666	0.000	-0.279	-0.039	-0.007	-0.105	-0.234	0.121	-0.091	0.153	0.060	0.069	0.001	-0.001	1.000

Table 6: Impact of climate-related disclosure regulation on firms' cost of capital in New Zealand - firm-specific estimation.

Variables	Pool OLS	Firm Fixed effect	Firm Fixed effect and Time trend
Intercept (%)	12.78***	17.34***	15.94**
	(3.66)	*(5.969)*	(6.918)
TRANS (%)	-0.282	-0.779	-0.521
	(0.31)	*(0.473)*	(0.527)
POST (%)	-1.225**	-1.920***	-1.415*
	(0.476)	*(0.627)*	(0.775)
β_{MKT}	0.0001	0.014	0.015
	(0.005)	*(0.009)*	(0.010)
β_{SMB}	0.005	0.00003	0.002
	(0.004)	*(0.003)*	(0.004)
β_{HML}	0.012**	0.009	0.008
	(0.006)	*(0.006)*	(0.006)
LogMV	-0.012***	-0.016**	-0.016*
	(0.004)	(0.007)	(0.008)
LogBM	0.005	-0.02	-0.017
	(0.016)	*(0.024)*	(0.024)
MMT	-0.034***	-0.029***	-0.031**
	(0.010)	*(0.011)*	(0.011)
Lev	0.007	-0.009	-0.008
	(0.019)	*(0.021)*	(0.021)
Ferr(%)	0.018	0.023*	0.024*
	(0.018)	*(0.001)*	(0.013)
Growth	0.011***	0.008***	0.008***
	(0.003)	*(0.002)*	(0.003)
LogDisp	0.034***	0.027***	0.027***
	(0.009)	*(0.007)*	(0.009)
Less2	-0.006	-0.005	-0.005
	(0.005)	*(0.006)*	(0.005)
IndRP	0.884***	0.567**	0.552**

	(0.142)	(0.227)	(0.259)
Time trend	**No**	**No**	0.001
			(0.001)
Firm fixed effect	**No**	**Yes**	**Yes**
Observations	783	782	782
N (firms)	51	50	50
R-Adjusted	0.602	0.761	0.761

*, **, *** indicate significance levels at 0.10, 0.05, and 0.01 respectively in a two-tail test.

Table 7: Distribution of R^1_{ES} and R^0_{ES} samples of regulated and unregulated firms in the United Kingdom

	Quarter	**Premium**		**Regulated AIM**		**Non-regulated AIM**	
		R^0_{ES}	R^1_{ES}	R^0_{ES}	R^1_{ES}	R^0_{ES}	R^1_{ES}
Pre-period	2018Q4	163	160	81	80	132	125
	2019Q1	158	146	84	79	135	127
	2019Q2	159	135	82	67	130	128
	2019Q3	161	125	83	69	128	128
	2019Q4	158	121	81	70	123	140
	2020Q1	145	134	82	76	132	154
	2020Q2	135	151	69	81	127	160
	2020Q3	125	150	69	89	129	173
Transition	2020Q4	123	157	71	93	139	182
	2021Q1	135	155	75	92	128	178

	2021Q2	149	159	81	101	162	170
	2021Q3	152	162	89	100	173	157
	2021Q4	157	159	94	89	188	162
Post-period	2022Q1	154	159	94	86	188	160
	2022Q2	158	153	101	88	174	162
	2022Q3	161	147	100	80	162	150
	2022Q4	158	132	94	79	163	129
	2023Q1	158		84		161	
	2023Q2	153		88		155	
	2023Q3	147		80		141	
	2023Q4	131		79		125	

Table 8: Distribution of R^1_{ES} and R^0_{ES} samples of regulated and unregulated firms in the United Kingdom – portfolio-specific estimation

(%)	**Premium sample**				**Regulated AIM**				**Non-regulated AIM**				
Var	R^0_{ES}	R^1_{ES}	Excess return R^0_{ES}	Excess return R^1_{ES}	R^0_{ES}	R^1_{ES}	Excess return R^0_{ES}	Excess return R^1_{ES}	R^0_{ES}	R^1_{ES}	Excess return R^0_{ES}	Excess return R^1_{ES}	R_{Ft}
Mean	6.384	5.931	4.719	4.821	7.161	8.475	5.497	7.365	8.234	10.14	6.570	9.027	1.7
SD	1.242	1.703	1.792	2.040	1.703	1.647	2.133	2.002	1.367	2.472	2.565	3.237	1.4
Min	4.026	2.451	0.913	1.886	4.146	5.983	0.268	2.531	6.039	7.002	2.035	3.551	0.2
Max	8.747	8.020	7.961	7.804	9.788	11.46	9.567	10.68	11.25	15.31	10.46	15.11	0.44
Obs	21	17	21	17	21	17	21	17	21	17	21	17	21

Table 9: Impact of climate-related disclosure regulation on firms' cost of capital in the United Kingdom - portfolio-specific estimation – changed samples.

$$R_{ESt} - R_{Ft} = \alpha + \beta_1 POST1_t + \beta_2 POST2_t + \varepsilon_t \qquad (14a) \qquad\qquad R_{ESt} - R_{Ft} = \alpha + \beta_1 POST2_t + \varepsilon_t \qquad (14b)$$

	Premium- Excess return R^0_{ES}		**Regulated AIM- Excess return R^0_{ES}**		**Non-Regulated AIM- Excess return R^0_{ES}**	
Coefficient (%)	**(14a)**	**(14b)**	**(14a)**	**(14b)**	**(14a)**	**(14b)**
Intercept	4.976***	5.554***	6.293***	6.27***	7.564***	8.04***
	(0.3)	*(0.441)*	*(1.099)*	*(0.676)*	*(0.398)*	*(0.37)*
POST1	1.5*		-0.060		1.249**	
	(0.77)		*(1.167)*		*(0.585)*	
POST2	-3.115***	-2.191**	-1.993**	-2.031*	-4.64***	-3.870***
	(1.04)	*(0.867)*	*(0.84)*	*(0.992)*	*(1.21)*	*(1.119)*
Observations	21	21	21	21	21	21
R-Adjusted	0.421	0.337	0.139	0.184	0.556	0.564

*, **, *** indicate significance levels at 0.10, 0.05, and 0.01 respectively in a two-tail test. The t-statistics are based on Newey and West (1987) adjusted standard errors.

Table 10: Descriptive Statistics – firm-specific cost of capital estimation – the U.K.

Variable	N	Mean	SD	Min	Max	Percentile 1%	25%	Median	75%	99%
R_{GLS} (%)	3365	3.751	4.815	0.046	41.60	0.072	0.002	0.005	0.099	0.149
R_F (%)	3365	1.906	1.485	0.195	4.372	0.195	0.002	0.005	0.099	0.149
$R_{GLS} - R_F$ (%)	3365	1.845	4.940	-4.317	37.50	-4.233	0.002	0.005	0.099	0.149
β_{MKT}	3365	0.765	0.500	-9.465	4.058	-0.329	0.511	0.760	1.036	1.953
β_{SMB}	3365	1.020	1.301	-3.669	14.793	-1.516	0.205	0.920	1.740	4.698
β_{HML}	3365	0.190	0.877	-4.536	5.881	-1.738	-0.375	0.187	0.703	2.510
$LogMV$	3365	8.748	0.832	6.343	10.983	6.973	8.156	8.708	9.301	10.603
LogBM	3365	-0.269	0.388	-2.609	0.908	-1.456	-0.503	-0.229	-0.010	0.458
MMT	3365	-0.026	0.186	-1.413	0.821	-0.572	-0.122	-0.014	0.078	0.430
Lev	3365	0.125	0.161	0.000	1.208	0.000	0.015	0.069	0.160	0.743
Ferr(%)	3365	0.100	2.300	-2.760	54.10	-3.200	0.000	0.000	0.100	5.100
Growth	3365	0.305	1.832	-16.500	38.668	-1.826	0.024	0.093	0.230	4.867
LogDisp	3365	0.305	0.321	-2.064	2.852	-0.555	0.233	0.313	0.391	1.395
Less2	3365	0.074	0.261	0.000	1.000	0.000	0.000	0.000	0.000	1.000
IndRP	3365	-0.004	0.028	-0.042	0.168	-0.040	-0.024	-0.005	0.002	0.094
POST1Reg1	3365	0.363	0.481	0.000	1.000	0.000	0.000	0.000	1.000	1.000
POST2Reg2	3365	0.366	0.482	0.000	1.000	0.000	0.000	0.000	1.000	1.000

Table 11: Correlation matrix – firm-specific cost of capital estimation – the U.K.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
$R_{GLS} - R_F$ (1)	1																
POST1 (2)	-0.184	1															
POST1*Reg1 (3)	-0.075	0.534	1														
POST2 (4)	-0.204	0.673	0.353	1													
POST2*Reg2 (5)	-0.150	0.537	0.538	0.798	1												
β_{MKT} (6)	0.016	0.041	0.181	0.038	0.116	1											
β_{SMB} (7)	-0.036	0.161	-0.071	0.143	0.054	-0.091	1										
β_{HML} (8)	0.067	0.167	0.138	0.170	0.164	0.007	0.199	1									
LogMV (9)	0.029	-0.039	0.426	-0.049	0.177	0.112	-0.307	-0.023	1								
LogBM (10)	0.165	0.014	0.085	0.050	0.083	0.064	0.007	0.311	-0.115	1							
MMT (11)	-0.016	0.067	0.036	-0.150	-0.129	-0.083	-0.123	-0.015	0.071	-0.037	1						
Lev (12)	0.080	-0.011	0.219	-0.008	0.094	0.171	-0.046	0.316	0.219	0.391	-0.054	1					
Ferr (13)	0.082	-0.037	-0.069	-0.004	-0.016	-0.126	0.041	0.011	0.031	0.009	-0.076	-0.015	1				
Growth (14)	0.058	0.028	-0.032	0.010	-0.044	0.059	0.011	0.037	-0.099	-0.013	-0.059	-0.013	-0.014	1			
LogDisp (15)	-0.043	-0.022	-0.030	-0.005	0.010	0.008	0.004	-0.015	0.045	-0.068	0.087	-0.071	-0.004	-0.051	1		
Less2 (16)	0.049	-0.035	-0.033	-0.007	-0.013	-0.030	0.065	0.020	-0.068	0.011	-0.107	0.069	0.110	0.009	-0.269	1	
IndRP (17)	0.301	-0.358	-0.184	-0.422	-0.338	-0.039	-0.122	0.022	0.084	0.046	0.025	0.108	0.073	-0.018	0.001	0.035	1

Table 12: Impact of climate-related disclosure regulation on firms' cost of capital in the U.K. - firm-specific estimation.

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_1 POST1_t + \gamma_1 POST1_t \times Reg1_i + \alpha_2 POST2_t + \gamma_2 POST2_t \times Reg2_i + \beta X_{it} + \varepsilon_{it} \quad (11)$$

Variables	Pool OLS	Firm Fixed effect	Firm Fixed effect and Ttrend	Firm Fixed effect and Ttrend- I	Firm Fixed effect and Ttrend -II	Firm Fixed effect and Ttrend - III
Intercept (%)	1.359	-4.180	-8.715	-4.850	-3.655	-3.646
	(1.914)	(6.595)	(6.765)	(6.802)	(6.911)	(6.909)
POST1 (%)	**-0.477**	**-0.102**	**0.580**	**-3.730*****	**-0.261**	**-1.747**
	(0.361)	**(0.322)**	**(0.384)**	**(1.285)**	**(0.412)**	**(1.656)**
POST2 (%)	**-1.019****	**-1.363*****	**-0.632**	**-0.036**	**-3.132*****	**-2.122***
	(0.515)	(0.454)	(0.517)	(0.537)	(0.845)	(1.188)
POST1*Reg1(%)	0.000	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
POST2*Reg2(%)	0.001	0.000	0.001	0.001	0.001	0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
β_{MKT}	0.002	0.001	0.002	-0.001	-0.001	-0.001
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
β_{SMB}	0.000	-0.003**	-0.002	-0.003**	-0.003**	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
β_{HML}	0.002	0.002	0.002	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
LogMV	0.002	0.008	0.011	0.010	0.008	0.009
	(0.002)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)
LogBM	0.021***	-0.007	-0.002	0.000	0.000	0.000
	(0.004)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
MMT	-0.005	-0.007	-0.006	-0.006	-0.007	-0.007
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Lev	-0.011	0.007	0.008	0.005	0.006	0.005
	(0.009)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Ferr (%)	12.74	5.691**	6.129**	5.920**	6.591**	6.365**
	(13.90)	(2.775)	(2.804)	(2.723)	(2.742)	(2.736)
Growth	0.002***	0.002**	0.002**	0.002**	0.002**	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
LogDisp	-0.004	-0.004	-0.005	-0.004	-0.005	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)

Less2	0.005	0.007	0.007	0.007	0.007	0.007
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
IndRP	0.426***	0.320***	0.300***	0.274***	0.270***	0.269***
	(0.056)	(0.037)	(0.037)	(0.039)	(0.039)	(0.039)
Ttrend	**No**	**No**	0.001***	-0.001	0.000	-0.001
			(0.000)	(0.001)	(0.001)	(0.001)
POST1*Ttrend				0.003***		0.001
				(0.001)		(0.001)
POST2*Ttrend					0.003***	0.002*
					(0.001)	(0.001)
Firm fixed effect	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Observations	3408	3365	3365	3365	3365	3365
N (firms)	488	445	445	445	445	445
R-Adjusted	0.135	0.404	0.406	0.410	0.410	0.410

Table 13: Distribution of R^0_{ES} samples of the whole market and Prime, Standard and Growth segments in Japan

	Quarter	Whole market	Prime	Standard and Growth
Pre-period	2020Q1	2647	1554	1093
	2020Q2	2623	1485	1138
	2020Q3	2525	1435	1090
	2020Q4	2561	1446	1115
	2021Q1	2723	1518	1205
Post1-period	2021Q2	2842	1577	1265
	2021Q3	2905	1598	1307
	2021Q4	2957	1621	1336
	2022Q1	3090	1671	1419
	2022Q2	3085	1666	1419
	2022Q3	3067	1651	1416
	2022Q4	3072	1639	1433
Post2-period	2023Q1	3146	1658	1488
	2023Q2	3124	1622	1502

	2023Q3	3157	1540	1617
	2023Q4	3123	1528	1595
	2024Q1	512	199	313

Table 14: Descriptive Statistics – Japan – Portfolio-specific cost of capital estimation

Variable	R^0_{ES}			Excess return R^0_{ES}			
(%)	Whole market	Prime market	Standard & Growth market	Whole market	Prime market	Standard & Growth market	Rft
Mean	8.759	8.783	8.719	8.542	8.536	8.471	0.248
Std. dev.	0.865	0.890	0.832	0.800	0.868	0.747	0.264
Min	7.291	7.268	7.270	7.264	7.242	7.243	-0.066
Max	9.786	9.991	9.581	9.571	9.776	9.436	0.748

Table 15: Impact of climate-related disclosure regulation on firms' cost of capital in Japan - portfolio-specific estimation (R^0_{ES})

$$R_{ESt} - R_{Ft} = \alpha + \beta_1 POST1_t + \beta_2 POST2_t + \varepsilon_t \qquad (14a) \qquad R_{ESt} - R_{Ft} = \alpha + \beta_1 POST2_t + \varepsilon_t \qquad (14b)$$

Excess return R^0_{ES}	The whole market- Excess return R^0_{ES}		Prime market firms- Excess return R^0_{ES}		Standard and Growth- Excess return R^0_{ES}	
Coefficient (%)	(14a)	(14b)	(14a)	(14b)	(14a)	(14b)
Intercept	7.578***	8.583***	7.602***	8.684***	7.509***	8.462***
	(0.127)	(0.369)	(0.157)	(0.398)	(0.098)	(0.346)
POST1	1.724***		1.855***		1.633***	
	(0.17)		(0.191)		(0.141)	
POST2	-0.886***	-0.167	-1.279***	-0.506	-0.648***	0.032
	(0.163)	(0.386)	(0.151)	(0.408)	(0.206)	(0.384)
Observations	17	17	17	17	17	17
R-Adjusted	0.853	-0.0662[19]	0.896	0.013	0.865	-0.065

[19] The negative adjusted R^2 (-0.0662) for the Standard and Growth market in Japan in equation 8b is due to an implicit constraint in equation 8b that the coefficient on R_{Ft} be equal to one. When we estimate a modified equation 8b where R_{Ft} is moved to the right-hand side, the adjusted R^2 for the market is -0.026, and the coefficient on R_{Ft} is insignificantly different from zero (1.954598, p=00.226). The coefficient of POST is insignificantly negative. (-0.01, p = 0.321).

Table 16 Descriptive Statistics – firm-specific cost of capital estimation – the Japan

Variable	N	Mean	SD	Min	Max	Percentile				
						1%	25%	Median	75%	99%
R_{GLS} (%)	18,008	7.390	3.787	0.018	48.61	1.286	4.976	7.104	9.232	19.972
R_F(%)	18,008	0.253	0.255	-0.066	0.748	-0.066	0.036	0.191	0.408	0.748
$R_{GLS} - R_F$(%)	18,008	7.137	3.809	-0.311	48.57	1.096	4.706	6.820	8.953	19.974
β_{MKT}	18,008	1.070	0.536	-2.223	5.552	-0.005	0.693	1.036	1.397	2.473
β_{SMB}	18,008	0.794	0.962	-8.958	11.989	-1.284	0.217	0.759	1.292	3.715
β_{HML}	18,008	0.275	0.700	-4.628	8.043	-1.927	-0.069	0.351	0.715	1.620
$LogMV$	18,008	11.143	0.694	8.766	13.559	9.703	10.641	11.086	11.583	12.882
LogBM	18,008	-0.139	0.380	-2.005	1.011	-1.251	-0.362	-0.069	0.125	0.588
MMT	18,008	0.029	0.141	-1.000	1.004	-0.324	-0.052	0.025	0.107	0.419
Lev	18,008	0.115	0.165	0.000	1.274	0.000	0.007	0.049	0.155	0.819
Ferr(%)	18,008	-0.076	7.784	-201.8	193.8	-18.02	-1.266	-0.127	0.833	21.15
Growth	18,008	0.206	1.565	-101.5	56.21	-2.203	0.039	0.113	0.239	4.072
LogDisp	18,008	0.033	0.071	0.000	2.309	0.000	0.000	0.016	0.039	0.269
Less2	18,008	0.319	0.466	0.000	1.000	0.000	0.000	0.000	1.000	1.000
IndRP	18,008	0.066	0.018	0.028	0.182	0.032	0.055	0.064	0.074	0.127
POST1Reg1	18,008	0.636	0.481	0.000	1.000	0.000	0.000	1.000	1.000	1.000

Table 17: Correlation matrix – firm-specific cost of capital estimation – Japan.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
$R_{GLS} - R_F$ (1)	1															
POST1 (2)	-0.044	1														
POST1*Reg1 (3)	-0.022	0.823	1													
POST2 (4)	-0.091	0.408	0.332	1												
β_{MKT} (5)	0.146	-0.064	-0.086	-0.199	1											
β_{SMB} (6)	-0.038	0.054	-0.051	0.013	0.000	1										
β_{HML} (7)	0.360	-0.069	0.026	-0.109	0.225	0.220	1									
LogMV (8)	-0.117	0.055	0.243	0.024	-0.134	-0.473	-0.026	1								
LogBM (9)	0.499	-0.087	0.016	0.005	0.000	-0.112	0.576	-0.061	1							
MMT (10)	-0.171	0.114	0.137	0.160	0.059	-0.034	0.075	0.045	0.011	1						
Lev (11)	0.287	-0.039	0.024	-0.016	0.061	-0.118	0.307	0.091	0.405	-0.008	1					
Ferr (12)	0.034	0.023	0.014	0.010	-0.044	0.015	-0.036	-0.014	-0.031	-0.165	-0.022	1				
Growth (13)	0.260	-0.018	-0.025	-0.015	0.031	0.010	-0.001	-0.038	-0.027	0.002	-0.014	-0.008	1			
LogDisp (14)	0.146	-0.078	-0.036	-0.056	0.076	-0.105	0.028	0.154	0.022	-0.077	0.099	0.023	0.214	1		
Less2 (15)	0.068	-0.048	-0.186	-0.025	0.016	0.225	0.046	-0.511	0.089	-0.076	-0.014	0.034	-0.051	-0.318	1	
IndRP (16)	0.426	-0.090	-0.053	-0.247	0.190	-0.109	0.164	0.053	0.156	-0.189	0.147	0.041	-0.005	0.056	-0.044	1

Table 18: Impact of climate-related disclosure regulation on firms' cost of capital in Japan - firm-specific estimation.

$$R_{GLSit} - R_{Ft} = \alpha_0 + \alpha_1 POST1_t + \gamma_1 POST1_t \times Reg1i + \alpha_2 POST2_t + \gamma_2 POST2_t \times Reg1i + \beta X_{it} + \varepsilon_{it} \quad (12)$$

Variables	Pool OLS	Firm fixed effect	Firm Fixed effect and Ttrend	Firm Fixed effect and Ttrend-I	Firm Fixed effect and Ttrend-II	Firm Fixed effect and Ttrend-III
Intercept (%)	8.325***	7.455	7.989	7.723	8.176	7.841
	(1.086)	(6.501)	(6.272)	(6.599)	6.606	6.588
POST1 (%)	0.527**	0.120	-0.021	0.113	0.013	0.264
	(0.208)	(0.247)	(0.243)	(0.304)	0.259	0.338
POST2 (%)	0.317	0.545**	0.437	0.463*	0.087	-0.094
	(0.236)	(0.274)	(0.331)	(0.260)	0.349	0.410
POST1*Reg1(%)	-0.068	0.226	0.002	0.002	0.002	0.002
	(0.211)	(0.251)	(0.003)	(0.003)	0.003	0.003
POST2*Reg1 (%)	-0.246	-0.389	-0.004	-0.004	-0.004	-0.004
	(0.238)	(0.267)	(0.003)	(0.003)	0.003	0.003
β_{MKT}	0.003***	-0.005**	-0.004	-0.004**	-0.004**	-0.004**
	(0.001)	(0.002)	(0.004)	(0.002)	0.002	0.002
β_{SMB}	-0.001*	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	0.001	0.001
β_{HML}	0.004***	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.002)	(0.001)	0.001	0.001
LogMV	-0.006***	-0.005	-0.006	-0.006	-0.006	-0.006
	(0.001)	(0.006)	(0.006)	(0.006)	0.006	0.006
LogBM	0.038***	0.005	0.004	0.004	0.004	0.004
	(0.002)	(0.006)	(0.006)	(0.006)	0.006	0.006
MMT	-0.032***	-0.034***	-0.034***	-0.034***	-0.034***	-0.034***
	(0.003)	(0.002)	(0.007)	(0.002)	0.002	0.002
Lev	0.015***	-0.006	-0.007	-0.006	-0.007	-0.006
	(0.003)	(0.008)	(0.014)	(0.008)	0.008	0.008
Ferr(%)	0.823	1.026	1.020	1.021	1.023	1.027
	(0.587)	(0.773)	(0.709)	0.775	0.774	0.775
Growth	0.006**	0.006**	0.006**	0.006**	0.006**	0.006**
	(0.003)	(0.003)	(0.003)	0.003	0.003	0.003
LogDisp	0.037**	0.042***	0.043**	0.043***	0.043***	0.043***
	(0.015)	(0.016)	(0.016)	0.016	0.016	0.016

Less2	0.002**	0.003***	0.003**	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	0.001	0.001	0.001
IndRP	0.680***	0.782***	0.793***	0.809***	0.793***	0.819***
	(0.024)	(0.024)	(0.020)	0.034	0.024	0.037
Ttrend	**No**	**No**	0.000	0.001	0.000	0.001
			(0.000)	0.001	0.000	0.001
POST1*Ttrend				0.000		-0.001
				0.001		0.001
POST2*Ttrend					0.000	0.000
					0.000	0.000
Firm fixed effect	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Observations	18,857	18,808	18,808	18,808	18,808	18,808
N (firms)	1,526	1,477	1477	1477	1477	1477
R-Adjusted	0.488	0.660	0.660	0.660	0.660	0.660

Table 19: Variable definition

Variables	Definition	Data Sources
R_{GLSit}	The implied cost of capital for firm i, in quarter t, estimated at the end of quarter t using the Gebhardt et al. (2001) model.	Self-estimated, Workspace database
R_{Ft}	The risk-free rate measured as the yield on the 10-year government (New Zealand, United Kingdom, Japan) Treasury bonds in quarter t.	Workspace database
$POST1_t$	An indicator variable that equals 1 if the firm-quarter observation is from June 2021 to December 2022 (December 2020 to December 2021) for Japan (U.K.) and zero otherwise.	
$POST2_t$	An indicator variable that equals 1 if the firm-quarter observation is from March 2023 to March 2024 (March 2022 to December 2023) for Japan (U.K.) and zero otherwise.	
$POST1_t \times Reg1_i$	Interaction between $POST1_t$ and $Reg1_i$. $Reg1_i$ is an indicator variable that equals 1 if the firm i in Japan (U.K.) is regulated by the Corporate Governance Code Revision 2021 (The new Listing Rule PS 20/17) and zero otherwise.	

$POST2_t \times Reg2_i$	Interaction between $POST2_t$ and $Reg2_i$. $Reg2_i$ is an indicator variable that equals 1 if the firm i in Japan (U.K.) is regulated by The Cabinet Office Order on Disclosure of Corporate Affairs Amendment 2023 (Company Regulations 2022) and zero otherwise.	
B_{MKT}, B_{SMB}, B_{HML},	Factor loadings for the three risk factors in Fama and French (1996) and are estimated for firm i in quarter t by regressing excess returns on the Fama and French three factors using monthly return in the 60 months (require at least 24 months) prior to the last month in quarter t.	Workspace database
$LogMV_{it}$	Natural logarithm of market value of equity measured at the end of the prior fiscal year.	Workspace database
$LogBM_{it}$	Natural logarithm of the book-to-market ratio measured at the end of the prior fiscal year.	Workspace database
MMT_{it}	Natural logarithm of one plus the compound return over the twelve months prior the last month in quarter t	Workspace database
Lev_{it}	Natural logarithm of one plus the ratio of total long-term debt to the market value of equity measured at the end of the prior fiscal year	Workspace database
$Ferr_{it}$	Analyst forecast error is the difference between the consensus analyst forecast at the of quarter t for the forthcoming year and the IBES reported actual earnings, scaled by the stock price at the end of prior fiscal year.	Workspace database
$Growth_{it}$	Analyst forecasted long-term growth rate, measured as analyst consensus long-term earnings growth rate from Workspace. If that rate is missing, we calculate the earnings growth rate implied from the 2-year-ahead and 1-year-ahead earnings forecast from Workspace.	Workspace database
$LogDisp_{it}$	Analyst forecast dispersion is measured as the natural logarithm of one plus standard deviation of analyst earnings forecasts at the end of quarter for the forthcoming year, scaled by the absolute value of the consensus earnings forecasts. $LogDisp_{it}$ is missing for observations with less than two analysts following at the end of quarter t. Instead of excluding the observations, we set $LogDisp_{it}$ to zero and control for this condition by including an indicator variable $Less2_{it}$	Workspace database
$Less2_{it}$	an indicator variable equals one if the number of analyst forecasts is less than two and zero otherwise.	
$IndRP_{it-4}$	Lag industry risk premium, calculated as the difference between the median cost of capital in each of the Fama and French (1997) industries at the end of the prior year and the corresponding risk-free rate.	Workspace database