Climate-Related Transition Risk and Corporate Debt Financing: Evidence from Southeast Asia

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The Paris Agreement signals increased climate awareness and potential changes in the business environment as an economy decarbonizes. Ratification of the Paris Agreement could heighten climate-related transition risks, especially for companies in high-emitting industries. This research analyzes the impact of Paris Agreement ratification on the debt financing decisions of publicly listed companies in Southeast Asian economies. Our empirical evidence shows that, after announcement of Paris Agreement ratification, firms in high-emitting industries have leverage and financial leverage that are an average of 1.8% and 4.2% lower, respectively, than firms in low-emitting industries. Firms in the region also witnessed higher risks 2 years after ratification, and these risks do not differ significantly between high- and low-emitting industries. This finding implies that firms become riskier under heightened transition risks, and this influences their financial decisions. Governments might thus consider introducing policies that facilitate their response to a low-carbon transition.

Keywords: Association of Southeast Asian Nations, climate-related risks, cost of debt, debt finance, leverage, Paris Agreement, transition risks

JEL codes: G12, G14, G30

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I. Introduction

Climate change is widely recognized as a major threat to economic development and human welfare. According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2022), climate change has a causal effect on extreme natural events, which leads to losses and damage to human lives and the natural physical environment. In the finance sector, climate change poses risks of two broad types: physical risks and transition risks (Bank for International Settlements 2021). Climate-related physical risks arise from the direct impairment of assets due to climate change, while climate-related transitional risks arise from changes in regulations and policies, technological advancements, and shifts in stakeholder behavior and sentiment during the transition to a low-carbon economy (Giglio, Kelly, and Stroebel 2021). These risks influence cash-flow patterns and the business and investment environment, entailing losses and costs for firms.

In light of their distinct impacts on markets, it is important to clearly distinguish between transition risk and physical risk. Physical risks are related to the economic costs and financial losses that result from extreme climate-related events such as heatwaves and floods; shifts in climate such as changes in precipitation, weather variability, and rising sea levels and temperatures; and the indirect effects of climate change such as desertification and water shortages. Such risks may lead to a revaluation of firms' assets—such as plants, property, and equipment—and to increased operating costs related to relocation and insurance. In contrast, transition risks are related to the process of adjustment to reach a low-carbon economy and are driven by changes in government policies and regulations, technology, and market sentiment, as well as shifts in business models (Ginglinger and Moreau 2019, Bank for International Settlements 2021). During the transition, the market is expected to price in expectations about shifts in policies, sentiments, and technologies. In the short to medium term, high-emitting firms are more likely to face transition risks rather than physical risks, unless they are located in areas that are highly vulnerable to extreme climate events.

There is evidence to suggest that financial markets price in climate-related risks. For example, in the stock market, Hsu, Li, and Tsou (2023) find that there is an average pollution premium of 4.4% per year between high-toxicity firms and low-toxicity firms. In the bond market, sovereign bond yields are higher for countries that are highly vulnerable to climate change (Beirne, Renzhi, and Volz 2021). For municipal bonds in the United States (US), counties affected by climate change pay higher yields and underwriting fees compared to unaffected counties (Painter 2020). Huynh and Xia (2021) estimate that a one standard deviation increase in corporate bonds' potential to hedge against climate change risk is linked to a monthly decrease in bond future excess returns of 6.3 basis points (bps), using data on bonds listed in US public markets from July 2002 to December 2016, and this could further decrease by 22.0 bps if climate change risk heightened. In the US real estate market, Bernstein, Gustafson, and Lewis (2019) find that coastal houses exposed to sea level rise are sold at a 7% discount compared to similar properties. Bolton and Kacperczyk (2021) find that a one standard deviation increase in the level of emissions leads to about a 2% per annum increase in expected returns in US equity markets, suggesting that investors may demand compensation for exposure to carbon risk.

Climate-related risks affect not only the prices of corporate financing, but also the financing structure. This is because such risks influence the borrowing ability of firms with larger climate-risk exposures. Ginglinger and Moreau (2019) find that greater climate risks led to a decline in leverage after the Paris Agreement. They argue that the reduction in leverage was driven by both a demand effect, which reduced the firm's optimal leverage, and a supply effect, which raised the cost of capital for high-risk firms. Ehlers, Packer, and de Greiff (2022) note a significant 3–4 bps premium charged on carbon-risk bank loans in 31 markets after the Paris Agreement, with the premium rising to as high as 7 bps for high-emitting industries. After the ratification of the Kyoto Protocol, high-emitting firms in Australia paid, on average, an interest rate that was 5.4% higher than that paid by low-emitting firms due to increased cash-flow risks and negative investor recognition (Nguyen, Truong, and Zhang 2020).

However, this literature lacks evidence on how climate-related risks affect corporates and lenders in emerging financial markets. Most of the evidence comes from relatively developed financial markets. While many emerging financial markets are relatively underdeveloped, emerging economies have already committed to climate change targets. As such, the impact of climate-related risk, particularly transition risk, on emerging financial markets is an important research question. When financial markets are relatively underdeveloped and potentially not efficient enough to price in climate risks in a timely way, will high-emitting corporates still face higher financial prices and adjust their leverage? We try to address this research question by providing micro-level evidence on how transition risks affect the finance sectors of emerging markets. Such evidence also has policy implications for efficiently allocating financial resources toward a timely and smooth transition while safeguarding financial stability.

This study focuses on members of the Association of Southeast Asian Nations (ASEAN). The financial markets of ASEAN are still being developed, and many ASEAN members have committed to pursue the net zero emission goals of the 2015 Paris Agreement. While ratification of the Paris Agreement cannot reduce emissions in the short term, it sends clear signals of climate awareness among various stakeholders. It also affects the business environment as the economy transits to a low-carbon development path over time. Having ratified the Paris Agreement, ASEAN markets now face climate-related transition risks. Since the decision to ratify the Paris Agreement is unlikely to be driven by companies' financing decisions, ratification by ASEAN countries represents an exogenous shock to corporates' exposure to climate-related transition risks in those countries. This offers a good opportunity to examine how increased climate-related transition risks will affect corporate financing behavior. This study fills in the gap in the literature by providing novel evidence on ASEAN markets with regard to the following research questions: (i) Do heightened climate-related transition risks affect ASEAN corporates' debt financing in terms of cost of debt and leverage? And (ii) what are the possible working channels of such effects?

This study uses a firm-level sample of publicly listed firms in Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam from 2012 to 2021. Using a difference-in-difference (DID) research design, this study empirically examines how the cost and level of borrowing of publicly listed firms in high-emitting industries in ASEAN were affected, relative to firms in low-emitting industries, after their host countries decided to ratify the Paris Agreement. Due to a lack of firm-level emissions data, this study follows existing literature and classifies firms as high emitters if they belong to the industries identified by the IPCC as high-emitting industries.

Our empirical analysis finds that public companies' debt financing is significantly affected by increased climate-related transition risks in ASEAN economies. Consistent with existing evidence in Ginglinger and Moreau (2019) and Nguyen, Truong, and Zhang (2020), companies in high-emitting industries in ASEAN markets face higher costs of debt and tend to borrow less compared to companies in low-emitting industries after the announcement of Paris Agreement ratification (PAR) by their respective host countries. Specifically, companies in high-emitting industries tend to have 1.8% lower leverage and 4.2% lower financial leverage compared to low-emitting industries 1 year after PAR. The difference in leverage and financial leverage between high-emitting industries and low-emitting industries further widened 2 years after PAR to 2.3% and 6.1%, respectively. Furthermore, firms in high-emitting industries borrow significantly less than low-emitting industries after PAR, while there is no sufficient evidence to show that the cost of borrowing increased among firms from high-emitting industries due to PAR. This indicates possible structural changes in the operational decisions of high-emitting industries during the transition to net zero, when they tend to borrow less than low-emitting industries as they seek to mitigate heightened climate-related transition risks.

Moreover, we find some evidence that high-emitting firms become riskier than low emitters in the year of PAR announcement in terms of a higher stock return volatility. They also experience a short-lived negative abnormal return 2 days after PAR announcement. This suggests some negative recognition from equity market investors. Financial regulators need to monitor the quality of assets, especially in high-emitting industries, to ensure that financial conditions remain stable and resilient amid possible negative outcomes arising from changes in the business conditions of high-emitting industries. To ensure a timely and smooth transition to net zero emissions, there is a need for policy makers to help high-emitting industries transition to low-emitting business operations.

This study adds to the growing literature of climate finance by providing new firm-level evidence on the impact of climate-related risks on firms' debt financing in emerging markets, specifically in ASEAN. The findings have policy implications that can help ASEAN markets develop effective policy instruments that facilitate a timely transition to net zero emissions while safeguarding financial stability. The evidence also highlights the need for policies that integrate climate-related risks into economic recovery and a prudential framework.

The rest of the paper is organized as follows. Section II provides the background for ASEAN's participation in the Paris Agreement. Section III explains the data and empirical methodology. Section IV reports and discusses the empirical results. Section V explores possible working channels, and section VI concludes.

II. The Paris Agreement and the Participation of Members of the Association of Southeast Asian Nations

The Paris Agreement is a landmark climate treaty that brought the world together to take collective action to mitigate and adapt to climate change. This legally binding international treaty was adopted by 196 parties in Paris on December 12, 2015 and entered into force on November 4, 2016. The agreement replaced the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) that aims to reduce greenhouse gas (GHG) emissions. On November 13, 2021, participants representing almost 200 countries agreed to the Glasgow Pact, which in effect completes the "Paris Rulebook."[1] This rulebook details how participating countries can contribute to the goals laid out in the Paris Agreement to account and reduce their respective GHG emissions. The aim of the Paris Agreement is to limit global temperature rise to well below 2°C and further to 1.5°C relative to pre-industrial levels

[1] For details on the Glasgow Pact, see ukcop26.org.

(UNFCCC 2015). This goal is to be achieved by reaching the global peaking of GHG emissions as soon as possible.

The current signatories, which account for 95% of global GHG emissions, recognize the risks of climate change and commit to pursue the objectives of the convention. The framework provided by the Paris Agreement gives guidance to the participating parties in shaping their climate policies and actions, as well as in monitoring their progress and ensuring transparency (UNFCCC 2015). This includes tracking and monitoring their commitments to reducing GHG emissions in their respective economies.

Central to the achievement of the goals of the Paris Agreement is the declaration of intended nationally determined contributions (INDCs), which were submitted to the UNFCCC Secretariat prior to the 2015 meeting in Paris. Each submission was required to specify country targets and how to measure and track progress. ASEAN member countries each submitted their INDCs specifying their commitments in achieving the goals of the Paris Agreement. During the 2015 meeting, all member countries of ASEAN signed the Paris Agreement and later ratified it. After ratification, the INDCs become NDCs, and countries could also opt to submit updated or revised NDCs. In general, the NDCs submitted by ASEAN countries have target reductions in total emissions as well as emissions with regard to energy supply, transport, industry, buildings, forestry (afforestation), and agriculture. Table 1 shows the dates of signing and ratification of the Paris Agreement by ASEAN countries.

Table 1. **Dates of Signing, Ratification, Approval, and Announcements**

	Paris Agreement: 15 December 2015		
Country	**Type**	**Date**	**Announcement Date of Ratification**
Indonesia	Signature	April 22, 2016	October 19, 2016
	Ratification	October 31, 2016	
Malaysia	Signature	April 22, 2016	October 19, 2016
	Ratification	November 16, 2016	
Philippines	Signature	April 22, 2016	March 14, 2017
	Ratification	March 23, 2017	
Singapore	Signature	April 22, 2016	September 21, 2016
	Ratification	September 21, 2016	
Thailand	Signature	April 21, 2016	September 21, 2016
	Ratification	September 21, 2016	
Viet Nam	Signature	April 22, 2016	October 31, 2016
	Approval	November 3, 2016	

Source: Authors' compilation.

III. Data and Research Method

A. Sample Selection

Publicly listed firms in six ASEAN markets were included in the study. Firm-level data for public firms operating in Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam were collected from S&P Capital IQ, while benchmark borrowing rates were retrieved from the International Monetary Fund data repository. The sample period is 2012–2021. Firms with insufficient data for analysis were excluded from the study.

B. High Emitters versus Low Emitters

All members of ASEAN submitted NDCs to the UNFCCC in 2015 detailing their mitigation and adaptation plans. The six ASEAN markets targeted the energy supply, transport, industry, buildings, forestry (afforestation), and agriculture sectors in their plans submitted for the Paris Agreement. These are the same sectors identified in the IPCC's Fourth Assessment Report as having the highest growth in GHG emissions between 1970 and 2004.

The Carbon Disclosure Project (2014) has identified 14 Global Industry Classification Standard (GICS) industries corresponding to the following: (1) oil, gas, and consumable fuels; (2) electric utilities; (3) gas utilities; (4) independent power producers and energy traders; (5) multi-utilities; (6) chemicals; (7) construction materials; (8) metals and mining; (9) paper and forest products; (10) air freight and logistics; (11) airlines; (12) marine; (13) road and rail; and (14) automobiles. In this paper, all firms belonging to the 14 industries were identified as high emitters, while all firms that did not belong to one of the listed industries were tagged as low emitters.

C. Variable Construction

To explore how PAR affected the financing decisions of publicly listed firms in ASEAN markets, we focus on four key variables related to companies' borrowing activities. First is the cost of debt (COD), which is calculated as the interest rate spread against a benchmark borrowing rate. In empirical tests, we compute it as the difference between the ratio of annual interest expense to annual total debt and the benchmark borrowing rate. Companies' leverage is measured by two indicators: One is the debt-to-asset ratio (LEV), which is computed as the ratio between total debt to total assets of a company; the other is the debt-to-equity ratio (LEV-FIN), which is computed as the ratio of total debt to total shareholder equity of a company. To shed additional

Table 2. **Number of Firms and Firm-Years by Country**

Country	Firms	Firm-Years	Firms in High-Emitting Industries	High Emitters (%)	Firms in Low-Emitting Industries	Low Emitters (%)
Indonesia	550	4,309	125	22.7	425	77.3
Malaysia	924	8,143	139	15.0	785	85.0
Philippines	228	2,020	58	25.4	170	74.6
Singapore	528	4,265	64	12.1	464	87.9
Thailand	699	5,571	134	19.2	565	80.8
Viet Nam	488	4,122	134	27.5	354	72.5
Total	3,417	28,430	654	19.1	2,763	80.9

Source: Authors' estimates.

Table 3. **Summary Statistics of Endogenous Variables**

Endogenous Variables	Pre-PAR				Post-PAR			
	Low Emitters		High Emitters		Low Emitters		High Emitters	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
COD	0.04	0.12	0.03	0.08	0.04	0.10	0.03	0.07
LEV	0.19	0.17	0.25	0.20	0.20	0.18	0.25	0.20
LEV-FIN	0.31	0.38	0.48	0.55	0.34	0.43	0.46	0.52
LTD	2.96	2.55	3.45	2.51	3.02	2.65	3.49	2.54

COD = cost of debt, LEV = leverage, LEV-FIN = financial leverage, LTD = natural logarithm of total debt, PAR = Paris Agreement ratification, SD = standard deviation.
Source: Authors' estimates.

light on the impacts at the level of company borrowings, we also constructed the natural logarithm of total debt (LTD) to proxy the size of firms' borrowing, which provides direct evidence on the change in financing needs of the companies.

Table 2 shows the distribution of firms and firm-year observations by country. There are a total of 3,417 firms from six ASEAN economies, with 28,430 firm-year observations during 2012–2021. Table 3 shows the summary statistics of endogenous variables used in the study and makes a comparison between high emitters and low emitters. Extreme values were winsorized by 1%–2% from each tail.

D. Research Method

To investigate the impacts of PAR on the debt financing decisions of firms in high-emitting industries relative to those in low-emitting industries, we employ DID estimation, using three different models: baseline, dynamic, and staggered DID.

Our baseline DID model uses panel data with firm and year fixed effects to control for time- and firm-invariant characteristics that may be related to country- and industry-specific attributes, as well as some timing factors related to PAR. This is specified as follows:

$$\text{Debt Financing}_{it} = a_0 + a_1\text{EMITTER}_i'\,\text{PAR}_t + a_2\text{PAR}_t + a_3\text{SIZE}_{it-1} + a_4\text{BTM}_{it-1} + a_5\text{BETA}_{it-1} + \text{year}_t + \text{firm}_i + e_{it}, \quad (1)$$

where Debt Financing_{it} indicates the cost of debt, leverage, financial leverage, and size of total debt of firm i in year t. $\text{EMITTER}_i'\,\text{PAR}_t$ is an indicator that takes the value of 1 for firms in high-emitting industries during the year when a country announced its PAR and all subsequent years, and 0 otherwise; its coefficient a_1 is thus the DID estimate that captures the change in the debt financing variables for high emitters relative to low emitters, which is attributable to the PAR announcement. The variable PAR_t is equivalent to 1 for the year when a country announced its PAR and all subsequent years, and 0 otherwise. To ensure that the impacts are driven by PAR and different changes in climate-related transition risk exposure between high emitters and low emitters, we control for common company attributes that affect a firm's financing decisions. In particular, we control for a company's size, which is measured as the natural logarithm of market capitalization (SIZE_{it-1}); growth prospects, which is proxied by book-to-market ratio (BTM_{it-1}); and risk exposure to the market, which is captured by market beta (BETA_{it-1}), as of previous year-end. The variables year_t and firm_i are dummy fixed effects that capture attributes unique to each year t and firm i. e_{it} is the error term.

Our second DID model allows for a dynamic time treatment. The dynamic DID equation is shown as follows:

$$\begin{aligned}\text{Debt Financing}_{it} = a_0 &+ a_1\text{EMITTER}_i'\text{Before}^{-2y} + a_2\text{EMITTER}_i'\text{Before}^{-1y} \\ &+ a_3\text{EMITTER}_i'\text{Current}^{0} + a_4\text{EMITTER}_i'\text{After}^{+1y} \\ &+ a_5\text{EMITTER}_i'\text{After}^{2y+} + a_6\text{Before}^{-2y} + a_7\text{Before}^{-1y} \\ &+ a_8\text{Current}^{0} + a_9\text{After}^{+1y} + a_{10}\text{After}^{2y+} + a_{11}\text{SIZE}_{it-1} \\ &+ a_{12}\text{BTM}_{it-1} + a_{13}\text{BETA}_{it-1} + \text{firm}_i + e_{it}, \end{aligned} \quad (2)$$

where EMITTER_i is equal to 1 if the firm belongs to a high-emitting industry. The additional variables interacted with EMITTER_i are defined as follows: Before^{-2y} is equal to 1 for the year that corresponds to 2 years before the announcement of PAR in a firm's home country, and 0 otherwise. Before^{-1y} is equal to 1 for the year before the announcement of PAR in a firm's home country, and 0 otherwise. Current^{0} is equal to 1 for the year of the announcement of PAR in a firm's home country, and 0 otherwise.

After^{+1y} is equal to 1 for the year after the announcement of PAR in a firm's home country, and 0 otherwise. After^{2y+} is equal to 1 for the year that corresponds to 2 years or more after the announcement of PAR in a firm's home country, and 0 otherwise. Equation (2) assesses the impact of being a high emitter for different groups of years.

As the PAR schedule differs across the sample ASEAN markets, we also use a third estimation method, the staggered DID, following Callaway and Sant'Anna (2021). We use this to address the staggered ratification years of the countries included in the analysis. Among the ASEAN signatories of the Paris Agreement, the announcement by the Philippines to ratify the agreement in 2017 came later than its neighbors, which announced in 2016.

The third DID method allows us to test whether the emitter coefficient in each year is systematically different from a common constant term for low emitters that extends over 10 years: 4 years before PAR, the year of PAR, and 5 years after the PAR.

The baseline equation (equation [1]) expresses the two-way fixed effects model for DID. Following the notation of Callaway and Sant'Anna (2021), we express the group-time average treatment effects as ATT, and we define G_g as a binary variable equal to 1 if a firm is part of the treatment group in period g. For example, Indonesia, Malaysia, Singapore, Thailand, and Viet Nam announced their ratification of the agreement in 2016, while the Philippines made the announcement in 2017. In this case, firms from the Philippines form one group and the rest are in another group. We then express the group-time ATT for group g and period t as follows:

$$\text{ATT}(g,t) = E[Y_t(g) - Y_t(0) | G_g = 1], \tag{3}$$

where $Y_t(g)$ is a firm's potential outcome in time period t if it becomes treated in period g. For firms that are never treated (i.e., firms in low-emitting industries), $Y_{it} = Y_{it}(0)$ for all time periods.

For $t = 1, \ldots \tau$ denoting all time periods, we then aggregate the group-time ATT to measure the average effect using all firms in group $\tilde{g}$ across all their post-treatment periods as follows:

$$\theta_{\text{sel}}(\tilde{g}) = \frac{1}{\tau - \tilde{g} + 1} \sum_{t=\tilde{g}}^{\tau} \text{ATT}(\tilde{g}, t). \tag{4}$$

And we further aggregate all $\theta_{\text{sel}}(g)$ across groups as a summary of the overall average effect of being treated using the following:

$$\theta_{\text{sel}}^{O} = \sum_{g \epsilon G} \theta_{\text{sel}}(g) P(G = g | G \leq \tau). \tag{5}$$

This is the ATT equivalent to a_1 in the baseline DID we have in equation (1).

To estimate the dynamic effect of the treatment after e periods, we further aggregate ATT(g, $g + e$) using the following expression:

$$\theta_{es}(e) = \sum_{g \epsilon G} 1\{g + e \leq T\} P(G = g | G + e \leq T) \text{ATT}(g, g + e), \qquad (6)$$

where $P(G = g|G + e \leq T)$ is the probability of being treated in period g for a given $G + e \leq T$ period.[2]

IV. Empirical Results: Impact of Paris Agreement on Cost of Debt and Leverage

In this section, we report and discuss the results of estimating the impacts of PAR on the cost of debt and leverage using the three DID methods.

A. Baseline Difference-in-Difference Model

The results of the baseline DID model estimation based on equation (1) are reported in Table 4. As mentioned earlier, we define high emitters as those belonging to the 14 industries listed in section III.B, and the variable PAR is equal to 1 for the year when a country announced its PAR and all subsequent years, and 0 otherwise. As shown, while the PAR announcement has no significant impact on the cost of debt of high emitters during the entire post-PAR period, the estimated effects on leverage, financial leverage, and amount of debt borrowing are significant. On average, during the entire post-PAR period, the leverage and financial leverage of high emitters are lower by 1.7% and 4.7%, respectively, relative to low emitters. Meanwhile, high emitters tend to borrow significantly less than low emitters during the post-PAR period.

B. Dynamic Difference-in-Difference Model

Table 5 reports the estimated results for the dynamic DID model, using equation (2) in which the treatment impacts on high emitters are separated into different year groupings before, during, and after PAR. It shows that high emitters and low emitters do not have significant differences in the cost of debt, but there is consistent evidence that high emitters have lower leverage and borrowing in and after the year of PAR relative to low emitters. In the first year after the PAR, the leverage and financial leverage of

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[2] For further details on the derivations, see Callaway and Sant'Anna (2021). These derivations correspond to coefficients a_1 to a_5 in equation (2).

Table 4. **Impact of Paris Agreement Ratification on Cost of Debt and Leverage: Baseline Difference-in-Difference Estimation**

Variables	COD	LEV	LEV-FIN	LTD
EMITTER′PAR	0.0040	−0.0174***	−0.0470***	0.1204*
	(1.39)	(−2.91)	(−2.92)	(−1.95)
PAR	−0.0030	−0.0002	0.0038	0.0874
	(−0.45)	(−0.04)	(0.26)	(1.40)
SIZE	−0.0008	−0.0028	−0.0079	0.3272***
	(−0.50)	(−1.04)	(−1.12)	(9.64)
BTM	0.0019	0.0009	0.0012	0.1124***
	(1.54)	(0.47)	(0.25)	(5.55)
BETA	−0.0012	0.0004	0.0066	0.0358**
	(−1.01)	(0.19)	(1.29)	(2.04)
Constant	0.0451***	0.2118***	0.3635***	1.3811***
	(5.66)	(15.85)	(10.69)	(8.26)
Firm and year fixed effects	YES	YES	YES	YES
Observations	26,632	27,160	27,160	24,034
Adjusted *R*-squared	0.00166	0.00902	0.00674	0.0434

BETA = market beta, BTM = book-to-market ratio, COD = cost of debt, LEV = leverage, LEV-FIN = financial leverage, LTD = natural logarithm of total debt, PAR = Paris Agreement ratification, SIZE = natural logarithm of market capitalization.
Notes: Robust *t*-statistics in parentheses. *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.
Source: Authors' estimates.

Table 5. **Impact of Paris Agreement Ratification on Cost of Debt and Leverage: Dynamic Difference-in-Difference Estimation**

Variables	COD	LEV	LEV-FIN	LTD
EMITTER′Before^{-2y}	−0.0071*	−0.0032	−0.0050	0.0310
	(−1.86)	(−0.60)	(−0.33)	(0.58)
EMITTER′Before^{-1y}	−0.0063	−0.0072	−0.0045	0.0355
	(−1.19)	(−1.06)	(−0.23)	(0.51)
EMITTER′Current^{-0}	−0.0017	−0.0110	−0.0166	−0.0089
	(−0.33)	(−1.47)	(−0.76)	(−0.12)
EMITTER′After^{+1y}	0.0006	−0.0176**	−0.0422*	−0.0221
	(0.13)	(−2.23)	(−1.88)	(−0.28)
EMITTER′After^{2y+}	0.0011	−0.0234***	−0.0605***	−0.1511*
	(0.27)	(−2.80)	(−2.74)	(−1.77)
Before^{-2y}	−0.0005	0.0027	0.0056	0.0204
	(−0.25)	(1.27)	(1.10)	(0.79)
Before^{-1y}	0.0052**	0.0054**	0.0114*	−0.0581*
	(2.14)	(1.99)	(1.77)	(−1.87)
Current^{-0}	0.0023	0.0070**	0.0179**	−0.0472
	(1.00)	(2.37)	(2.54)	(−1.36)

Continued.

Table 5. *Continued*.

Variables	**COD**	**LEV**	**LEV-FIN**	**LTD**
After^{+1y}	–0.0017	0.0065**	0.0198***	0.0414
	(–0.75)	(2.13)	(2.61)	(1.15)
After^{2y+}	0.0006	0.0194***	0.0463***	0.2049***
	(0.34)	(5.81)	(5.59)	(5.49)
SIZE	–0.0008	–0.0027	–0.0075	0.3277***
	(–0.51)	(–0.99)	(–1.07)	(9.69)
BTM	0.0023*	0.0015	0.0023	0.1238***
	(1.83)	(0.81)	(0.48)	(6.21)
BETA	–0.0007	–0.0001	0.0052	0.0394**
	(–0.61)	(–0.04)	(1.03)	(2.31)
Constant	0.0418***	0.2103***	0.3618***	1.3871***
	(5.35)	(15.97)	(10.80)	(8.39)
Firm fixed effects	YES	YES	YES	YES
Observations	26,632	27,160	27,160	24,034
Adjusted *R*-squared	0.000873	0.00698	0.00540	0.0408

BETA = market beta, BTM = book-to-market ratio, COD = cost of debt, LEV = leverage, LEV-FIN = financial leverage, LTD = natural logarithm of total debt, SIZE = natural logarithm of market capitalization.
Notes: Robust t-statistics in parentheses. *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.
Source: Authors' estimates.

high emitters are significantly lower by 1.8% and 4.2%, respectively, compared to low emitters. During the second year of the PAR announcement, the leverage and financial leverage of high emitters are even less—2.3% and 6.1%, respectively—compared to low emitters. High emitters also borrow significantly less than low emitters—by 20.5% after the second year of the PAR announcement.

In summary, we conclude that there is evidence to show that high emitters in ASEAN markets witness lower leverage (–0.0174) and financial leverage (–0.0470) in and after the year of PAR announcement, and they also borrow less (–0.1204) compared to low emitters. This is consistent with Ginglinger and Moreau (2019), who find that greater climate-related transition risks lead to a decline in leverage. According to their study, the reduction in leverage is driven by both the demand effect as high-emitting firms' optimal leverage is reduced and the supply effect as high-emitting firms face higher cost of capital, as well as possibly negative investor recognition, similar to the findings of Nguyen, Truong, and Zhang (2020).

We would like to caution, however, that the adjusted *R*-squared values in Table 5 are low: less than 1% for the cost of debt, leverage, and financial leverage, and around 5% for total debt. Such low adjusted *R*-squared values are also found in Table 4. This may suggest the difficulty of finding significant effects when grouping industries to proxy firm-level emissions and when the data are aggregated across six different ASEAN countries.

C. Staggered Difference-in-Difference Model

Table 6 reports the aggregate average treatment effects from using the staggered DID model based on equation (6). It shows the average treatment effects on high emitters before, during, and after PAR. Essentially, it shows how firms in high-emitting industries differ in each year relative to firms in low-emitting industries. It checks whether there is (i) an anticipation effect of the Paris Agreement, (ii) year-of-Paris-Agreement effect, and (iii) lagged effect of the Paris Agreement.

As done in the estimation for Table 5, Table 6 uses panel data across countries for 10 years with one equation for each of the debt financing variables.

We also test the parallel trends assumption of our debt financing variables during the pre-PAR periods. One main assumption of this method is that in the absence of the treatment, the difference between the treatment group and control (untreated) group would be constant over time. This allows us to validly compare the treatment group with the control group. (In this paper, the treatment is PAR.) The treatment group comprises firms in high-emitting industries that are exposed to PAR, while the control group comprises firms from low-emitting industries.

Table 6. **Impact of Paris Agreement Ratification on Cost of Debt and Leverage: Average Treatment Effects from the Staggered Difference-in-Difference Estimation**

Variables	COD	LEV	LEV-FIN	LTD
$T = -4$ (year 4 before PAR)	0.033*	0.003	0.026	–0.225
$T = -3$ (year 3 before PAR)	–0.006	0.000	–0.004	0.050
$T = -2$ (year 2 before PAR)	–0.009*	–0.001	0.004	–0.014
$T = -1$ (year 1 before PAR)	0.004	–0.003	0.001	–0.032
$T = 0$ (PAR year)	0.004	–0.005	–0.014	–0.044
$T = 1$ (year 1 after PAR)	0.006	–0.011*	–0.036*	–0.039
$T = 2$ (year 2 after PAR)	0.004	–0.007	–0.021	–0.072
$T = 3$ (year 3 after PAR)	0.012*	–0.006	–0.018	–0.167*
$T = 4$ (year 4 after PAR)	0.012*	–0.022*	–0.072*	–0.270*
$T = 5$ (year 5 after PAR)	0.006	–0.036*	–0.111*	–0.182*

COD = cost of debt, LEV = leverage, LEV-FIN = financial leverage, LTD = natural logarithm of total debt, PAR = Paris Agreement ratification.

Notes: The COD passed the parallel trends test for windows 1 year before PAR, while the other dependent variables passed the test up to 4 years before PAR, which means that in the absence of the treatment the difference between the treatment group and control group would be constant over time. * $p<0.1$.

Source: Authors' estimates.

The terms $T = -4$ to $T = -1$ refer to year 4 to year 1 before PAR, $T = 0$ refers to PAR year, and $T = 1$ to $T = 5$ refer to year 1 to year 5 after PAR. These are interpreted the same way as in Table 5.

The results from Table 6 show that there is no anticipation effect, as evidenced by the coefficients corresponding to $T = -4$ to $T = -1$ for leverage (LEV) and financial leverage (LEV-FIN). There is also no year-of-Paris-Agreement effect for any of the debt financing variables (see coefficients for $T = 0$). However, there is some evidence of lagged effects for leverage and financial leverage at year 1 after PAR and at years 4 and 5 after PAR. We also know from Table 6 that there are some effects on the cost of debt at years 2 and 3 after PAR and on total debt at years 3–5 after PAR. The results are consistent with those in Table 5 that show significant coefficients for high emitters after PAR.

In general, the results indicate that the impacts of the Paris Agreement are statistically significant at the 10% level on the cost of debt at years 3 and 4 after PAR and on leverage at years 4 and 5 after PAR. Using the 14-industry high-emitter definition, high-emitting firms on average face a 1.2% higher cost of debt compared to low emitters 3–4 years after the PAR announcement.[3] This difference is substantial as it accounts for 30% of the sample mean cost of debt. Meanwhile, high-emitting firms' leverage and financial leverage are significantly lower by 1.1% and 3.6%, respectively, compared to low-emitting firms during year 1 after PAR. This difference represents 5% and 10% of the sample mean leverage and financial leverage, respectively. During year 4 after PAR, high emitters' leverage and financial leverage are even lower than those of low emitters, by 2.2% and 0.7%, respectively, and more so in year 5 after PAR at 3.6% and 1.1%, respectively. Consistently, in terms of the level of debt borrowings, high emitters borrow significantly less than low emitters during years 3–5 after PAR. This evidence indicates that after the announcement of PAR, firms in high-emitting industries face a significantly higher cost of debt relative to firms in low-emitting industries. Further, firms in high-emitting industries reduce their leverage and borrowing to mitigate transition risks.

In summary, the results of the three DID methods suggest that the evidence of a PAR effect for high emitters is stronger when the post-PAR years are grouped together (Tables 4 and 5) than when estimating the effects for each year before, during, and after PAR (Table 6). In Table 4, we see that overall, there are significant PAR effects on high emitters. In Table 5, we see that PAR effects are present when we consider year

[3] We also estimated the results using the nine-industry high-emitter definition, following the categorization in Nguyen, Truong, and Zhang (2020). Results are not included in the paper but are available upon request.

groupings after PAR, in which high emitters experience lower leverage and financial leverage compared to low emitters, and the differences between high emitters and low emitters tend to increase over time. However, Table 6 suggests that the PAR effects are not evident if we examine these for each year before, during, and after PAR, or when allowing for individual year effects with a fixed constant across all years.

V. How Does Transition Risk Transmit to Corporate Financing: Possible Channels

Nguyen, Truong, and Zhang (2020) explored the possible channels by which climate risks transmit to the cost of capital in Australia and showed that high-emitting firms faced bigger cash-flow risks and negative investor recognition after the Kyoto Protocol ratification. Following their study, this section explores how climate-related transition risks transmit to corporate financing via a risk channel, which is increased exposure to transition risks, and an investor-recognition channel, which is when investors are more risk averse and have negative sentiment toward high-emitting firms during the low-carbon transition.

A. Risk Channel

To examine the link between climate-related transition risks and risks of high-emitting firms, we construct two risk measures: returns volatility (VOL) and idiosyncratic risk volatility (IVOL). We construct a firm's VOL as the standard deviation of its daily stock returns during a year to describe how risky the asset of a company is for investors in equity markets. We construct a firm's IVOL as the standard deviation of its daily idiosyncratic return, which is the alpha plus residual of the market model, during a year.

The two risk measures help demonstrate the possible transmission channels of climate-related transition risks after PAR. VOL measures how volatile a company's stock price is during a year, which is largely driven by investors' views on both the entire market and firm-specific fundamentals, while IVOL mainly measures volatility of the movement in stock returns, arising from investors' views over a firm's fundamentals. The idiosyncratic return captures the return component in the actual stock return that is not driven by the stock market and thus reflects mainly firm-specific operations. A higher VOL indicates that the equity market demonstrates a more diverse and volatile view on the assets of the company, while a higher IVOL indicates that the market deems a firm's operational fundamentals as having greater uncertainty compared to the overall market environment.

Panel A in Table 7 reports the DID estimates on how VOL and IVOL change before and in and after the year of PAR announcement. The baseline results show that PAR leads to an overall reduction in VOL and IVOL. However, when we account for dynamic effects, VOL tends to decrease 1 year after PAR but increases 2 years after, while IVOL tends to increase 2 years after PAR. Further, there is no difference between firms from high-emitting industries and low-emitting industries. This may indicate that regardless of whether firms are in high-emitting or low-emitting industries, they are likely to experience material risks from PAR in their operations.

B. Investor-Recognition Channel

To explore whether investors demonstrate any negative sentiment toward high emitters after the PAR announcement, this paper examines short-term market reaction around the announcement to capture changes in sentiment. The short-term market reaction is captured using cumulative absolute returns after the announcement. In doing so, for each firm we estimate its market model by regressing daily stock returns on returns on a market index during the estimation window of [–60, –6] days before the PAR announcement. Using the estimated alpha and market beta, we calculate the daily abnormal return as the difference between actual daily returns and the sum of estimated alpha and the estimated systematic returns related to market movement, which is the product of a firm's market beta and actual market index return. When there is no particular pattern, the abnormal returns average 0. We then cumulate the abnormal returns over different event windows after the PAR to obtain cumulative abnormal returns (CAR) for each stock during different post-event windows. Specifically, CAR (0, 1–5) represents the cumulative abnormal returns 1–5 days after the PAR announcement. We then use the following model specification to examine the market reaction after the PAR announcement:

$$\mathrm{CAR}_i = a_0 + a_1\mathrm{EMITTER}_i + a_2\mathrm{SIZE}_i + a_3\mathrm{BTM}_i + a_4\mathrm{BETA}_i + e_i, \tag{7}$$

where i denotes firm i. Like the DID approach, previous-year values of control variables were used. Short-term investor reactions using cumulative abnormal returns are reported in panel B of Table 7. The results indicate that high emitters post an overall smaller return relative to low emitters, besides the normal beta return and return on risk exposure to the market, but the decline is not statistically significant except during the window from the day of the announcement to 2 days after the announcement. This indicates that there is some short-lived negative sentiment from investors after the PAR announcement toward firms that face higher climate-related risks.

Table 7. **Transmission Channels of Climate-Related Transition Risks**

Panel A. Changes in Risks Before and After PAR: Baseline and Dynamic DID Estimations

	VOL		IVOL	
Variable	**Baseline DID**	**Dynamic DID**	**Baseline DID**	**Dynamic DID**
EMITTER′PAR	–0.0009		–0.0007	
	(–0.77)		(–1.13)	
PAR	–0.0061***		–0.0025***	
	(–3.08)		(–2.60)	
EMITTER′Before^{-2y}		0.0021		0.0010*
		(1.55)		(1.66)
EMITTER′Before^{-1y}		–0.0018		–0.0007
		(–1.25)		(–1.09)
EMITTER′Current^{-0}		0.0022		0.0008
		(1.40)		(1.01)
EMITTER′After^{+1y}		–0.0016		–0.0003
		(–0.90)		(–0.33)
EMITTER′After^{2y+}		–0.0015		–0.0011
		(–0.87)		(–1.31)
Before^{-2y}		–0.0040***		–0.0013***
		(–6.87)		(–4.91)
Before^{-1y}		0.0016**		0.0015***
		(2.42)		(4.71)
Current^{-0}		–0.0007		0.0014***
		(–1.06)		(3.83)
After^{+1y}		–0.0037***		0.0000
		(–5.04)		(0.02)
After^{2y+}		0.0098***		0.0058***
		(12.53)		(13.31)
SIZE	–0.0077***	–0.0076***	–0.0040***	–0.0039***
	(–9.67)	(–9.51)	(–9.50)	(–9.41)
BTM	0.0020***	0.0033***	0.0014***	0.0017***
	(3.55)	(5.69)	(3.80)	(4.68)
BETA	–0.0033***	–0.0038***	–0.0024***	–0.0025***
	(–5.98)	(–6.75)	(–6.48)	(–7.08)
Constant	0.0898***	0.0893***	0.0447***	0.0440***
	(23.99)	(23.62)	(22.58)	(22.29)
Firm fixed effects	YES	YES	YES	YES
Observations	28,430	28,430	28,430	28,430
Adjusted R-squared	0.142	0.0861	0.107	0.0887

BETA = market beta, BTM = book-to-market ratio, DID = difference-in-difference, IVOL = idiosyncratic returns volatility, PAR = Paris Agreement ratification, SIZE = natural logarithm of market capitalization, VOL = returns volatility.

Notes: Robust t-statistics in parentheses. *** $p<0.01$, ** $p<0.05$, and * $p<0.1$.

Source: Authors' estimates.

Table 7. **Transmission Channels of Climate-Related Transition Risks**

Panel B. Investor-Recognition Channel: Cumulative Abnormal Returns Regression					
	(1) CAR (0,1)	**(2) CAR (0,2)**	**(3) CAR (0,3)**	**(4) CAR (0,4)**	**(5) CAR (0,5)**
EMITTER	–0.0020	–0.0057**	–0.0033	–0.0031	–0.0025
Controls	YES	YES	YES	YES	YES

CAR = cumulative abnormal returns.
Notes: Robust *t*-statistics in parentheses. ** $p<0.05$.
Source: Authors' estimates.

Overall, while the results for the two possible working channels are not very significant, there is some modest evidence to show that high emitters tend to face more volatility in the year of the PAR announcement and some short-lived negative sentiment from investors. As a consequence, high emitters tend to borrow less and have lower leverage compared to low emitters.

C. Climate Transition Risk and Physical Risk Exposure

As we have earlier argued, the Paris Agreement carries more transition risks for firms over the short term since a firm's physical risk exposures cannot be suddenly changed by climate actions. To verify that the types of climate risks that companies face after the Paris Agreement are more about increased transition risks rather than physical risks, we use country-level physical risk exposure data and compare the changes in high-emitting firms in countries that face higher physical climate risks with those in countries that face lower physical climate risks.[4]

In this analysis, we utilize two country-level measures of physical climate risks. First, we use the vulnerability index developed by Chen et al. (2015) that measures countries' physical climate vulnerabilities accounting for exposure, sensitivity, and adaptability. This vulnerability measure was computed from health, food, ecosystems, habitat, water, and infrastructure sectors. Our second measure was developed by Eckstein, Künzel, and Schäfer (2021) and defines physical climate risks in terms of

[4] In the literature, Trucost data accessible through S&P Capital IQ and Asset4 by Thompson Reuters are the popular data sources that rate the efforts of firms to reduce their carbon emissions. See, for example, de Villiers, Jia, and Li (2022); Arouri, El Ghoul, and Gomes (2021); and El Ghoul et al. (2018). Trucost developed the S&P ESG Scores, which is based on the annual evaluation of companies' sustainability practices. Trucost also provides data that measure the environmental impact of companies including GHG emissions, waste disposal, and use of natural resources. The authors do not currently have access to Trucost data. In future research, the authors will attempt to obtain Trucost data and perform firm-level empirical analysis, which will allow for a clearer understanding of the link between climate-related transition risk and corporate debt financing in ASEAN markets.

Table 8. **Difference-in-Difference-in-Differences with Firms in Highly Vulnerable Countries**

Variables	**(1) COD**	**(2) LEV**	**(3) LEV-FIN**	**(4) LTD**
PAR	–0.0020	0.0002	0.0049	0.0022
	(–0.30)	(0.03)	(0.29)	(0.03)
EMITTER′PAR	–0.0003	–0.0182**	–0.0460**	–0.1217
	(–0.09)	(–2.27)	(–2.27)	(–1.46)
PAR′High Vulnerability	–0.0025	–0.0009	–0.0014	0.1288**
	(–0.81)	(–0.18)	(–0.11)	(2.37)
EMITTER′PAR′High Vulnerability	0.0106*	0.0021	–0.0020	–0.0323
	(1.75)	(0.17)	(–0.06)	(–0.26)
Firm and year fixed effects	YES	YES	YES	YES
Observations	26,632	27,160	27,160	24,034
Adjusted *R*-squared	0.00162	0.00912	0.00702	0.0436

COD = cost of debt, LEV = leverage, LEV-FIN = financial leverage, LTD = natural logarithm of total debt, PAR = Paris Agreement ratification.
Notes: Robust *t*-statistics in parentheses. ** p<0.05 and * p<0.1.
Source: Authors' estimates.

fatalities and economic loss due to exposure to extreme climate events. This climate risk index is constructed using weighted ranks of deaths, loss in purchasing power parity, loss in gross domestic product, and human development.

Using a difference-in-difference-in-differences (DDD) approach, we analyze how high-emitting firms from countries that are highly vulnerable to physical climate risks differ from those in low-physical-risk countries in and after the year of PAR announcement.

Table 8 reports the first set of DDD results, in which the variable "High Vulnerability" is a dummy variable that is equal to 1 if a firm is located in a country that is in the upper 50% of the vulnerability index of Chen et al. (2015), and 0 otherwise. In this classification, Indonesia, the Philippines, and Viet Nam are identified as "Highly Vulnerable," while Malaysia, Singapore, and Thailand are "Less Vulnerable."

We use another measure of vulnerability, which is based on the climate risk of countries. Table 9 shows each country's climate risk status by year. A country is at "High Climate Risk" if it is in the upper 50% of exposure to physical climate risk, based on the measure of Eckstein, Künzel, and Schäfer (2021). Based on this classification, the Philippines is considered "High Risk," while Singapore is "Low Risk" for the entire period. Thailand and Viet Nam are classified as "High Risk" in most years, while Indonesia and Malaysia are "Low Risk" in most years.

Table 9. **Climate Risk of Countries by Year**

Year	Indonesia	Malaysia	Philippines	Singapore	Thailand	Viet Nam
2012	Low	Low	High	Low	High	High
2013	Low	Low	High	Low	High	High
2014	High	High	High	Low	Low	Low
2015	High	Low	High	Low	Low	High
2016	Low	Low	High	Low	High	High
2017	Low	Low	High	Low	High	High
2018	High	Low	High	Low	Low	High
2019	High	Low	High	Low	High	Low
2020	High	Low	High	Low	High	Low
2021	High	Low	High	Low	High	Low

Source: Authors' estimates.

Table 10. **Difference-in-Difference-in-Differences with Firms in Countries with High Climate Risk**

Variables	(1) COD	(2) LEV	(3) LEV-FIN	(4) LTD
PAR	–0.0017	0.0006	0.0093	0.0507
	(–0.25)	(0.09)	(0.59)	(0.76)
High Climate Risk	0.0006	0.0021	0.0086	–0.0471
	(0.28)	(0.85)	(1.42)	(–1.61)
EMITTER′PAR	0.0008	–0.0218***	–0.0603***	–0.1435**
	(0.24)	(–3.03)	(–3.34)	(–1.98)
EMITTER′High Climate Risk	–0.0043	0.0009	0.0007	–0.0362
	(–1.08)	(0.14)	(0.04)	(–0.56)
PAR′High Climate Risk	–0.0026	–0.0026	–0.0121	0.0471
	(–0.87)	(–0.69)	(–1.34)	(1.11)
EMITTER′PAR′High Climate Risk	0.0077	0.0119	0.0363	0.0440
	(1.42)	(1.36)	(1.47)	(0.48)
Firm and year fixed effects	YES	YES	YES	YES
Observations	26,632	27,160	27,160	24,034
Adjusted R-squared	0.00164	0.00931	0.00716	0.0436

COD = cost of debt, LEV = leverage, LEV-FIN = financial leverage, LTD = natural logarithm of total debt, PAR = Paris Agreement ratification.
Notes: Robust t-statistics in parentheses. *** $p<0.01$ and ** $p<0.05$.
Source: Authors' estimates.

Table 10 shows the DDD results in which "High Climate Risk" is a dummy variable that is equal to 1 if the firm is located in a high-climate-risk country as defined above, and 0 otherwise. We see that while PAR leads to declines in leverage and debt among firms from high-emitting industries, climate-related physical risks do not significantly affect borrowing behaviors among ASEAN firms. This strengthens the view that PAR heightened transition risks and influenced high-emitting firms' financing behavior.

VI. Conclusion

Much of the existing literature on the impact of climate-related transition risks on corporate financing centers on advanced economies. Yet, an increasing number of emerging economies have committed to climate change targets. It is thus important to understand how climate-related transition risks will affect the financing environment of companies in these economies. This paper investigates the impact of PAR on corporate debt financing in ASEAN economies, focusing on the cost of debt, leverage, financial leverage, and the debt level of publicly listed companies. Our analysis finds there is evidence that high emitters, defined as firms in 14 high-emitting industries, experience 1.7% lower leverage and 4.7% lower financial leverage after the PAR announcement. Accounting for dynamic effects, we also find that these firms experience 1.8% and 4.2% lower leverage and financial leverage, respectively, than low-emitting industries 1 year after the PAR announcement. The gap widens to 2.3% and 6.1%, respectively, from year 2 onward. In addition, high-emitting firms borrow significantly less (by 15.1%) relative to low-emitting firms after 2 years from the PAR announcement. However, there is no evidence that high-emitting firms faced a higher cost of debt compared to low emitters after the PAR announcement. Overall, our findings suggest that firms in high-emitting industries encounter more difficult financial conditions during the transition to net zero. In particular, they may borrow less to mitigate their heightened exposure to transition risks.

In terms of the possible working channels of the lower leverage and higher cost of debt, we find that while firms from high-emitting industries experience a short-lived negative abnormal return after PAR, the risks they experience do not differ significantly from firms in low-emitting industries. This suggests that increased risks and negative investor sentiment do not change the debt financing decisions of firms in high-emitting industries.

Our findings have two key policy implications. First, financial regulators need to monitor the quality of assets in high-emitting industries to ensure that potentially higher risks in operations and negative investor recognition will not impair the balance sheets of financial institutions and overall finance sector stability. Second, policy makers should try to develop innovative instruments to help high-emitting industries shift toward low-emitting operational models as part of a timely and smooth transition to net zero emissions.

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