International Business Review 32 (2023) 102166

Contents lists available at ScienceDirect

International Business Review

journal homepage: www.elsevier.com/locate/ibusrev

Business resilience: Lessons from government responses to the global COVID-19 crisis

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A R T I C L E I N F O

JEL classification:
Q54
G01
G15
G18
G41
I18

Keywords:
Business resilience
Firm default risk
Government responses
Crisis management practices

A B S T R A C T

This study explores the survival of firms across countries, and what factors contribute to their ability to withstand large-scale exogenous shocks, focusing on the COVID-19 pandemic. Using corporate default risk as a measure of non-resilience, our empirical results from 97 countries reveal that stringent COVID-19 containment measures created a significant resilience test for businesses worldwide. Further tests suggest that cash holdings, knowledge assets, international sales, and access to foreign capital markets are crucial for global businesses to pull through exogenous shocks. Country-level institutional qualities also play an essential role in shaping business resilience during a crisis. Our study is the first to comprehensively analyze the drivers of business resilience across diverse countries using the COVID-19 outbreak as a major global crisis, providing a nuanced understanding of this topic in international business.

1. Introduction

Over the past decades, the world has witnessed many catastrophic events, such as the natural disaster hurricane Katrina (US; 2008), the Fukushima Daiichi nuclear disaster (Japan; 2011), and of course, the human-made global financial crisis (2007–2008). While each of these events is unique per se, they all entail significant disruptions to the global economy with adverse, swift, and unpreventable consequences (Barton & Wiseman, 2014). What has captured the attention of international business (IB) researchers after these events is that some firms have been proven to withstand the destructive impacts of such crises better than others (see, e.g., Winston, 2014; Frick, 2019; Amankwah-Amoah & Wang, 2019). This fact raises a natural question of what factors constitute a business's resilience – its ability to adapt, survive, and bounce back – to a catastrophic event beyond its control. Our study provides insights into this research question and tests how financially susceptible firms across countries are, as well as what drives their ability to absorb the impact of large-scale exogenous shocks, such as the recent Coronavirus (COVID-19) epidemic.

The COVID-19 pandemic has resulted in a tragically large number of human lives being lost, forcing almost every country into lockdown with stringent containment measures. These measures, in turn, triggered a massive drop in economic output and supply chain activities, increased costs in international transactions, and forced many firms into permanent closure. These effects are unlike anything experienced in our lifetimes (e.g., Wenzel, Stanske, & Lieberman, 2020; Brodeur, Clark, Fleche, & Powdthavee, 2021). As such, we consider the COVID-19 pandemic to be a *rare* and *non-ergodic* event that puts international businesses through rigorous resilience tests and provides a real-world example through which IB literature can determine what firm qualities or strategies are essential for them to meet the extraordinary demands of a crisis (Verbeke & Yuan, 2021; Beamish & Hasse, 2022; Puhr & Müllner, 2022). Another reason for choosing the COVID-19 pandemic as our empirical laboratory is that it is not a purely economic-driven crisis and reflects a clear trade-off for countries between saving lives and saving livelihoods. Thus, nations have been very diverse in their response to the pandemic, both in the measures adopted and the implementation timing of these measures (Hale et al., 2020). Such diversity is ideal for us to explore the role of a country's governmental and institutional characteristics in shaping business outcomes in challenging times.

To offer further context, this study uses corporate default risk to measure a firm's non-resilience to an exogenous shock. This variable is

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https://doi.org/10.1016/j.ibusrev.2023.102166
Received 6 July 2022; Received in revised form 29 June 2023; Accepted 30 June 2023
Available online 8 July 2023

well-parameterized based on firm fundamentals, which indicates the firm's capability to weather rapid drops in revenue, increased costs, or credit issues. Thus, understanding how and why the probability of default is different among firms in the face of a stormy situation is particularly interesting to scholars and managers (e.g., Campbell, Hilscher, & Szilagyi, 2008; Anderson & Mansi, 2009; Kisgen & Strahan, 2010; Davydenko, Strebulaev, & Zhao, 2012). However, neither the field of strategic management nor the literature on IB has systematically investigated how corporate default risk evolves during an exogenous shock on a global scale. This is perhaps due to a lack of a non-ergodic global event that puts businesses worldwide on the verge of closure. Using the recent COVID-19 pandemic, our study attempts to acquire an understanding of this topic.

Our empirical investigations first show that corporate default risk, overall, increases with the stringency of COVID-19 movement restrictions, demonstrating the pandemic's negative impact on business survival. Specifically, in an international sample of 19,549 firms across 97 countries, we find that firms in a country with more stringent government movement restrictions have a higher probability of default in several subsequent quarters after the pandemic struck. These findings remain robust to various sensitivity analyses, including four identification strategies to address the endogeneity problems. Our baseline results confirm the empirical validity of the COVID-19 pandemic in enabling an investigation of corporate non-resilience to a crisis episode.

Next, we acquire a deeper understanding of what factors facilitate a firm's survival ability by conditioning the effects of COVID-19 responses on corporate insolvency on multiple firm-level attributes. IB research has often studied global crises as the external "context" for business strategies (e.g., Amankwah-Amoah, Khan, & Osabutey, 2021; Fainshmidt, Nair, & Mallon, 2017; Jooss, Conroy, & McDonnell, 2022; Park and Mezias, 2005). Still, firms remain active participants rather than passive actors in unfolding crises. Consistent with this notion, the *dynamic capability theory* (*DCT*) highlights the importance of a firm's ability to adapt to changing environments to sustain its competitive advantage (Teece, Pisano, & Shuen, 1997; Teece, 2014). More particularly, without knowledge about an exogenous crisis, firms that can flexibly extend or reconfigure their internal and external resource base to address radically changing environments may more effectively mitigate the adverse effects on their business operations and reduce the risk of default.

Our first set of cross-sectional analyses is built on this notion. This analysis studies how a firm's internal and external resource attributes influence its ability to withstand undesirable business outcomes of governmental actions during the COVID-19 epidemic. The estimation results yield two intriguing findings. First, regarding internal economic resources, our results highlight the benefits of cash holdings, reducing labor intensity, and accumulating more knowledge assets in building a business's resilience against a global crisis. Second, considering external economic resources, our results show that internationalization could enhance or erode business resilience, contingent on the economic conditions that firms face during a crisis. Our analyses demonstrate that cross-border sales and funding acquired from abroad through foreign ownership could mitigate the adverse consequences of COVID-19 containment measures on corporate default risk. In contrast, internationalizing supply chains is not a suitable response, perhaps due to the significant disruptions in the global supply chains during the pandemic.

Besides firm-level characteristics, we also investigate whether the unfavorable impacts of government responses vary across countries with different institutional arrangements. IB literature has stressed how external market contexts, such as a country's institutions, create incentives and constraints in global business strategies (e.g., Porter, 1980; La Porta et al., 1998; Cumming et al., 2017) and link firms' performance to whether they can promptly respond to diverse institutional contexts of the countries where they operate (e.g., Wan, 2005). Our results suggest that firms in pro-creditor countries, those fragile to economic uncertainty, and those dependent on migrant workers are more likely to default in the face of COVID-19 government restrictions. We also document that citizens' trust in each other can reduce the adverse effects of government responses on corporate default risk. At the same time, individualism and civil liberty can exacerbate these effects. These results underscore the importance of institutional qualities in keeping the economic consequences of crisis responses faced by the corporate sector under control.

Additional analyses examine the underlying mechanisms through which a government's response adversely increases firm default probability. We find that higher leverage, increased stock return volatility, higher cash flow risk, and deteriorated corporate liquidity channel the lockdown measures' adverse effects onto corporate solvency. Finally, we investigate the time-series variation in how government prevention measures affect a firm's probability of default. The results imply that more extreme control measures at the early stage of the pandemic are conducive to longer-term benefits in reducing corporate default risk in subsequent periods.

Our study contributes to the existing literature in two main ways. First, this paper extends a growing body of research that explores the adverse impacts of the black-swan events on various financial outcomes (e.g., Altig et al., 2020; Bazel-Shoham & Shoham, 2020; Bretscher, Hsu, Simasek, & Tamoni, 2020; Ramelli & Wagner, 2020; Liu, Qiu, & Wang, 2021). We show that government policies responding to the COVID-19 pandemic negatively impact firm solvency, indicating how vulnerabilities in health systems due to the pandemic can spill over to the functioning of the corporate sector globally. We also offer empirical evidence that, while highly stringent containment measures could result in a greater corporate default risk in the short run, these responses benefit firms' solvency in later periods. This finding adds insights to the debate that has drawn significant attention from policymakers and the public on the effectiveness of government interventions amid extreme events (e.g., Pontusson & Raess, 2012; Ha & Kang, 2015; Pulejo & Querubín, 2021).

Second, our paper adds to studies investigating the constituents of business resilience in times of crisis.[1] This study exploits the COVID-19 pandemic as a natural platform to examine how an exogenous shock affects business resilience. Such a pandemic is a *rare* event through which researchers can observe governments' concurrent enforcement of social measures globally. We also identify several firm-specific attributes that could be the beacon for international business managers when coordinating their operations through future storms. Our paper is among the first to investigate corporate default risk in a global setting with various institutional and regulatory features, providing a more refined picture of firms' risk outcomes.

We organize the paper as follows. Section 2 discusses related literature and states our hypotheses. Section 3 discusses the data and methodology. Sections 4 and 5 present the empirical findings. Section 6 offers concluding remarks.

2. Theoretical backgrounds and hypotheses

2.1. Default risk and corporate resilience

The complexity and unpredictability created by globalization have imposed significant threats on global businesses, and resilience to unprecedented economic shocks has arisen as an essential factor for companies striving for long-term success in the global marketplace (Linnenluecke, 2017). While existing literature often uses firm performance measures to assess a firm's financial health, operational stamina,

[1] See, for example, Beltratti and Stulz (2012), Lins, Servaes, and Tamayo (2017), Albuquerque, Koskinen, Yang, and Zhang (2020), Bartik et al. (2020), Perez-Batres and Treviño (2020), Van Assche and Lundan (2020), Ding, Levine, Lin, and Xie (2021), Fahlenbrach, Rageth, & Stulz, 2021, Li, Liu, Mai, & Zhang, 2021, Puhr and Müllner (2022), and Nguyen, Pham, & Truong, 2023.

and endurance level (e.g., Denrell, Fang, & Zhao, 2013), these measures are subject to criticism. Carmeli and Markman (2011) suggest that most firms measure diverse outcomes yet often do not directly track their resilience in their performance measures. Given such an empirical caveat, this study exploits a firm's probability of default during a global crisis as a more direct proxy for its non-endurance level.

Default risk refers to the likelihood that a firm cannot fulfill its debt obligations, and the probability of default is a vital indicator of a firm's financial health and overall risk profile (e.g., Merton, 1974; Vassalou & Xing, 2004; Anderson & Mansi, 2009). Intuitively, a financially healthy firm with low default risk is better positioned to survive, bounce back, and sustain its performance over the long term in the face of unexpected events and abrupt changes. Besides this aspect, default risk is of particular concern to a firm's key stakeholders (e.g., shareholders, debtholders, customers, employees) since it materially affects stock returns, corporate valuation, financing costs, or investment decisions (e.g., Campbell et al., 2008; Kisgen & Strahan, 2010; Davydenko et al., 2012; Aabo, Pantzalis, Sørensen, & Toustrup, 2016). Therefore, minimizing default risk is critical to retaining the trust and loyalty of stakeholders. Finally, corporate resilience is about reacting to and proactively preparing for setbacks. Managing default risk can be viewed as a firm's proactive effort to tackle risks arising from adversity, as a successful default risk strategy must be well-managed before disruptions occur.

Despite a large body of literature examining various firm-specific characteristics and managerial attributes that affect firm default risk,[2] limited attention has been given to how this risk evolves and what might be done to manage it during an exogenous shock on a global scale, like the COVID-19 pandemic, from an IB perspective. This study attempts to address this inconvenient gap.

2.2. Corporate resilience during a global crisis

During a crisis, firms confront numerous challenges against their resilience strategies amidst uncertainties and disruptions in their business environments. Regulatory changes are a typical example of these challenges. While firms often have some forewarning and the opportunity to react to anticipated regulatory adjustments, crises can introduce unanticipated modifications in regulations and policies. Although necessary in crises, these modifications may create undesirable uncertainty and hinder the effectiveness of business resilience strategies.

Nevertheless, studying business resilience in the face of government interventions during non-economic-driven turbulences like terrorist attacks, natural catastrophes, and disease outbreaks is crucial but challenging. Unlike economic-driven crises, these events often demand non-economic measures to coordinate the economy effectively. The recent COVID-19 pandemic is an example of this. The pandemic has prompted governments worldwide to adopt social distancing measures to contain the coronavirus and its consequences. Nevertheless, how these disease prevention measures and, in general, social policies affect a business's viability remains an empirical issue.

This study exploits the COVID-19 pandemic as a natural platform to examine the impact of abrupt government interventions in social policies on business non-resilience, as measured by default risk, at a cross-country level. Such a pandemic is a *non-ergodic* event that triggers governments' concurrent enforcement of social distancing measures globally. However, these measures caused significant disruptions to the world supply chain and eroded business revenue while not reducing the costs accrued, producing higher uncertainty and earnings volatility. Hence, firms can face severe financial hardship and a higher probability of default during the pandemic.

[2] See, for example, Bakshi, Madan, and Zhang (2006) and Bakshi, Gao, & Zhong, (2023) for reviews of the literature.

Hypothesis 1. More stringent government responses to the pandemic are associated with higher firm default risk.

2.3. The moderating effect of firm-level attributes

IB research has often studied global crises as the external "context" for business strategies (e.g., Amankwah-Amoah, Khan, & Osabutey, 2021; Fainshmidt, Nair, & Mallon, 2017; Jooss, Conroy, & McDonnell, 2022). However, firms are diverse in their capabilities of handling unprecedented uncertainties and remain active participants instead of passive actors in unfolding crises. The *dynamic capability* theory (DCT) suggests that firms with the flexibility to adjust their internal and external resource base to modify short-term competitive positions and address radically changing environments may better sustain their business activities in uncertain times (Teece, Pisano, & Shuen, 1997; Teece, 2014).

Based on this theoretical framework, we discuss two firm-level factors that might significantly impact a firm's ability to cope with uncertainties associated with exogenous crises.[3] These are; (1) the composition of internal economic resources a firm uses to create goods and services and (2) their degree of internationalization, which captures the external economic resources.

2.3.1. The composition of economic resources

Wernerfelt (1984, p.171) described the firm as bundles of resources and argued that "*resources and products are two sides of the same coin*". In this subsection, we inspect whether a firm's composition of internal economic resources can affect its capability to transform, maintain competitiveness, and survive a crisis episode.

In the context of the COVID-19 pandemic, government movement restrictions have stretched firms to new limits by intensifying labor shortages with stay-at-home orders (Baker et al., 2020), obstructing their access to capital markets (Halling, Yu, & Zechner, 2020), and forcing them to innovate and transform with technologies to survive (Riom & Valero, 2020). Under these circumstances, firms should be flexible enough to adjust their portfolios of internal economic resources and coordinate their business activities to overcome these challenges. As such, it is reasonable to assess a firm's ability to cope with the pandemic by looking at its financial, human, or intellectual capital composition.

First, regarding internal financial funding, Keynes (1936) posits that firms hold cash as a buffer against adverse cash flow shocks due to costly external financing, often referred to as the precautionary savings hypothesis. Opler et al. (1999), Harford (1999), and Duchin (2010), among others, have also provided empirical evidence to confirm this precautionary motive in cash policy. In congruence with this theory, firms with more significant cash holdings are assumed to be more flexible in using their internal funds to alleviate external financing constraints and reduce their probability of default during the pandemic.[4] Thus, we put forth the following hypothesis:

Hypothesis 2A. : The effect of government response on corporate default risk is more pronounced among firms with lower cash holdings.

[3] We thank the Referees for their excellent suggestions of using this theoretical framework as a solid ground for our hypotheses as to a firm's ability to cope with crises.

[4] We are aware of a counterargument that excess cash holdings can exacerbate the agency problem between managers and shareholders. Managers have incentives to direct abundant resources under their control toward pursuing their self-interests at the expense of shareholders. This argument is referred to as the free cash flow hypothesis, put forward by Jensen (1986). However, this hypothesis is unlikely to hold in extreme economic conditions where corporate managers face a significantly higher unemployment risk and tightened capital markets with binding financial constraints (Campello, Graham, & Harvey, 2010).

Second, concerning human resources from within, COVID-19 containment measures prevented workers from returning to their place of work (Baker et al., 2020), meaning many manufacturers struggled with labor shortages and relocations. One example of this disruption is that China's average working hours fell from 46.7 h in January to 40.2 h in February 2020 (Zeng, 2020). This impact was naturally pertinent to labor-intensive industries, where labor is a critical, if not the most important, resource. Thus, we hypothesize that labor-intensive firms are more likely to default when facing stringent social restrictions to combat a global crisis like COVID-19.

Hypothesis 2B. : The effect of government response on corporate default risk is more pronounced among more labor-intensive firms.

Lastly, as for intellectual capital, knowledge assets (e.g., intellectual property, organizational routines, and employee expertise) are among the most valuable resources for a firm's resilience. Knowledge assets can spur innovation, helping firms quickly adapt and respond to changes in the business environment. The ownership of such assets is widely recognized as a significant driver of growth and performance in all firms, ranging from small-to-medium enterprises to large multinational corporations (Kogut & Zander, 1996; Kyläheiko et al., 2011; Teece, Pisano, & Shuen, 1997). Prior literature (e.g., Moberly & Cheon, 2009; Demers et al., 2021; Altomonte, Bauer, Gilardi, & Soriolo, 2022) shows that intangible assets can help firms weather the negative impact of the financial crisis and immunize stocks during the COVID-19 crisis. Consistent with this notion, we conjecture that knowledge assets would effectively protect a firm against the risk of default and facilitate business resilience when facing financial hardships during a global crisis.

Hypothesis 2C. : The effect of government response on corporate default risk is more pronounced among firms with lower ownership of knowledge assets.

2.3.2. Degree of internationalization

Besides the internal economic resources, the degree of internationalization supports global businesses' access to external resources when confronting environmental developments. For instance, selling their products overseas and acquiring necessary resources from multiple locations are potential avenues for firms to mitigate local market disruptions (Bloom, 2009; Lee & Chung, 2022; Puhr & Müllner, 2022). These methods help firms achieve geographically diversified portfolios of suppliers and customers and a larger pool of knowledge from different countries that could facilitate market reorganization, thereby ensuring greater shock resilience.

Nevertheless, it is worth noting that the process of internationalization might expose firms to more location-specific risks such as terrorism (Czinkota et al., 2010), violent conflict (Lee & Chung, 2022), or natural disasters (Oh & Oetzel, 2011; Mithani, 2017), and pervasive economic factors (Reeb et al., 1998; Ding et al., 2021). Due to these local risks, internationalized firms may experience a higher systematic risk than domestic firms. Combining the above arguments, whether internationalized supply chains and customers can enhance firms' flexibility in response to exogenous shocks remains inconclusive. Our study seeks an answer to this question. We test whether the risk-reducing benefits - diversification - or the risk-increasing cost - higher systematic risk - of internationalization prevails during the COVID-19 pandemic. Thus, we construct the following hypothesis:

Hypothesis 2D. : The effect of government response on corporate default risk is more pronounced among firms with more internationalized supply chains and customers.

In addition to affecting operational performance, internationalization can provide firms with real market-side options in financial markets. A global presence enables firms to access a bigger pool of funding from foreign investors, who are generally less susceptible to exogenous shocks. This trump card might help increase the firms' financial flexibility (Shaver, 2011; Jang, 2017) and significantly reduce losses in firm valuation when exogenous shocks jeopardize the local capital markets. During the COVID-19 lockdowns, tightened access to the credit market and underinvestment were significant (Li et al., 2020; O'Hara & Zhou, 2021); therefore, we expect that internationalization in the global capital markets can prevail and enhance a firm's resilience to government containment measures.

Hypothesis 2E. : The effect of government response on corporate default risk is less pronounced among firms with better access to global capital markets.

2.4. The moderating effect of institutional qualities

Institutional qualities are a central concept of IB, which refers to the formal and informal rules, including but not limited to laws, regulations, norms, and practices, that influence economic and social activities within or across nations. *Institutional theory* suggests that a country's institutions can materially affect how firms respond to government interventions, particularly in managing firm-specific risk (Tolbert & Zucker, 1996). This arises from the fact that firms should conform to their country's institutional requirements to gain legitimacy and achieve sustainable competitive advantage. In line with this argument, we subsequently evaluate how the assumed effects of government responses to COVID-19 on corporate default may vary dependent on several institutional aspects.

2.4.1. Legal institutions

The effectiveness of the battle against any crisis depends crucially on the government policies undertaken. However, in unexpected and unfamiliar situations, governments in many countries may lack solid economic foundations and technical know-how to form and implement the necessary procedures to stabilize economic activities. Such uncertainties in government policies may induce firms to adopt a wait-to-see approach and postpone their investment activities (Bernanke, 1983; Gulen and Ion, 2016), thereby prompting further sluggish economic growth in these countries. Therefore, we expect that firms in a country with higher public policy uncertainty could suffer more from abrupt government interventions.

Hypothesis 3A. : The effect of government response on corporate default is more pronounced in countries with higher public policy uncertainty.

Next, we evaluate the effects of government interventions on corporate default risk conditioning on a country's legal protections for creditors. According to *institutional theory*, it is reasonable that creditor-friendly regimes could further depress corporate debtors during financial distress. For instance, prior studies show that enhanced credit rights can result in inefficient liquidations of assets (Acharya, Sundaram, & John, 2011), lower innovation (Acharya & Subramanian, 2009), and reduced corporate investment (Favara, Morellec, Schroth, & Valta, 2017). Thus, we expect that stringent government interventions' adverse impact on default risk could be more pronounced for firms in countries with higher creditor protection.

Hypothesis 3B. : The effect of government response on corporate default is more pronounced in countries with solid protection of creditors' rights.

2.4.2. Labor market institutions

In an immigration-dependent economy, migrant labor is a crucial resource for many firms. When government responses restrict or reduce the availability of migrant labor, firms that rely heavily on this resource may face difficulties in meeting their operational needs, fulfilling contracts, or maintaining productivity. These challenges can increase the risk of default for firms in countries with significant inputs of migrants. Furthermore, anecdotal evidence has shown that an immigration-dependent economy may witness more severe unfavorable outcomes of COVID-induced cuts to immigration for disease prevention.[5] Hence, we expect that firms in countries more reliant on migrant workers are subject to a higher risk of default due to pandemic containment policies.[6] This leads us to the following hypothesis:

Hypothesis 3C. : The effect of government response on firm default risk is more pronounced in countries that rely more on migrants.

2.4.3. *Cultural institutions*

A critical element of the relationships between suppliers, distributors, government officials, and other key stakeholders is mutual trust, understanding, and shared norms (Guiso, Sapienza, & Zingales, 2004, 2008). Prior studies suggest that mutual trust between economic agents can facilitate cooperative relationships and provide firms with sufficient resources to navigate the complexities and uncertainties of international business environments, particularly during crises (Sapienza & Zingales, 2012; Thakor & Merton, 2018).

In an unprecedented event like the COVID-19 pandemic, high levels of mutual trust may precipitate coordinated responses among individuals, societies, and organizations. This, in turn, alleviates lenders' fears of default, which is essential for maintaining the efficient functioning of financial markets during times of crisis. In countries with high social trust, firms may face less pressure to liquidate their business assets to settle loans during lockdown episodes. Strong social trust mitigates the perceived risks associated with default, promoting a more stable business environment. In line with this argument, we propose the following hypothesis:

Hypothesis 3D. : The effect of government stringency responses on default risk is less pronounced in countries with higher social trust.

Besides social trust, cultural norms shape individuals' and organizations' decision-making behavior in an economy. Countries characterized by individualistic cultures and a strong emphasis on civil liberty are likely to possess institutions that prioritize personal freedoms and individual autonomy. As such, these countries are often equipped with legal frameworks designed to uphold freedom of speech and societal norms that underscore individual rights and independence.

In the battle against the spread of COVID-19, many government-initiated restrictive orders have faced substantial criticism due to their infringement on freedom of movement and violations of international human rights laws (Meier, Habibi, & Yang, 2020). As a result, citizens residing in countries with individualistic cultures or stronger freedom of speech tendencies may opt not to comply with these orders but instead raise their voices in opposition. This resistance further complicates the enforcement of restrictive policies, rendering them less effective. Based on these premises, we conjecture that individualistic culture and civil liberty could prolong the impacts of government-initiated policies, thereby drawing firms into insolvency.

Hypothesis 3E. : The effect of government stringency responses on default risk is more pronounced in countries with individualistic cultures and civil liberty.

3. Data and methodology

3.1. *Sample construction*

This study gathers data from various sources. First, we obtain firm-level default risk from the Credit Research Initiative (CRI) database created by the National University of Singapore Risk Management Institute. The CRI covers the daily updated probability of default data of more than 85,000 publicly listed firms in 134 economies as of January 2022, with prediction horizons from 1 month to 5 years. Though the default risk measures from the CRI are compiled daily, little variation is observed due to the lack of accounting disclosures used to model a firm's credit risk, which is only reported quarterly. Therefore, we aggregate each firm's CRI default risk measures at a quarterly level to tackle the frequency mismatching between dependent and independent variables in our empirical setting.

To be included in our sample, firms must have available default risk data reported by CRI from January 2019 to June 2021. We then collect the quarterly government response stringency index (GSI) from the Oxford COVID-19 Government Response Tracker (OxCGRT) (Hale et al., 2020).[7] Quarterly stock trading and accounting data are extracted from CRSP/Compustat North America for the US firms and Compustat Global for international firms.

The intersection of these databases yields a final sample of 19,549 firms from 97 countries from January 2019 to June 2021, equivalent to 170,950 firm-quarter observations.[8] The sample starts in January 2019 to facilitate the comparison of corporate default risk between the periods with and without COVID-19 lockdown policies, while the availability of the CRI default risk measures limits the ending point to June 2021.

3.2. *Dependent variables: default risk measures*

Our primary dependent variable is the CRI one-year distance-to-default, defined as volatility-adjusted leverage based on Merton's (1974) structural model with special treatments following Duan et al. (2012). We use this variable to proxy for corporate default risk in this study for two main reasons. First, the distance-to-default measure is market-based and has gained prominence, partly due to its proven commercial applicability as applied by Moody's Kealhofer, McQuown, and Vasicek (KMV), compared to other accounting-based proxies for default risk (e.g., Bharath and Shumway, 2008; Campbell, Hilscher, & Szilagyi, 2008; Das, Hanouna, & Sarin, 2009; Brogaard et al., 2017). Second, this measure can be conveniently implemented in an international setting (e.g., Zhang, Ouyang, Liu, & Xu, 2020; Kabir, Rahman, Rahman, & Anwar, 2021), promoting our cross-country comparison of the impacts of government responses to the crisis. The higher the CRI distance-to-default (*DTD*) value, the larger the positive spread between firm value and firm liabilities, and the lower the probability of default.[9]

Following Bharath and Shumway (2008) and Brogaard, Lia, and Xia (2017), we also use the cumulative normal distribution of the negative distance to default (denoted *EDF*) as an alternative measure of default risk. Appendix 3 reports the summary statistics of our default risk measures for the pre-and post-March 2020 periods in each country or industry in our sample. On average, we observed a lower distance to default and higher expected default frequency across industries and countries after the pandemic was officially confirmed in March 2020. This evidence is consistent with an exogenous increase in corporate default risk associated with the COVID-19 pandemic.

3.3. *Independent variables*

3.3.1. *The government response stringency index (GSI)*

This study adopts Hale et al.'s (2020) country-level COVID-19

[5] Australia is a telling example. A typical article regarding this economy can be found at: https://www.theguardian.com/business/2020/aug/02/migration-australia-cliff-economy-international-students-covid-19-coronavirus

[6] We thank the referee for suggesting the effect of immigration on the relation between government stringency response and firm default risk.

[7] The government response stringency index is accessible at: https://www.bsg.ox.ac.uk/research/covid-19-government-response-tracker

[8] The filtering steps to construct our testing sample can be found in Appendix 2.

[9] The detailed construction of CRI distance-to-default measure is presented in Appendix 3 of this study. One can also refer to Duan et al. (2012)'s Appendix B for further explanations.

response stringency index as our explanatory variable for corporate default risk. The index measures how stringent government movement restrictions are in the fight against the pandemic and is constructed based on nine different metrics, including; (i) school closures, (ii) workplace closures, (iii) cancellation of public events, (iv) restrictions on public gatherings, (v) public transport closures, (vi) stay-at-home orders, (vii) restrictions on internal movement, (viii) international travel controls, and (ix) public information campaigns. The government response stringency index is a simple average of the nine component indicators, each taking a value between 0 and 100. We compute the government (non-financial) response stringency variable (*GSI*) as the mean value of the daily response stringency scores within each quarter. We rescale GSI to take the values between 0 and 1 to ease the interpretation of our regression results. A higher *GSI* value indicates that the government imposes stricter movement policies to tackle the pandemic.

3.3.2. Control variables

We control for six firm-level factors that previous studies reported as potentially impacting a firm's probability of default in our regression models. Numerous studies have observed that default risk is closely related to firm size (Vassalou & Xing, 2004; Glennon & Nigro, 2005; Zhang et al., 2020). We use the value of the natural log of total assets in the prior quarter (*Size*) to control for firm size. Besides that, firms with more cash holdings, earning higher profits, and less financially leveraged should have a lower probability of default, *other things being equal* (Opler et al., 1999; Almeida, Campello, & Weisbach, 2004; Nadarajah et al., 2021). We, thus, control for the cash-to-assets ratio (*Cash*), return on assets (*Profitability)*, and debt-to-assets value (*Leverage*) in our baseline regression. To account for the disciplinary role of equity market participants in a firm's default risk (Brogaard et al., 2017), we control for the cumulative stock return over a given quarter *q* (*Return*) and Amihud's (2002) illiquidity measure (*Illiquidity*).

3.4. Descriptive statistics

Table 1 contains the descriptive statistics for our main variables (Panel A) and the pairwise correlation matrix between these variables (Panel B). On average, the stringency of government response to COVID-19 across 97 countries is 0.303. The sample means for the two default risk measures, *DTD* and *EDF*, are 4.013 and 0.034, respectively. An average firm in our cross-country sample has a log of the asset book value of 8.036, a return on assets of 1.1%, holds 18.4% as cash in proportion to total assets, and 21.6% of its capital comes from debt financing. These statistics are comparable to other cross-country studies (e.g., Nadarajah et al., 2021).

We present a pairwise correlation matrix in Panel B of the table to ensure that the significant relationships between our explanatory variables do not cause multicollinearity. Two observations are of note. First, the correlation coefficients between *GSI* and the two default risk measures are statistically significant. More importantly, *GSI* is shown to be negatively correlated with the distance to default, while being positively correlated with expected default frequency, which is consistent with our first hypothesis (i.e., H1). Second, the highest absolute value of the correlation coefficients between the regressors is 0.336 (i.e., *Cash* and *Profitability*), well below 0.5 and indicating that our regression analysis is unlikely to be subject to multicollinearity problems.

3.5. Empirical methods

We first employ multivariate regression analysis to examine whether a country's COVID-19 lockdown measures negatively impact firms' probability of default (i.e., H1). Specifically, we estimate the following regression model:

$$\text{Default Risk}_{i,j,q}=\beta_0+\beta_1\times GSI_{j,q-1}+Z_{i,q-1},+\chi_j+\gamma_{industry}+\varphi_{year}+\varepsilon_{i,j,q} \quad (2)$$

where *i, j,* and *q* subscript firm, country, and quarter, respectively. *Default Risk* represents two alternative default risk measures, *DTD* and *EDF*, of firm *i* in country *j* during quarter *q*. *GSI* is the country-level

Table 1

Descriptive statistics. The table reports the descriptive statistics (Panel A) and pairwise correlation matrix (Panel B) of the key variables in our study. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is defined as the cumulative normal distribution of the negative distance-to-default. *GSI* is the government response stringency index developed by Hale et al. (2020). *Size* is the natural logarithm of the book value of total assets. *Cash* is the cash-to-assets ratio. *Profitability* is the earnings before interest, tax, depreciation, and amortization scaled by previous-quarter total assets. *Leverage* is the sum of short-term and long-term debt divided by the book value of total assets. *Return* is cumulative stock return during a given quarter *q* in year *t*. *Illiquidity* is Amihud's (2002) illiquidity measure, computed as the average daily ratio of absolute stock return to its trade volume (i.e., number of shares traded times the share price) over a quarter. Appendix 1 provides detailed descriptions of the variables. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample covers 19,549 firms across 97 countries/regions between January 2019 and June 2021.

Panel A: Summary statistics

Variable	Obs	Mean	Std	25th pct	Median	75th pct
DTD	170,950	4.013	2.414	2.308	3.607	5.271
EDF	170,950	0.034	0.095	0.000	0.000	0.010
GSI	170,950	0.303	0.321	0.000	0.216	0.673
Size	170,950	8.036	2.899	6.210	7.890	9.617
Cash	170,950	0.184	0.186	0.055	0.123	0.246
Profitability	170,950	0.011	0.049	0.003	0.017	0.033
Leverage	170,950	0.216	0.202	0.021	0.184	0.348
Return	170,950	0.050	0.304	-0.119	0.008	0.165
Illiquidity	170,950	0.016	0.088	0.000	0.000	0.001

Panel B: Pairwise correlation matrix

	DTD	EDF	GSI	Size	Cash	Profitability	Leverage	Return
EDF	-0.487 * **							
GSI	-0.136 * **	0.028 * **						
Size	0.046 * **	-0.058 * **	-0.017 * **					
Cash	0.164 * **	-0.126 * **	0.056 * **	-0.226 * **				
Profitability	0.256 * **	-0.139 * **	-0.023 * **	0.314 * **	-0.336 * **			
Leverage	-0.328 * **	0.262 * **	0.035 * **	0.171 * **	-0.332 * **	0.060 * **		
Return	0.008 * **	-0.050 * **	0.216 * **	-0.059 * **	0.038 * **	-0.003	0.011 * **	
Illiquidity	-0.123 * **	0.139 * **	-0.022 * **	-0.228 * **	-0.031 * **	-0.074 * **	-0.007 * **	0.006 * *

government response stringency index in the previous quarter *q-1*. The subsequent one-quarter lag for the independent variable accounts for potential reverse causality. *Z* is the vector of control variables as defined in sub-Section *3.3.2*. The accounting controls are also one-quarter lagged. Detailed definitions of these variables are presented in Appendix 1.

Given the structure of our data, we use panel data analysis to estimate the baseline Eq. (2). We first perform a Hausman test to decide the most appropriate modeling approach. As shown in Appendix 4, Hausman's *p*-values suggest rejecting the null hypothesis that a random-effect model is consistent; alternatively, a fixed-effect estimator would be more suitable for our empirical tests. Therefore, we include a fixed effect of country *j* (χ_j), an industry-fixed effect ($\gamma_{industry}$) based on two-digit standard industry classification (SIC), and a year-fixed effect (φ_{year}) in Eq. (2). These fixed effects help control any country- or industry-level factors that are constant over time. To correct cross-sectional and time-series dependence, we use robust standard errors clustered at the firm-and-year level (e.g., Petersen, 2009; Gow, Ormazabal, & Taylor, 2010; Thompson, 2011).

4. Testing results of main hypotheses

4.1. Univariate analysis

We present preliminary evidence of the association between the government response stringency and corporate default risk using a nonparametric approach in Panel A of Table 2. To conduct a univariable analysis, we first rank firms into quintiles based on the government response stringency index (*GSI*) during the first 6 months of 2020. Firm-month observations assigned to the fifth quintile face the most stringent lockdown measures, whereas those in the first quintile are the least restricted. We then perform univariate tests for the firm months in each quintile and compare their likelihood of default in 2020 to that shifted backward to 2019 within a six-month window. For instance, if a firm's default risk measures are as of April 2020, we compare these values to those backdated to October 2019.

We document significantly higher default risk among firms in the fifth quintile than those in the first quintile over the first six months of 2020, as shown in columns (1) and (2) of Panel A, providing supportive evidence for our Hypothesis 1. In columns (3) and (4), the difference between these extreme quintiles is reversed: firms located in the most stringent areas are less likely to default six months before the pandemic. These results underpin the unprecedented business interruptions due to the "black swan" event of COVID-19, which results in exceptional corporate default risk.

4.2. Baseline regression results: testing of H1

Table 2 Panel B presents the regression results for the effects of government response stringency and corporate default risk based on Eq. (2). Columns (1) and (4) present the ordinary least squares (OLS) regressions, including all firm-specific control variables but without any fixed effects. We find that the coefficient estimates of *GSI* are significantly negative in the *DTD* regression while being positive and statistically significant in the *EDF* regression. In the other columns of the panel, we extend the OLS models with the country-, industry-, and year-fixed effects and continue to observe an increasing impact of GSI on corporate default risk. In terms of economic significance, the coefficients of *GSI* in columns (3) and (6) imply that a one-standard-deviation increase in the stringency index is associated with a 5.87% (=(0.7341 ×0.321)/4.013) decrease in *DTD* and an 11.24% (=0.0119 ×0.321/0.034) increase in *EDF* relative to their means. These results align with our prediction that the more stringent government responses to the COVID-19 pandemic are associated with a higher probability of default. Overall, Table 2's results confirm that the pandemic is an appropriate testing laboratory for business resilience.

Consistent with prior studies (e.g., Ashbaugh-Skaife, Collins, & LaFond, 2006; Bharath and Shumway, 2008; Bonsall, Holzman, & Miller, 2017; Brogaard et al., 2017; Nadarajah et al., 2021), default risk is less pronounced for larger firms, firms with a higher cash-to-asset ratio, firms with higher profitability and stock returns, while it is higher for firms with higher leverage and less liquid stocks.

As the government stringency index is constructed from nine different metrics, we further explore whether one measure may have a more significant impact. We rerun our baseline Eq. (2) with each of the nine metrics used as the independent variable of interest and report the results for these tests in Appendix 5. Further testing shows that all nine components significantly contribute to the increased corporate default risk. When we include all lockdown measures in the same regression model in column (10), school closures, workplace closures, internal movement restrictions, international travel controls, and public information campaigns appear to be the dominant drivers of the observed positive association between GSI and corporate default risk.

4.3. The heterogeneous effects of government responses on default risk

4.3.1. Cross-sectional analyses based on firm-level characteristics (H2A – E)

To test for the moderating effects discussed in H2A-E, we design the following Eq. (3):

$$\text{Default Risk}_{i,j,q} = \beta_0 + \beta_1 \times \text{GSI}_{j,q\text{-}1} + \beta_2 \times \text{Resources}_{,q\text{-}1}$$

$$+ \beta_3 \times \text{GSI}_{j,q\text{-}1} \times \text{Resources}_{,q\text{-}1} + Z_{i,q\text{-}1}, + \chi_j + \gamma_{industry} + \varphi_{year} + \varepsilon_{i,j,q} \quad (3)$$

where $Resources_{i,q\text{-}1}$ represents the internal and external economic resources that would render a firm more resilient to entrenched fault lines in restricted business environments during COVID-19 lockdowns.

For the first set of analyses, we position a firm's financial slack, human resource dependency, and intellectual capital to determine the probability that it can withstand stringent lockdown measures (e.g., Hypothesis 2A). To test this conjecture, we construct three variables: (1) *Cash*, the cash-to-assets ratio to proxy for the firm's financial slack; (2) *Labor intensity*, measured by sales per employee to capture the workload per employee, following Caskey and Ozel (2017); and (3) *Firm age*, the number of years from a firm's incorporation, as a measure of a firm's knowledge assets, building on the assumption that, as firms get older they become more experienced and routinized in innovation (Coad, Segarra, & Teruel, 2016).[10] A higher value of these three variables indicates firms with more significant financial slack, using intensive labor, and with a more extensive base of knowledge assets.

We then extend our baseline Eq. (2) with the interaction terms between *GSI* and each of the three variables defined above. The estimation results of the expanded models are reported in Panel A of Table 3. Several findings are worth discussing. First, the relationship between *GSI* and firm default risk persists after controlling for firm-level exposure to COVID-19 and the ability to cope with the lockdown measures. Second, the results in Columns (1) and (4) show that holding cash could enable a firm to overcome liquidity shortages in unprecedented business conditions (Keynes, 1937), reducing the probability of default due to government actions to combat COVID-19. These findings, therefore, corroborate Hypothesis 2A. In addition, the estimated coefficients of *GSI × Labor intensity* in columns (2) and (5) suggest that the lockdowns cause more severe disruptions to labor-intensive firms, consistent with our Hypothesis 2B. Finally, as shown in columns (3) and (6), the effect of government response stringency on corporate default risk is less pronounced among older firms. These results reconfirm knowledge assets' role in alleviating unfavorable implications of government responses to a crisis on corporate solvency. Thus, Hypothesis 2C is supported.

[10] In untabulated results, we use the value of intangible assets divided by the book value of total assets, following Denicolai et al. (2014), as an alternative proxy for knowledge assets. Our findings remain qualitatively unchanged.

Table 2

The government response stringency and corporate default risk. The table illustrates the association between the stringency of government responses to COVID-19 and corporate default risk. Panel A presents the mean values of *DTD* and *EDF* across quintiles of firms based on their governments' response stringency from June 2019 to June 2020. The *p*-values are for the *t*-tests of the mean differences between the fifth (most stringent) and the first (least stringent) quintiles. Panel B displays the estimated regression models of our default risk measures on *GSI*, controlling for various firm-level characteristics. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. *GSI* is the government response stringency index developed by Hale et al. (2020). The list of control variables includes *Size, Cash, Profitability, Leverage, Return,* and *Illiquidity*. Country, industry, and year-fixed effects are included unless otherwise stated. All regressions are estimated at the firm-quarter level. All variables are defined in Appendix 1. The *p*-values in paratheses are based on heteroskedasticity-consistent and firm-and-year clustered standard errors. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from January 2019 to June 2021.

Panel A: Univariate test

	2019		2020	
GSI Quintiles	DTD (1)	EDF (2)	DTD (3)	EDF (4)
1 (least stringent)	4.36	0.041	4.393	0.044
2	3.966	0.056	3.398	0.073
3	4.465	0.038	3.545	0.054
4	4.265	0.041	3.222	0.06
5 (most stringent)	4.408	0.038	3.747	0.048
(5) - (1)	0.048 *	-0.003 * **	-0.646 * **	0.004 * **
p-value	(0.054)	(0.009)	(0.000)	(0.001)

Panel B: Regression results

	Dependent variable = DTD			*Dependent variable = EDF*		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
GSI	-1.0405 * **	-0.7516 * **	-0.7341 * **	0.0106 * **	0.0122 * **	0.0119 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Size	0.0119 * **	0.1348 * **	0.1616 * **	-0.0016 * **	-0.0045 * **	-0.0052 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash	2.3943 * **	2.4685 * **	1.9903 * **	-0.0551 * **	-0.0519 * **	-0.0429 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Profitability	15.7064 * **	14.2226 * **	13.9776 * **	-0.3185 * **	-0.3051 * **	-0.3027 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-3.4096 * **	-3.6520 * **	-4.1477 * **	0.1151 * **	0.1150 * **	0.1213 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Return	0.2907 * **	0.3302 * **	0.3390 * **	-0.0189 * **	-0.0201 * **	-0.0200 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Illiquidity	-2.6227 * **	-2.1909 * **	-1.9534 * **	0.1238 * **	0.1170 * **	0.1123 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	170,950	170,950	170,950	170,950	170,950	170,950
Adj. R-Squared	0.237	0.316	0.360	0.123	0.19	0.206
Country FE	No	Yes	Yes	No	Yes	Yes
Industry FE	No	No	Yes	No	No	Yes
Year FE	No	Yes	Yes	No	Yes	Yes

Next, we test Hypotheses 2D and 2E regarding the moderating effect of external resources through internalization. We proxy a firm's degree of internationalization in supply chains and customer portfolios using two alternative measures. More particularly, we estimate the ratio of foreign sales to total sales (*Overseas sales*) and the fraction of foreign suppliers in the supplier list (*Overseas supply*) as proxies for supply chain geographical exposure. The data to construct these two measures are drawn from the Factset Revere database.[11] As for internationalized access to capital markets, we use foreign institutional ownership (*IO Foreign*) from the Thomson Reuters/Refinitiv database, which is the proportion of a firm's shares held by foreign institutional investors. This variable captures the firm's reliance on foreign investors to provide capital for its operations.

Table 3 Panel B presents the estimated regression models of corporate default risk on the interaction terms between *GSI* and internationalization measures. The findings across all models are mixed. We find that capital support from foreign investors can help alleviate the adverse effect of COVID-19 responses on default risk, evident in the opposite signs of the estimated coefficients of the interaction terms *GSI* × *IO_Foreign* compared to the *GSI* stand-alone coefficients. The same conclusion is documented for firms with a higher proportion of sales earned from overseas clients. These results align with Alfaro and Chen (2012) and Puhr and Müllner (2022), who emphasize an asset of multi-nationality that enhances corporate resilience to adverse non-ergodic exogenous shocks.

In contrast, the results from Panel B columns (3) and (6) suggest that greater reliance on overseas supply increases firms' exposure to the unfavorable effect of COVID-19 responses on default risk. These findings speak to the increased systematic risk of internationalized firms when acquiring economic resources from various parts of the world. Overall, geographically diversifying customer portfolios and foreign ownership support Hypotheses 2D and 2E and underline the value of internationalization to business resilience to exogenous shocks. On the other hand, relying on overseas supply offers a contradictory view that internationalization exposes firms to higher levels of riskiness. These non-monotonic results in Panel B of Table 3 reinforce the findings of Puhr and Müllner (2022) that internationalization can create both liabilities

[11] FactSet Revere hand-collects and verifies supply chain relationship information from various sources: 10-K filings, conference call transcripts, presentations to investors, company press releases, company websites, and major news-media reports. Supply-chain relationships are classified into 4 major categories (customer, supplier, partner, competitor) and 13 sub-types. The FactSet Revere dataset contains approximately 20,000 supply-chain links per year. The coverage of the FactSet Revere dataset varies between 5500 and 8000 firms each year.

Table 3
Cross-section analyses at the firm level. This table estimates the effects of *GSI* on corporate default risk conditioning on (1) a firm's ability to cope with the COVID-19 lockdown measures, (2) its degree of internationalization, and (3) its knowledge asset availability. *Labor intensity* is the ratio of sales to the number of employees. *Overseas sales* denotes the proportion of sales sourced from foreign customers. *Overseas supply* represents a firm's fraction of foreign suppliers. *Firm age* is the years since the firm's year of incorporation. *IO_Foreign* is the proportion of a firm's shares held by foreign institutional investors. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. *GSI* is the government response stringency index developed by Hale et al. (2020). The list of unreported control variables includes *Size, Cash, Profitability, Leverage, Return,* and *Illiquidity*. Country, industry, and year-fixed effects are included unless otherwise stated. All regressions are estimated at the firm-quarter level. All variables are defined in Appendix 1. The *p*-values in paratheses are based on heteroskedasticity-consistent and firm-and-year clustered standard errors. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from January 2019 to June 2021.

Panel A: Composition of firm-level economic resources

	Dependent variable = DTD			Dependent variable = EDF		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
GSI	-0.7908 * **	1.6078 * **	-0.3806 * **	0.0156 * **	-0.0228 * *	0.0177 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.030)	(0.000)
GSI × Cash	0.3108 * **			-0.0203 * **		
	(0.009)			(0.000)		
Cash	1.8929 * **			-0.0365 * **		
	(0.000)			(0.000)		
GSI × Labor intensity		-0.1843 * **			0.0025 * **	
		(0.000)			(0.003)	
Labor intensity		-0.0355 * **			0.0009 *	
		(0.004)			(0.088)	
GSI × Firm age			0.1043 * **			-0.0028 * *
			(0.000)			(0.018)
Firm age			-0.2013 * **			0.0005
			(0.000)			(0.425)
Observations	170,950	134,804	155,354	170,950	134,804	155,354
Adj. R-Squared	0.360	0.353	0.354	0.206	0.189	0.192
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Firm-level degree of internationalization

	Dependent variable = DTD			Dependent variable = EDF		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
GSI	-1.6103 * **	-0.6604 * **	-0.5209 * **	0.0254 * **	0.0108 * **	0.0124 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GSI × Overseas sales	0.7266 * **			-0.0145 * *		
	(0.000)			(0.045)		
Overseas sales	-0.1753 * **			-0.0023		
	(0.000)			(0.181)		
GSI × Overseas supply		-0.3134 * **			0.0049 * *	
		(0.000)			(0.016)	
Overseas supply		0.1930 * **			-0.0048 * **	
		(0.000)			(0.000)	
GSI × IO_Foreign			6.2101 * **			-0.0281 * *
			(0.000)			(0.036)
IO_Foreign			5.2083 * **			-0.1049 * **
			(0.000)			(0.000)
Observations	74,039	170,950	170,950	74,039	170,950	170,950
Adj. R-Squared	0.359	0.360	0.369	0.206	0.206	0.209
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

and assets contingent on the type of environmental uncertainty that firms face.

4.3.2. Cross-sectional analyses based on institutional qualities (H3A – E)

To test Hypothesis 3 A, we exploit the World Uncertainty Index (WUI) of Ahir, Bloom, and Furceri (2022), which evaluates economic policy uncertainty using the text mining of a country's reports by the Economist Intelligence Unit. A higher index value suggests more uncertain economic conditions in a country. Results in columns (1) and (3) of Panel A Table 4 demonstrate a more pronounced effect of *GSI* on corporate default risk in countries with higher WUI, supporting Hypothesis 3A.

Next, to test hypothesis 3B, we follow Favara, Schroth, and Valta (2012) and use the renegotiation failure index (RFI), which summarizes the legal characteristics that protect debtholders from shareholders' strategic default (Djankov et al., 2008). A higher value of the index indicates stronger protection of creditors' rights. We report the results of the extended models with the interaction terms *GSI* × *RFI* in columns (2) and (5) of Table 4. We find that the adverse impacts of *GSI* on corporate default risk are more potent for firms in countries with higher protection of creditors' rights. Thus, findings from Panel A of Table 4 corroborate Hypothesis 3B.

To test Hypothesis 3C regarding the moderating effect of immigration, we collect the yearly net migration rate from the United Nations Department of Economic and Social Affairs (UN-DESA). This variable is calculated as the number of immigrants minus the number of emigrants

Table 4
Cross-section analyses at the country level. This table estimates the effects of *GSI* on corporate default risk conditioning on country-level economic and cultural institutions. *WUI* represents the world uncertainty index, which reflects a country's economic policy uncertainty by text mining the country's reports of the Economist Intelligence Unit. *RFI* is the renegotiation failure index, which summarizes the legal characteristics that protect debtholders from shareholders' strategic default adopted by Djankov et al. (2008). *Net migration* is computed as the number of immigrants (people moving into a given country) minus the number of emigrants (people moving out of the country) in the previous five years, divided by the person-years lived by the population of the receiving country over that period. According to the World Value Survey, *Trust in others* is a measure of people's trust in other members of the same society. *Individualism* is a country's Hofstede (1997) normalized individualism score. *Civil liberty* is a measure of the extent of freedom of expression and association, the rule of law, and personal autonomy, based on Freedom House's Freedom in the World. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. *GSI* is the government response stringency index developed by Hale et al. (2020). The list of unreported control variables includes *Size, Cash, Profitability, Leverage, Return,* and *Illiquidity*. Country, industry, and year-fixed effects are included unless otherwise stated. All regressions are estimated at the firm-quarter level. All variables are defined in Appendix 1. The *p*-values in paratheses are based on heteroskedasticity-consistent and firm-and-year clustered standard errors. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from January 2019 to June 2021.

Panel A: Economic institutions

	Dependent variable = DTD			Dependent variable = EDF		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
GSI	-0.4618 * **	-0.5452 * **	-0.7381 * **	0.0020	0.0113 * **	0.0081 * **
	(0.000)	(0.000)	(0.000)	(0.583)	(0.000)	(0.000)
GSI × WUI	-0.1196 * **			0.0043 * **		
	(0.000)			(0.002)		
WUI	0.0250			-0.0005		
	(0.326)			(0.603)		
GSI × RFI		-1.3997 * **			0.0161 * **	
		(0.000)			(0.000)	
RFI		0.1950 * **			0.0097 * **	
		(0.000)			(0.000)	
GSI × Net migration			-0.1297 * **			0.0021 * **
			(0.000)			(0.000)
Net migration			0.1056 * **			-0.0019 * **
			(0.000)			(0.000)
Observations	147,095	163,110	170,751	147,095	163,110	170,751
Adj. R-Squared	0.351	0.287	0.283	0.210	0.151	0.143
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Cultural institutions

	Dependent variable = DTD			Dependent variable = EDF		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
GSI	-1.9014 * **	-0.5495 * **	-1.9631 * **	0.0187 * **	0.0038 * **	0.0281 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	(0.000)
GSI × Trust in others	0.0197 * **			-0.0001		
	(0.000)			(0.192)		
Trust in others	0.0022 * **			-0.0004 * **		
	(0.003)			(0.000)		
GSI × Individualism		-0.8952 * **			0.0169 * **	
		(0.000)			(0.000)	
Individualism		0.6461 * **			-0.0192 * **	
		(0.000)			(0.000)	
GSI × Civil liberty			-0.2914 * **			0.0050 * **
			(0.000)			(0.000)
Civil liberty			0.1395 * **			-0.0028 * **
			(0.000)			(0.000)
Observations	166,142	170,075	170,726	166,142	170,075	170,726
Adj. R-Squared	0.284	0.282	0.286	0.145	0.145	0.144
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

in the previous five years, divided by the person-years lived by the receiving country's population over that period. We then interact *GSI* with the net migration rate in the regression models in columns (3) and (6) of Table 4's Panel A. The results support anecdotes that firms in countries with significant inputs of migrants are subject to a higher risk of default due to pandemic containment policies. Hence, Hypothesis 3C is supported.

To test the moderating effect of social trust (Hypothesis 3D), we employ the index of people's trust in other members of the same society available on the World Value Survey database (*Trust in others*). Higher values of this measure imply higher social trust. Columns (1) and (3) of Table 4 Panel B show that the estimated coefficients on the interaction terms *GSI* × *Trust in others* are positive in the *DTD* regressions and negative in the *EDF* regressions. These results indicate the vital role of societal trust in lessening the unpleasant impact of the government's responses on corporate solvency, supporting Hypothesis 3D.

In the final set of cross-sectional analyses, we test Hypothesis 3E involving the effect of individualistic cultures and freedom of speech.

We adopt two cultural proxies to test this hypothesis; one is a country's individualism score based on Hofstede's (1997) method (*Individualism*), and the other is the extent of freedom of expression and association, the rule of law, and personal autonomy, based on Freedom House's Freedom in the World measure (*Civil liberty*). In columns (2) – (3) and (5) – (6) of Panel B, we document that individualism and civil liberty both magnify the effects of *GSI* on corporate default risk, as could be inferred from the estimated coefficients on the interactions between *GSI* and the two cultural proxies. Thus, Hypothesis 3E is supported.

5. Robustness tests and additional analyses

5.1. Identification tests

It is possible that unobserved factors omitted from our specification and sample-induced endogeneity can spuriously drive the observed effects of GSI on corporate default risk. We adopt four main identification strategies to alleviate these endogeneity concerns. First, we include firm-fixed effects along with the country- and year-fixed effects to control for firm-invariant factors that could be associated with corporate default risk. We report the results for these tests in columns (1) and (2) in Panel A of Table 5. Our results are consistent with the previous testing.

Second, we exploit the entropy balancing matching approach by Hainmueller (2012) to address the endogeneity concerns related to the differences in observed factors in our specification.[12] We re-estimate our baseline regression in Eq. (2) using post-entropy balancing weights, with β_1, the parameter of interest, capturing the influence of *GSI* on the likelihood of being insolvent. We report the results for these tests in columns (3) to (4) in Panel A of Table 5. We find our results robust with the findings in Table 2.

Third, to further address potential omitted variables, we apply a difference-in-differences approach to investigate a pair of neighboring countries that adopt different strategies to handle the pandemic. They are Norway and Sweden. On March 12, 2020, Norway was among the first European countries to impose a national lockdown to curb the spread of COVID-19. On the other hand, Sweden took a more lenient approach, allowing large parts of its society to remain open. While Norway and Sweden are similar across many societal aspects, the differences in their policy responses toward controlling the pandemic provide a natural setting to establish the effect of a national lockdown on corporate default risk.

We first conduct a nearest-neighbor matching contingent on the propensity to be a Norwegian firm. We match a Norwegian firm with its most comparable Swedish firm based on their default risk and all other variables in Eq. (2) from July 2019 to February 2020. Through this approach, matched firms within a pair were subject to a similar default risk level and other characteristics before the Norwegian lockdown implementation in March 2020. The national lockdown lasted until the Norwegian government began to ease its pandemic-related restrictions on April 24, 2020. We create an indicator variable *Lockdown,* which equals 1 for Norwegian and Swedish firms from March 2020 to April 2020, and 0 during other periods. We generate an indicator, *Norway,* that equals 1 for Norwegian firms and 0 for Swedish firms. Our variable of interest is the interaction term between *Norway* and *Lockdown*. Panel B of Table 5 presents the results of the test.

In columns (1) and (2) of Panel B, where *DTD* is the default risk measure, the negative and significant difference-in-difference estimator *Norway* $\times$ *Lockdown* indicates that Norwegian firms experience a considerable decrease in the distance-to-default (*DTD*) during the implementation of the national lockdown. Compared to Swedish firms, Norwegian peers face a 7% decline in the average level of distance to default during the lockdown period. In columns (3) and (4), where *EDF* is the dependent variable, the coefficient of the interaction term *Norway* $\times$ *Lockdown* is positive and statistically significant at a 5% level, suggesting that Norwegian firms are subject to a higher degree of expected default frequency (*EDF*) in the face of the national lockdown. The magnitude of this coefficient suggests that Norwegian firms confronted a 61% increase in the average level of expected default frequency relative to their Swedish counterparts during the lockdown period. Overall, the difference-in-difference results corroborate that the most severe government response to COVID-19 (i.e., national lockdown) leads to a higher corporate default risk.

Besides the endogeneity problems, our findings may also be subject to a bias in the sample selection (i.e., survivorship bias) since we restrict our sample to firms with their default risk data available over all three years, from 2019 to 2021. To address this issue, we remove this restriction and repeat our baseline analysis using the complete set of firms reported in the CRI database during the sample period. Columns (5) and (6) of Table 5 Panel A show that the estimated coefficients of *GSI* remain broadly consistent with our baseline findings, confirming that the stringency in government responses to COVID-19 damages a firm's solvency.

Lastly, in the final robustness check, we use credit default swap (CDS) spread (*CDS Spread*) as a market-based indicator of default risk to validate our empirical findings. The CDS spread represents the cost per annum that the CDS buyer pays the CDS seller for insurance against a reference entity's default. An increase in the default risk of the reference entity makes it more costly for the buyer to secure insurance.

We obtain the daily CDS composite spread from the Markit CDS pricing database. Following Loon and Zhong (2014), we use five-year CDS spreads as these contracts are the most liquid ones and provide the most reasonable pricing of default risk of the underlying assets. We aggregate the data quarterly by taking the average composite spread of all CDS instruments traded each quarter. We then re-estimate regression model Eq. (2), with *CDS Spread* being the dependent variable. We report the results for these tests in column (7) of Table 5 Panel A. The regression results indicate a statistically significant positive association between *GSI* and *CDS Spread*. These results suggest that investors are willing to pay a higher price to insure themselves against firms facing more stringent COVID-19 measures.

5.2. Economic channels: path analyses

We complement the baseline findings by looking into potential economic mechanisms through which the COVID-19 lockdown policies affect firm-level default risk. We rely on the CRI manual related to the construction of DTD and credit risk assessment criteria to identify these channels and perform path analyses to check whether they mediate the effects of *GSI* on default risk.

The DTD measure, by definition, estimates the probability that a firm's asset value (V_L) falls below the face value of its debt (L), considering the implied equity price volatility (σ). The COVID-19 lockdown measures could have obliterated the revenues of many firms across countries, while their expenses were left accrued. For instance, Carletti et al. (2020) suggest that Italian firms experienced having to halt production, causing an aggregate annual profit drop of €170 billion, equivalent to roughly 10% of the gross domestic product in 2018, after a 3-month lockdown. In addition, these measures triggered a substantial increase in stock price volatility globally due to investors' fears of business uncertainty associated with the pandemic (Zhang, Hu, & Ji, 2020). The significant profit drop and escalated volatility might erode a firm's equity and liquid assets, precipitating an increased need for additional liquidity in the form of debt and, consequently, a higher default risk. Therefore, one could expect government responses to COVID-19 to heighten corporate default risk by reducing a firm's value-to-default ratio (i.e., higher leverage) or increasing implied stock

[12] The entropy balancing approach overcomes several drawbacks of the propensity score matching method, such as its statistical inferences being less sensitive to design choices, and is well-employed in recent studies (e.g., Bonsall and Miller, 2017; McMullin and Schonberger, 2020).

Table 5
Robustness tests. The table performs alternative identification strategies for robustness checks on the relationship between the government stringency index and corporate default risk. Panel A reports the baseline regression results using a firm-fixed effects estimator (columns (1)-(2)), entropy-balancing matched sample (columns (3)-(4)), alternative sample (column (5)-(6)), and market-based measure of default risk (column (7)). Panel B presents the difference-in-difference (DiD) regression results of default risk on the Norway treatment dummy variable and its interaction with an indicator of months after the adoption of COVID-19 lockdowns. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. *GSI* is the government response stringency index developed by Hale et al. (2020). The list of unreported control variables includes *Size, Cash, Profitability, Leverage, Return,* and *Illiquidity*. Country, industry, and year-fixed effects are included unless otherwise stated. All regressions are estimated at the firm-quarter level. All variables are defined in Appendix 1. The *p*-values in paratheses are based on heteroskedasticity-consistent and firm-and-year clustered standard errors. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from January 2019 to June 2021.

Panel A: Robustness tests

	Firm-fixed effects		Entropy Balancing		Alternative sample		
	DTD	EDF	DTD	EDF	DTD	EDF	CDS Spread
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GSI	-0.7073 * **	0.0106 * **	-0.590 * **	0.009 * **	-0.6832 * **	0.0102 * **	0.0026 *
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.085)
Observations	170,950	170,950	170,950	170,950	178,021	178,021	6055
Adj. R-Squared	0.814	0.733	0.355	0.211	0.353	0.207	0.252
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Difference-in-differences analysis

	Dependent variable = DTD		Dependent variable = EDF	
Variable	(1)	(2)	(3)	(4)
Norway	0.2201	0.149	0.0012	0.0043
	(0.170)	(0.287)	(0.891)	(0.596)
Lockdown	-0.4258 * **	-0.3268 * **	0.0023	-0.0041
	(0.000)	(0.000)	(0.574)	(0.293)
Norway × Lockdown	-0.1254	-0.2677 *	0.0239 * *	0.0310 * **
	(0.431)	-0.061	(0.016)	(0.001)
Observations	2621	2621	2621	2621
Adj. R-Squared	0.212	0.291	0.159	0.291
Control variables	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

return volatility.

We introduce two new variables to capture these aspects. The first variable is the ratio of the market value of assets to the face value of debt, which represents a firm's leverage. The firm's face value of debt is defined as the adjusted KMV default point *L*, as discussed in Section 3.2, and the market value of assets is the sum of the market value of equity (i.e., share price multiplied by the number of outstanding shares) and *L*. These variables are constructed using the balance sheet information from the Compustat database. The second variable is the implied stock return volatility σ, computed as the standard deviation of market-adjusted daily returns one year before the first day of a given quarter (i.e., the 1st of January, April, July, and October).[13]

Besides the two conceptual channels, we extend our analyses to two more proven determinants of default risk. These are; (1) a firm's earnings volatility, calculated as the standard deviation of the quarterly return-on-assets (ROA) over the four most recent quarters (*q-3* to *q*), and (2) corporate liquidity, which is the current assets to current liabilities ratio. Earnings volatility can be positively related to default risk as the debt market considers information risk signaled by earnings volatility (Francis, LaFond, Olsson, & Schipper, 2005; Jung, Soderstrom, & Yang, 2013). Finally, corporate liquidity is vital in determining a firm's ability to meet its debt obligations.

Fig. A2 graphically summarizes our path analyses to examine government response stringency's effects on default risk. The path coefficient β_1 is the magnitude of the direct path from government responses to COVID-19 to default risk. The path coefficient β_2 (β_3, β_4) represents the effect of the economic channel on corporate default risk. The product of $\widehat{\alpha}_1 \times \widehat{\beta_2}(\widehat{\sigma}_1 \times \widehat{\beta_3}; \widehat{\mu}_1 \times \widehat{\beta_4})$ represents the indirect effects of government responses to COVID-19 to default risk mediated through the four channel variables specified previously. We report the estimation of the coefficients in Table 6 of this study. The significance of the indirect coefficient is estimated using Sobel's (1982) test statistics.

Panels A and B of Table 6 display the mediating effects of *GSI* on corporate default risk measures through the value-to-default-point ratio (*VTL*) and stock return volatility (σ). The results show a negative (positive) and statistically significant coefficient of *GSI* on *VTL* (σ), implying that stringent government responses to COVID-19 lead to equity erosion and stock return volatility, forcing firms to rely more on debt financing. On the other hand, the *VTL* ratio (σ) is positively (negatively) correlated to the distance to default. At the same time, it is negatively (positively) associated with the expected default frequency, in line with the predictions of Merton's (1974) model. The products of a multitude of combinations between these coefficients, denoted *P (GSI, Path)* × *P (Path, DTD)* and *P (GSI, Path)* × *P (Path, EDF)*, reflect the indirect effects of *GSI* on default risk measures, which are all statistically significant at a 1% level. These findings suggest that the value-to-default-point ratio and stock return volatility are critical in explaining our baseline relationship between *GSI* and default risk.

Panel C of Table 6 consistently reports that 1.03% (5.05%) of the relationship between *GSI* and DTD (EDF) can be attributable to earnings volatility. Results from Panel D suggest that corporate liquidity accounts

[13] We thank the CRI for directly providing this variable in their database.

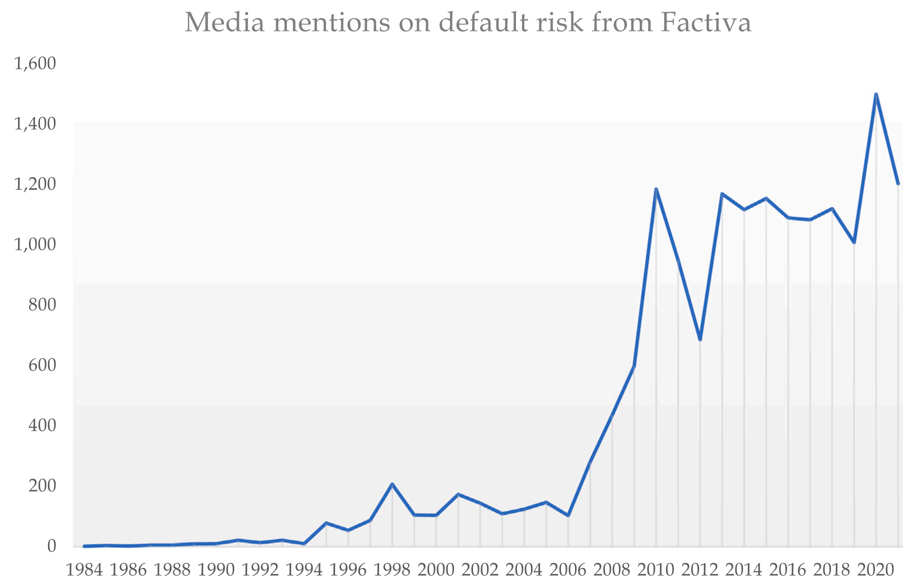

Fig. A1. Media Mentions. Fig. A1 reports the number of media mentions of “corporate default”, “default risk”, or “insolvency risk” from Factiva from January 1984 to December 2021.

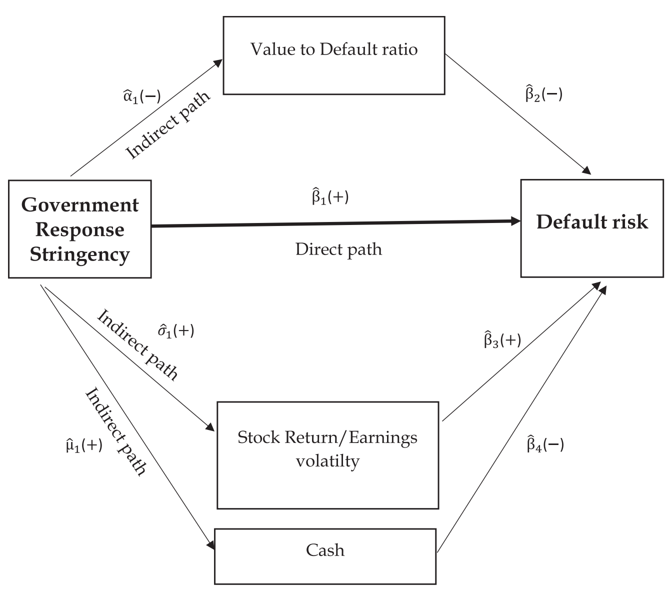

Fig. A2. Path analysis. The figure depicts the direct and indirect effects of government response stringency on firm default risk through increasing the extent of debt financing, fundamental volatility, and cash slack. We estimate the following simultaneous equations in the path analysis: *(i) Firm Default* $= \beta_0 + \beta_1 \times GSI + \beta_2 \times Profitability + \beta_3 \times Account\ Payable + \beta_4 \times Cash\ Holding + Controls + \mathcal{E}$; *(ii) Value to Default (VTL)* $=\alpha_0 + \alpha_1 \times GSI + \mathcal{E}$; *(iii) Stock return/Earnings volatility* $= \sigma_0 + \sigma_1 \times GSI + \mathcal{E}$; *(iv) Cash* $= \mu_0 + \mu_1 \times GSI + \mathcal{E}$. The independent variable of interest is government response stringency (*GSI*). *Controls* are those from the baseline regression in Table 2. The path coefficient β_1 is the magnitude of the direct effect of *GSI* on corporate default risk. The path coefficients β_2, β_3, and β_4 are the magnitude of the effects of the value to default ratio, stock return volatility, earnings volatility, and cash holding on corporate default, respectively. The path coefficient $\hat{\alpha}_1 \times \widehat{\beta_2}$, $\hat{\mu}_1 \times \widehat{\beta_3}$, $\hat{\mu}_1 \times \widehat{\beta_3}$ represent the magnitude of the indirect effects of *GSI* on corporate default.

for 3.76% (2.67%) of the relationship between *GSI* and DTD (EDF). These indirect effects of GSI through earnings volatility and the current ratio are statistically significant at a 1% level. We interpret the overall results from Table 6 as evidence that government responses disrupt a firm’s access to equity capital and lower its liquidity position while increasing stock return and earnings volatility.

5.3. *The dynamics of GSI effects on corporate default risk*

Finally, we analyze whether government response stringency carries differential effects on corporate default risk over time when facing the same COVID-19 severity. We anticipate that stringent government responses can be necessary in the long run as pre-emptive measures seem to contain the outbreak faster, increasing the chance of saving the economy. To test this conjecture, we first sort countries in our study sample into high and low COVID-19 severity groups to perform this time-series analysis.[14] We conduct a median split within each group of countries with high and low COVID-19 severity based on the degree of government response stringency. We are interested in two groups of countries facing high COVID-19 severity but adopting contrasting degrees of government response stringency (i.e., high or low). Table 7 reports the regression estimates of *GSI* value in March 2020 from the first quarter of 2020 to the second quarter of 2021 for two subsamples of countries that implement relatively contrasting approaches to the pandemic while facing a similarly high level of COVID-19 severity.[15]

In columns (1) to (5) of Table 7 Panel A, we find that firms in countries imposing the strictest responses to curb the spread of COVID-19 in March 2020 first experienced a significant decrease in the distance-to-default (*DTD*) in the last two quarters of 2020. However, the results suggest a reversal in the effect of stringent government responses in later quarters. Similar evidence is obtained in columns (6) to (10) when *EDF* is used as the dependent variable. These results suggest that while highly stringent policy responses to the pandemic trigger an immediate increase in corporate default risk in the following quarters, this effect is likely to disappear and, to some extent, even reverse in 2021.

Table 7 Panel B illustrates the effect of lenient government responses to the pandemic on corporate default risk in countries with higher exposure to COVID-19. We consistently document significant evidence

[14] The classification is based on the median of the distribution regarding the country-level ratio of the quarterly increase in the number of confirmed COVID-19 cases to the population for March 2020.

[15] We also conduct regression analyses based on firms in countries with less severe COVID-19 conditions. We report the results for this test in Appendix 6. Overall, we find no consistent patterns for countries with less severe COVID-19 conditions.

Table 6

Economic channels: A path analysis. This table reports the effects of government response stringency on corporate default risk mediated through various constituents of our default risk measures. These constituents include a firm's value-to-default point ratio (*VTL*), stock return volatility (σ), earnings volatility (*ROA Volatility*), and corporate liquidity (*Current ratio*). *VTL* is the sum of market capitalization and the KMV default point *(L)* scaled by the KMV default point. The default point (L) is computed as the short-term liabilities plus half of the long-term liabilities and a fraction of other liabilities. σ is each firm's one-year stock return volatility, computed as the standard deviation of its residuals using the market model. *ROA Volatility* is the standard deviation of the quarterly return-on-assets ratio over the four most recent quarters (*q-3* to *q*). *Current ratio* is the current assets to current liabilities ratio. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. *GSI* is the government response stringency index developed by Hale et al. (2020). The list of unreported control variables includes *Size, Cash, Profitability, Leverage, Return,* and *Illiquidity*. Country, industry, and year-fixed effects are included unless otherwise stated. All regressions are estimated at the firm-quarter level. All variables are defined in Appendix 1. The *p*-values in paratheses are based on heteroskedasticity-consistent and firm-and-year clustered standard errors. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from January 2019 to June 2021.

Panel A: Value to Default Point

	Path = VTL			
	Dependent variable = DTD		Dependent variable = EDF	
	(1) Coeff.	(2) *p*-value	(3) Coeff.	(4) *p*-value
Direct Path				
P (GSI, DTD)	-0.710 * **	0.000	0.012 * **	0.000
Indirect Path				
P (GSI, Path)	-0.036 * *	0.024	-0.036 * *	0.024
P (Path, DTD)	0.6801 * **	0.000	-0.010 * **	0.000
P (GSI, Path) × P (Path, DTD)	-0.024 * *	0.024	0.000 * **	0.024
Total effect	-0.734 * **	0.000	0.012 * **	0.000
Mediated % in Total	3.27%		3.00%	
Observations	170,950		170,950	

Panel B: Stock return volatility (σ)

	Path = σ			
	Dependent variable = DTD		Dependent variable = EDF	
	(1) Coeff.	(2) *p*-value	(3) Coeff.	(4) *p*-value
Direct Path				
P (GSI, DTD)	-0.647 * **	0.000	0.007 * **	0.000
Indirect Path				
P (GSI, Path)	0.060 * **	0.000	0.060 * **	0.000
P (Path, DTD)	-1.440 * **	0.000	0.085 * **	0.000
P (GSI, Path) × P (Path, DTD)	-0.087 * **	0.000	0.005 * **	0.000
Total effect	-0.734 * **	0.000	0.012 * **	0.000
Mediated % in Total	11.85%		42.15%	
Observations	170,950		170,950	

Panel C: Earnings Volatility

	Path = ROA Volatility			
	Dependent variable = DTD		Dependent variable = EDF	
	(1) Coeff.	(2) *p*-value	(3) Coeff.	(4) *p*-value
Direct Path				
P (GSI, DTD)	-0.526 * **	0.000	0.007 * ** *	0.000
Indirect Path				
P (GSI, Path)	0.062 *	0.056	0.062 *	0.056
P (Path, DTD)	-0.088 * **	0.000	0.006 * **	0.000
P (GSI, Path) × P (Path, DTD)	-0.005 *	0.056	0.000 *	0.056
Total effect	-0.532 * **	0.000	0.007 * **	0.000
Mediated % in Total	1.03%		5.05%	
Observations	139,082		139,082	

Panel D: Corporate liquidity

	Path = Current ratio			
	Dependent variable = DTD		Dependent variable = EDF	
	(1) Coeff.	(2) *p*-value	(3) Coeff.	(4) *p*-value
Direct Path				
P (GSI, DTD)	-0.513 * **	0.000	0.007 * **	0.000
Indirect Path				
P (GSI, Path)	-0.096 * **	0.003	-0.096 * **	0.003
P (Path, DTD)	0.201 * **	0.000	-0.002 * **	0.000
P (GSI, Path) × P (Path, DTD)	-0.019 * **	0.003	0.000 * **	0.003
Total effect	-0.532 * **	0.000	0.007 * **	0.000
Mediated % in Total	3.76%		2.67%	
Observations	139,082		139,082	

Table 7
Regression analyses for firms in countries with severe COVID-19 conditions. The table reports the regression estimates of the relation between different levels of government response stringency and default risk over time for countries with high exposure to COVID-19. Stringent and less-stringent government responses to COVID-19 are based on the sample median of the government response stringency measure. High and low exposure to COVID-19 is based on the sample median of the country-level ratio of the monthly increase in the number of confirmed COVID-19 cases to the population in March 2020. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. *GSI* is the government response stringency index developed by Hale et al. (2020). The list of unreported control variables includes *Size, Cash, Profitability, Leverage, Return,* and *Illiquidity*. Country, industry, and year-fixed effects are included unless otherwise stated. All regressions are estimated at the firm-quarter level. All variables are defined in Appendix 1. The *p*-values in paratheses are based on heteroskedasticity-consistent and firm-and-year clustered standard errors. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from April 2020 to June 2021.

Panel A: Stringent COVID-19 response in countries with high exposure to COVID-19

	Dependent variable = DTD					Dependent variable = EDF				
Variable	Q2/2020 (1)	Q3/2020 (2)	Q4/2020 (3)	Q1/2021 (4)	Q2/2021 (5)	Q2/2020 (6)	Q3/2020 (7)	Q4/2020 (8)	Q1/2021 (9)	Q2/2021 (10)
GSI	-0.4177	-6.2307 * **	-0.2675	4.1485 * **	5.2659 * **	-0.1301 *	0.4031 * **	0.0309	-0.3319 * **	-0.1788 * **
	(0.710)	(0.000)	(0.381)	(0.000)	(0.000)	(0.085)	(0.000)	(0.181)	(0.000)	(0.000)
Size	0.1035 * **	0.1093 * **	0.1306 * **	0.1479 * **	0.2779 * **	-0.0047 * **	-0.0060 * **	-0.0069 * **	-0.0058 * **	-0.0063 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash	1.9253 * **	2.1749 * **	1.9379 * **	1.5997 * **	0.9927 * **	-0.0830 * **	-0.0911 * **	-0.0968 * **	-0.0580 * **	-0.0496 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Profitability	10.7164 * **	11.2955 * **	10.8717 * **	10.8442 * **	11.0047 * **	-0.4287 * **	-0.3882 * **	-0.4079 * **	-0.3094 * **	-0.2185 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-2.6779 * **	-2.5044 * **	-2.5273 * **	-2.5657 * **	-2.7993 * **	0.1720 * **	0.1510 * **	0.1447 * **	0.1335 * **	0.0885 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Return	1.8282 * **	-0.1944 * **	0.3010 * **	-0.4062 * **	-0.8138 * **	-0.0625 * **	-0.0007	-0.0429 * **	0.0014	0.0091 *
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.895)	(0.000)	(0.796)	(0.098)
Illiquidity	-1.6309 * **	-1.0790 * **	-1.1669 * **	-1.2012 * **	-1.4936 * **	0.1212 * **	0.0648 * **	0.0582 * **	0.0903 * **	0.0179
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.006)	(0.003)	(0.375)
Observations	5283	5308	5360	5387	5375	5283	5308	5360	5387	5375
Adj. R-Squared	0.388	0.358	0.349	0.341	0.313	0.215	0.207	0.214	0.187	0.135
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B Less stringent COVID-19 response in countries with high exposure to COVID-19

	Dependent variable = DTD					Dependent variable = EDF				
Variable	Q2/2020 (1)	Q3/2020 (2)	Q4/2020 (3)	Q1/2021 (4)	Q2/2021 (5)	Q2/2020 (6)	Q3/2020 (7)	Q4/2020 (8)	Q1/2021 (9)	Q2/2021 (10)
GSI	-1.5399 * **	-2.5114 * **	-3.5165 * **	-2.2102 * **	-2.1543 * **	-0.0182	0.0434 *	0.0459 * *	0.0148	-0.0287
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.573)	(0.075)	(0.022)	(0.465)	(0.139)
Size	0.0618 * **	0.0814 * **	0.1017 * **	0.0502 * **	0.1227 * **	0.0002	-0.0010	-0.0022 * *	-0.0001	0.0000
	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.834)	(0.367)	(0.043)	(0.887)	(0.965)
Cash	1.8781 * **	1.6145 * **	1.2136 * **	1.0827 * **	0.7066 * *	-0.0558 * **	-0.0422 * **	-0.0403 * **	-0.0298 * **	-0.0389 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.016)	(0.000)	(0.008)	(0.005)	(0.010)	(0.000)
Profitability	11.3446 * **	12.8008 * **	11.3417 * **	11.6395 * **	11.7763 * **	-0.4164 * **	-0.4425 * **	-0.3253 * **	-0.2581 * **	-0.2581 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-3.4604 * **	-3.5175 * **	-3.5318 * **	-3.3400 * **	-3.9009 * **	0.1404 * **	0.1367 * **	0.1374 * **	0.1088 * **	0.0917 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Return	1.3541 * **	-0.5999 * **	0.2568 * *	-0.5269 * **	-0.1253	-0.0417 * **	-0.0001	-0.0277 * **	0.0102	-0.0106
	(0.000)	(0.000)	(0.016)	(0.000)	(0.401)	(0.000)	(0.995)	(0.000)	(0.212)	(0.242)
Illiquidity	-1.6635 * **	-0.8755 * **	-1.4142 * **	-1.9812 * **	-2.2545 * **	0.1352 * **	0.0916 * **	0.0850 * **	0.0930 * **	0.1355 * **
	(0.000)	(0.007)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	2751	2715	2786	2890	2931	2751	2715	2786	2890	2931
Adj. R-Squared	0.309	0.291	0.276	0.295	0.225	0.169	0.157	0.149	0.118	0.102
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

regarding the impact of lenient policy responses to COVID-19 implemented in March 2020 on firms' distance to default in columns (1) to (5) of the panel. These results suggest that insufficient government restrictions at the pandemic's beginning might lead to long-lasting economic consequences regarding corporate solvency. The Panel B columns (5) to (10) results also indicate no sign of reversals from April 2020 to June 2021.

6. Discussion and conclusion

Our world has witnessed many economic and non-economic crises over the past decades. One question of IB literature inherent in these crises is what factors make some firms more resilient than others to escalated uncertainties due to turbulent economic conditions. In this study, we respond to this question by utilizing the most recent global crisis of the COVID-19 pandemic. With stringent lockdown policies to contain the virus, this event has forced hundreds of businesses worldwide to shutter, or has exposed them to extreme operational and financial conditions. Therefore, we consider this a suitable laboratory to explore the underlying drivers of resilience in an international context.

Our study finds that the cost of prioritizing human health could temporarily lead to an increased risk of corporate default, confirming the validity of the COVID-19 pandemic as a survival test for businesses across countries. More interesting, such negative impacts of government responses to the pandemic bring long-term benefits, as they help firms build better resilience to insolvency risks in later periods. Further cross-sectional analyses show that global businesses can consider holding more cash, acquiring more knowledge assets, sales earned from overseas markets, and using foreign capital contributions to alleviate the unpleasant effects of government interventions during global crises.

Our analysis uncovers the vital role of specific institutional characteristics, such as policy uncertainty, trust, and creditor's right, in shaping the resilience of businesses to government interventions during exogenous shocks. These findings highlight which institutional dimensions deserve more attention from policymakers in designing proactive solutions for the repercussions of global crises and enhancing business resilience. Based on a universe of firms across 97 countries, this paper provides extensive empirical evidence to support the notion that "*to save the economy, save people first*".

6.1. Theoretical implications

Our study contributes to the literature in several ways. Firstly, we provide empirical evidence of the applicability of the DCT in the context of a rare and non-ergodic event, namely the COVID-19 pandemic. Doing so offers deeper insights into the characteristics contributing to business resilience during crises. Our findings indicate that the composition of internal economic resources firms use to create goods and services and their degree of internationalization materially determine their ability to mitigate the adverse effects of a global crisis. These findings underscore the importance of strategic internal resource management and external resources through internationalization as essential elements in building and maintaining stability in crisis-induced disruptions. In addition, our study presents a sustainable, new, and timely look at exploring how country-level institutional qualities can affect business resilience, thereby supporting *institutional theory*.

Second, we extend the small body of extreme context research (ECR hereafter) that has greatly interested practitioners, academic scholars, and policymakers. The ECR approach is particularly relevant for economic and business analysis, as international business is "exposed more than any other management domain to the multiple tensions of changes in geographical, political, sociological, cultural and business environments" (Andriani and McKelvey, 2007: p.1226–1227). We respond to Buckley, Doh, and Benischke's (2017) call to expand the impacts of cross-country studies and address the current issues in international business studies (Buckley & Casson, 2021; Ghauri, Strange, & Cooke, 2021; Grøgaard, Sartor, & Rademaker, 2022; Verbeke & Yuan, 2021).

6.2. Managerial implications

Our study serves a wide range of audiences in international business and other interdisciplinary research (e.g., management, finance, economics, and accounting) since it carries significant implications for crisis management practices to relieve the consequences of, and build resilience to, exogenous adverse incidences from a practitioner's perspective. While it may seem evident that preserving sufficient liquidity and knowledge assets strengthens corporate resilience in times of crisis, our study provides empirical evidence to support this notion. Although liquidity and knowledge assets generally bolster business resilience, it is essential to acknowledge that there may be scenarios where these factors can pose challenges. For instance, excessive liquidity reserves may limit investment opportunities and reduce profitability, while an overreliance on specific knowledge assets without diversification can hinder adaptability and responsiveness to changing market conditions. Therefore, managers should carefully assess the optimal balance of resources based on each crisis's specific characteristics and requirements.

Moreover, our study emphasizes the need for corporate managers to align their internationalization strategies with their internal capabilities and external demands in dynamic environments. This highlights the importance of adapting internationalization approaches to mitigate risks and enhance resilience during times of crisis. However, it is worth noting that internationalization is double-edged and could expose firms to the liability of foreignness. Our results provide evidence for both sides of the story. Lastly, our findings also raise awareness for policymakers to consider the potential impact of cultural factors on firm default risk during significant disruptions. Understanding the interplay between a country's cultural values and firm resilience can inform policymakers in making decisions and supporting business stability and resilience during crises.

6.3. Limitations and future research

Admittedly, though our study offers valuable insights for firms to build their resilience to future exogenous shocks, it has a few limitations concerning empirical methodologies that future studies can address. First, while we conduct our analyses using a large-scale international sample, we focus on the period of the unfolding of the COVID-19 pandemic. Therefore, our testing hypotheses and empirical tests are conceived on the premise that government-restrictive policies (captured by our primary independent variable GSI) deter economic resource movements and increase the cost of international transactions. Thus, our findings might lack generalizability since not all destructive events may affect movement similarly. We suggest future research extend the boundary conditions and test our hypotheses' validity in a more general context or for multiple episodes of crises to draw a more comprehensive conclusion on what factors are critical to business resilience during unprecedented events.

Second, this study employs the probability of default, particularly the distance-to-default (DTD) and expected default frequency (EDF), to proxy for business non-resilience to a global crisis. Despite the reasons we provided in Sections 2.1 and 3.2 to motivate the use of these measures, we acknowledge that they only capture a specific aspect of business resilience: survivability during a crisis. Therefore, our results can be helpful for firms to manage their default risk when the crisis is unfolding; however, we are yet to establish evidence of how firms can bounce back during the post-crisis period. We leave this question for future studies to answer.

Another limitation is that our paper uses only the firms' existing internal and external resources to evaluate how well they could survive the COVID-19 pandemic. However, the DCT suggests that a firm's dynamic capabilities could also be inferred through its ability to innovate new assets or strategically combine its economic resources. For instance, a company's plants, researchers, and intellectual property may provide a synergistic combination of complementary assets. Therefore, we urge future research to investigate these applications of the DCT. Finally, limited by archival data, we cannot directly measure the underlying value of cultural merits or observe the real-time movement in economic resources during the pandemic that could help moderate its unfavorable impacts on the global economy. Future scholars can conduct more extensive experiments or use surveys to explore these aspects.

Data availability

The authors do not have permission to share data.

Acknowledgments

We appreciate helpful comments from Jim Arrowsmith, Jo Bensemann, Ralph Bathurst, Morten Bennedsen, Anna Berka, Margaret Brunton, Steven Cahan, Bevan Catley, Brian Connelly, Joe Cooper, Charl de Villiers, Jonathan Doh, Natalia D'Souza, Huu Nhan Duong, Sendil Ethiraj, Gabriel Eweje, Stav Fainshmidt, John Friedman, Maja Graso, Ahsan Habib, Jenny Hoang, Wenxuan Hou, Kaz Kobayashi, Conor O'Kane, Beatriz Garcia Osma, Nitha Palakshappa, Paolo Pasquariello, David Pauleen, David Tappin, Grazia Santangelo, Aymen Sajjad, Brian Spisak, Cameron Truong, Duc Vu, Ivo Welch, Suze Wilson, Jason Xiao, Sustainability and Corporate Social Responsibility Research Group at Massey University, seminar participants at Massey University, and conference participants at the 2022 New Zealand Finance Colloquium (Christchurch, 2022) and the 2022 International Conference on Fostering a Resilient Business Ecosystems and Economic Growth: Towards the Next Normal (India, 2022). Special thanks go to two anonymous referees and to Thomas Lindner, the Senior Editor, for generous comments and suggestions. We thank the Risk Management Institute of the National University of Singapore for providing the CRI database and Blavatnik School of Government, and Oxford University for providing the Oxford COVID-19 Government Response Tracker Data. Part of the work on this paper was completed while Anh Pham was affiliated with Monash Business School, Monash University. An earlier version of the paper was circulated under the title "Global Disaster Risk: Government Responses and Business Resilience". All remaining errors are our own.

Appendix A. Variable description

See Appenidx Section here.

Variable	Definition	Data Source
Default risk measures and their components		
DTD	Merton (1974)'s distance-to-default in a given quarter *q* in year *t*., measured based on Duan et al. (2012)'s approach for multiperiod default prediction. The larger the value, the lower the probability of default.	Credit Research Initiative
EDF	The expected default frequency is calculated as the cumulative normal distribution of the negative distance to default.	Credit Research Initiative, Authors' calculation
CDS Spread	The average conventional spread of all 5-year CDS contracts related to a firm in a given quarter *q* in year *t*.	Markit CDS database
VTL	The sum of a firm's market capitalization and the KMV default point L, scaled by the default point. The default point (L) is calculated as the short-term liabilities plus half of the long-term liabilities and a fraction of other liabilities.	Credit Research Initiative, Authors' calculation
σ	One-year return volatility of each firm, computed as the standard deviation of its residuals using the market model.	Credit Research Initiative
ROA Volatility	The standard deviation of the quarterly return-on-assets ratio over the four most recent quarters (*q-3* to *q*).	Compustat
Current ratio	The ratio of current assets to current liabilities in a given quarter *q* in year *t*.	Compustat
Government Responses to COVID-19		
GSI	The average COVID-19 government response stringency index in a given quarter *q* in year *t*. The index is constructed based on nine different metrics, including restrictions on internal movement, international travel controls, public information campaigns, cancellation of public events, restrictions on public gatherings, public transport closures, school closures, stay-at-home orders, and workplace closures. The stringency index is normalized by 100 to ease our interpretation.	Hale et al. (2020)
Control Variables		
Size	The natural logarithm of prior-quarter total assets	Compustat
Cash	Cash-to-asset ratio	Compustat
Profitability	Earnings before interest, taxes, depreciation, and amortization scaled by the book value of total assets in the most recent prior quarter	Compustat
Leverage	Book value of debt to asset	Compustat
Return	The cumulative stock return in the previous calendar quarter	Compustat and CRSP
Illiquidity	Amihud's (2002) measure of illiquidity. Quarterly average of the daily ratio of the absolute value of stock return divided by dollar trading volume, multiplied by one million.	Compustat and CRSP
Other firm-specific variables		
Labor intensity	The ratio of sales to the number of employees. A higher value indicates a higher workload for each employee.	Compustat
IO Foreign	The percentage of shares held by foreign institutional investors in a given quarter *q* in year *t*.	Refinitiv's Stock Ownership Database
Overseas sales	The ratio of foreign sales to total sales in a given year *t*.	Factset Revere
Overseas supply	The fraction of foreign suppliers in the total number of suppliers in a given year *t*.	Factset Revere
Firm age	The number of years since the date of incorporation	BvD Orbis
Other country-specific variables		
WUI	The world uncertainty index is a measure that reflects a country's economic policy uncertainty by text-mining the country's reports of the Economist Intelligence Unit.	Ahir, Bloom, and Furceri (2022)
RFI	The renegotiation failure index summarizes the legal characteristics that protect debtholders from shareholders' strategic default; a higher value of *RFI* suggests stronger protection of creditors' rights.	Djankov et al. (2008)
Net migration	The number of immigrants (people moving into a given country) minus the number of emigrants (people moving out of the country) in the previous five years, divided by the person-years lived by the receiving country's population over that period.	United Nations Department of Economic and Social Affairs (UN DESA)
Trust in others	A measure of people's trust in other members of the same society.	World Value Survey
Individualism	A country's normalized individualism score.	Hofstede's (1997) cultural dimension scores
Civil liberty	The variable, based on Freedom House's Freedom in the World, identifies the extent of freedom of expression and association, the rule of law, and personal autonomy.	Freedom House (2022)
Identification variables		
Norway	An indicator variable that equals 1 for firms located in Norway and 0 otherwise.	Self-construction
Lockdown	An indicator variable that equals 1 for both Norwegian and Swedish firms from March 2020 to April 2020 and 0 otherwise.	Self-construction

Appendix B. Sample construction

This table summarizes the filtering criteria we apply to construct our sample of firms for empirical analyses. The filtering steps are listed in Column (1), while the number of observations dropped and the remaining balance after each filtering step are reported in Columns (2) and (3), respectively. The sample period is from January 2019 to June 2021.

Filtering steps (1)	Reduction (2)	Remaining (3)
Total number of firm-quarters with available default risk data from CRI		372,671
• Observations dropped due to unavailable default risk data throughout the period from 2019 to 2021	(23,899)	348,772
• Observations dropped due to missing *GSI* data	(566)	348,206
• Observations dropped due to missing values of control variables constructed based on Compustat	(177,256)	**170,950**

Appendix C. The construction of CRI DTD measure

The daily *DTD* values from the CRI are rooted in the traditional Kealhofer-Merton-Vasicek (KMV) estimation model as follows:

$$\mathrm{DTD} = \frac{\ln\left(\frac{V_t}{L}\right) + \left(\mu - \frac{\sigma^2}{2}\right)\left(T - t\right)}{\sigma\sqrt{T-t}} \tag{1}$$

where V_t is a firm's market value estimated using a geometric Brownian motion with drift μ and volatility σ; μ represents the short-term risk-free rate; and σ captures the firm's stock return volatility using the standard deviation of its market-adjusted returns. The default point, L, equals short-term liabilities + (0.5 × long-term liabilities). $\sqrt{T-t}$ is set to 1 year. However, the CRI follows Duan, Sun, and Wang (2012) and implements some adjustments to its DTD estimation.[16] These adjustments are: (1) adding a fraction (δ) of other liabilities to the KVM default point L, estimated at a sectoral level for each calibration group[17]; (2) setting μ equal to $\sigma^2/2$ to improve the stability of the DTD measure; and (3) standardizing the firm's market value by its book value to handle the scale change due to any significant investment and financing actions.

Appendix D. Corporate default risk by countries, industries, and years

This table reports the descriptive statistics of our corporate default risk measures by country, industry, and year. Panel A presents the changes in DTD and EDF before and after March 2020 (i.e., the official announcement of the COVID-19 pandemic by WHO) by countries, while Panel B replicates the same structure by industries. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. All variables are defined in Appendix 1. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from January 2019 to June 2021.

Panel A: Default risk by countries for the pre-and post-COVID-19 announcement.

Country	Obs (1)	#Firms (2)	DTD before March 2020 (3)	EDF before March 2020 (4)	DTD after March 2020 (5)	EDF after March 2020 (6)	ΔDTD (5) - (3)	ΔEDF (6) - (4)
Argentina	414	46	0.755	0.290	1.186	0.199	0.431	-0.091
Australia	6957	1024	3.941	0.025	3.075	0.039	-0.866	0.013
Austria	304	35	4.623	0.005	3.732	0.011	-0.891	0.006
Azerbaijan	10	1	3.727	0.001	2.907	0.004	-0.820	0.003
Bahrain	12	3	8.867	0.000	8.464	0.000	-0.403	0.000
Bangladesh	1259	190	4.178	0.023	4.141	0.018	-0.037	-0.005
Belgium	565	64	4.662	0.028	3.864	0.032	-0.798	0.003
Bermuda	23	3	4.011	0.035	3.423	0.023	-0.588	-0.012
Botswana	3	1	9.360	0.000	0.000	0.000	-9.360	0.000
Brazil	1457	160	3.435	0.096	2.465	0.119	-0.970	0.023
British Virgin Islands	11	3	2.869	0.029	0.000	0.000	-2.869	-0.029
Bulgaria	58	12	4.219	0.074	4.091	0.088	-0.128	0.013
Cambodia	10	1	7.358	0.000	5.519	0.000	-1.839	0.000
Cayman Islands	23	5	4.993	0.012	0.000	0.000	-4.993	-0.012
Chile	372	50	5.262	0.009	3.174	0.031	-2.088	0.022
China	35983	3767	4.495	0.010	4.515	0.011	0.020	0.002
Colombia	116	13	4.826	0.010	3.493	0.010	-1.333	0.000
Croatia	127	19	5.138	0.041	3.929	0.066	-1.209	0.024
Cyprus	75	12	5.621	0.033	4.161	0.063	-1.460	0.030
Czech Republic	58	6	7.256	0.000	5.726	0.000	-1.530	0.000
Denmark	818	94	5.264	0.023	4.622	0.022	-0.642	0.000
Egypt	871	120	2.970	0.062	2.814	0.070	-0.156	0.008
Estonia	117	13	6.111	0.039	5.297	0.037	-0.814	-0.002
Faroe Islands	5	1	7.333	0.000	0.000	0.000	-7.333	0.000
Finland	1103	125	4.728	0.025	4.328	0.029	-0.400	0.004
France	3891	427	4.042	0.033	3.265	0.047	-0.777	0.014
Gabon	10	1	3.958	0.001	3.092	0.002	-0.866	0.001

(continued on next page)

[16] Duan et al. (2012) provide comprehensive evidence suggesting that this method of estimating *DTD* outperformance the traditional destination technique.
[17] See Duan et al. (2012)'s Appendix B for the details of the estimation process.

(*continued*)

Country	Obs (1)	#Firms (2)	DTD before March 2020 (3)	EDF before March 2020 (4)	DTD after March 2020 (5)	EDF after March 2020 (6)	ΔDTD (5) - (3)	ΔEDF (6) - (4)
Germany	2559	307	4.401	0.015	3.805	0.026	-0.596	0.011
Ghana	9	1	4.107	0.001	2.669	0.015	-1.438	0.015
Gibraltar	10	2	2.836	0.076	0.000	0.000	-2.836	-0.076
Greece	646	88	3.741	0.065	2.885	0.087	-0.856	0.022
Guernsey	16	4	5.040	0.021	0.000	0.000	-5.040	-0.021
Hong Kong	5084	675	3.458	0.064	2.826	0.090	-0.632	0.027
Hungary	138	16	4.808	0.017	4.234	0.012	-0.574	-0.005
Iceland	82	11	4.865	0.038	4.886	0.053	0.021	0.015
India	568	179	4.541	0.055	3.898	0.061	-0.643	0.007
Indonesia	3106	406	3.693	0.062	2.911	0.084	-0.782	0.022
Ireland	257	29	5.378	0.018	4.160	0.014	-1.218	-0.004
Isle Of Man	16	4	3.673	0.069	0.000	0.000	-3.673	-0.069
Israel	2047	244	4.396	0.028	3.420	0.039	-0.976	0.011
Italy	1986	241	4.159	0.034	3.308	0.046	-0.851	0.012
Jamaica	225	28	3.368	0.022	2.535	0.041	-0.833	0.019
Japan	33	4	4.416	0.012	2.939	0.023	-1.477	0.011
Jersey	24	5	3.758	0.010	0.000	0.000	-3.758	-0.010
Jordan	170	31	3.524	0.026	3.870	0.019	0.346	-0.008
Kazakhstan	47	5	6.196	0.003	6.334	0.000	0.138	-0.003
Kenya	101	13	3.971	0.100	3.084	0.152	-0.887	0.053
Kuwait	359	52	4.359	0.034	4.028	0.033	-0.331	-0.001
Latvia	57	10	5.370	0.025	4.808	0.039	-0.562	0.014
Lithuania	115	18	5.263	0.017	4.800	0.027	-0.463	0.010
Luxembourg	158	18	4.035	0.007	3.581	0.011	-0.454	0.003
Macao	35	4	4.834	0.000	4.901	0.000	0.067	0.000
Macedonia	3	1	5.790	0.000	0.000	0.000	-5.790	0.000
Malaysia	5624	704	3.891	0.053	3.204	0.065	-0.687	0.012
Malta	71	10	4.351	0.017	3.597	0.037	-0.754	0.020
Mauritius	74	13	5.764	0.059	3.033	0.120	-2.731	0.061
Mexico	572	66	4.849	0.028	3.952	0.052	-0.897	0.023
Moldova	10	1	6.717	0.000	7.490	0.000	0.773	0.000
Monaco	10	1	6.096	0.000	6.167	0.000	0.071	0.000
Mongolia	20	2	2.389	0.066	2.396	0.103	0.007	0.036
Morocco	154	24	5.940	0.004	5.483	0.007	-0.457	0.002
Namibia	14	2	3.245	0.011	3.176	0.019	-0.069	0.008
Netherlands	651	76	5.022	0.017	4.095	0.029	-0.927	0.012
New Zealand	758	94	5.876	0.012	4.200	0.030	-1.676	0.018
Nigeria	430	51	2.229	0.127	2.133	0.117	-0.096	-0.010
Norway	1175	132	3.402	0.075	3.036	0.102	-0.366	0.027
Oman	85	16	4.095	0.058	3.873	0.039	-0.222	-0.019
Pakistan	1093	130	2.919	0.082	3.041	0.063	0.122	-0.019
Panama	11	2	0.409	0.424	0.002	0.763	-0.407	0.339
Papua New Guinea	5	1	2.694	0.008	3.577	0.001	0.883	-0.007
Peru	142	18	5.225	0.039	4.250	0.034	-0.975	-0.004
Philippines	1035	130	4.049	0.030	3.069	0.043	-0.980	0.013
Poland	2617	302	3.029	0.061	2.791	0.056	-0.238	-0.004
Portugal	229	26	3.890	0.055	3.021	0.061	-0.869	0.006
Qatar	194	20	7.008	0.001	6.354	0.001	-0.654	0.000
Romania	249	36	5.380	0.005	5.201	0.008	-0.179	0.003
Russia	1427	163	2.862	0.128	2.407	0.119	-0.455	-0.010
Saudi Arabia	1211	126	6.413	0.004	5.545	0.006	-0.868	0.002
Serbia	19	2	5.518	0.028	6.234	0.000	0.716	-0.028
Singapore	1508	243	4.478	0.052	3.304	0.074	-1.174	0.023
Slovenia	52	6	6.747	0.013	6.343	0.000	-0.404	-0.013
South Africa	1169	137	3.370	0.075	2.506	0.125	-0.864	0.051
South Korea	14778	1580	3.599	0.023	3.269	0.024	-0.330	0.001
Spain	806	91	4.278	0.036	3.316	0.040	-0.962	0.004
Sri Lanka	730	154	2.851	0.083	2.556	0.071	-0.295	-0.012
Sudan	2	1	1.859	0.031	0.000	0.000	-1.859	-0.031
Sweden	4639	512	4.146	0.035	3.721	0.034	-0.425	-0.001
Switzerland	1351	145	5.957	0.011	5.317	0.017	-0.640	0.005
Taiwan	8293	846	5.898	0.005	5.158	0.005	-0.740	0.000
Thailand	4881	520	5.273	0.017	4.064	0.024	-1.209	0.007
Tunisia	142	18	5.917	0.003	5.214	0.004	-0.703	0.001
Turkey	2682	281	2.633	0.087	2.828	0.042	0.195	-0.045
Ukraine	65	8	2.888	0.057	1.826	0.165	-1.062	0.108
United Arab Emirates	212	26	4.029	0.069	3.170	0.112	-0.859	0.042
United Kingdom	6290	750	4.506	0.028	3.522	0.044	-0.984	0.016
United States	30942	3218	4.231	0.030	3.083	0.052	-1.148	0.022
Vietnam	2025	273	4.426	0.025	4.114	0.023	-0.312	-0.002
Total	**170,950**	**19,549**						
Average			**4.519**	**0.039**	**3.462**	**0.047**	**-1.057 * ****	**0.007 * ****

Panel B: Default risk by industries for pre- and post-COVID-19 announcement.

Industry	Obs	#Firms	DTD before March 2020	EDF before March 2020	DTD after March 2020	EDF after March 2020	ΔDTD	ΔEDF
	(1)	(2)	(3)	(4)	(5)	(6)	(5) - (3)	(6) - (4)
Agriculture, Forestry, And Fishing	1369	158	4.521	0.031	3.982	0.034	-0.539	0.003
Construction	5000	599	3.345	0.054	2.743	0.065	-0.602	0.012
Finance, Insurance, And Real Estate	6816	706	4.016	0.023	2.428	0.064	-1.588	0.041
Manufacturing	93,218	10,460	4.404	0.024	3.938	0.028	-0.466	0.003
Mining	8112	1111	3.379	0.052	2.771	0.079	-0.608	0.027
Public Administration	1389	159	4.121	0.058	3.409	0.057	-0.712	-0.001
Retail Trade	7724	857	3.972	0.040	3.244	0.058	-0.728	0.017
Services	25,360	2982	4.371	0.028	3.695	0.038	-0.676	0.010
Transportation, Communications, Electric & Gas	16,186	1820	4.365	0.041	3.553	0.051	-0.812	0.010
Wholesale Trade	5776	697	3.778	0.041	3.266	0.051	-0.512	0.010
Total	**170,950**	**19,549**						
Average			**4.027**	**0.039**	**3.303**	**0.052**	**-0.724 * ****	**0.013 * ****

Appendix E. Random-effects regression results

The table presents the estimated regression models of corporate default risk on the government response stringency index using a random-effects estimator. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. *GSI* is the government response stringency index developed by Hale et al. (2020). The list of control variables includes *Size, Cash, Profitability, Leverage, Return,* and *Illiquidity.* All regressions are estimated at the firm-quarter level. All variables are defined in Appendix 1. The *p-value* of the Hausman test is reported at the bottom of the table. The *p*-values in paratheses are based on heteroskedasticity-consistent and firm-and-year clustered standard errors. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from January 2019 to June 2021.

Variable	DTD (1)	EDF (2)
GSI	-0.9554 * **	0.0092 * **
	(0.000)	(0.000)
Size	0.0081 *	-0.0021 * **
	(0.061)	(0.000)
Cash	0.7833 * **	-0.0280 * **
	(0.000)	(0.000)
Profitability	3.7583 * **	-0.1196 * **
	(0.000)	(0.000)
Leverage	-2.4992 * **	0.0933 * **
	(0.000)	(0.000)
Return	0.4766 * **	-0.0205 * **
	(0.000)	(0.000)
Illiquidity	-0.8039 * **	0.0480 * **
	(0.000)	(0.000)
Obs	170,950	170,950
R-Squared:		
• Within	0.114	0.037
• Between	0.229	0.155
• Overall	0.191	0.114
Hausman test's *p*-value	0.000	0.000

Appendix F. Individual components of GSI and corporate default risk

This table reports the estimated regression models of default risk on nine separate components of the government response stringency index. These components include school closures, workplace closures, cancellation of public events, restrictions on public gatherings, public transport closures, stay-at-home orders, restrictions on internal movement, international travel controls, and public information campaigns. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. *GSI* is the government response stringency index developed by Hale et al. (2020). The list of unreported control variables includes *Size, Cash, Profitability, Leverage, Return,* and *Illiquidity.* Country, industry, and year-fixed effects are included unless otherwise stated. All regressions are estimated at the firm-quarter level. All variables are defined in Appendix 1. The *p*-values in paratheses are based on heteroskedasticity-consistent and firm-and-year clustered standard errors. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from January 2019 to June 2021.

Panel A: Dependent variable = *DTD*.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
School closures	-0.1917 * **									-0.1101 * **
	(0.000)									(0.000)
Workplace closures		-0.1548 * **								-0.0194
		(0.000)								(0.384)
Cancellation of public events			-0.2261 * **							0.1008 * **
			(0.000)							(0.001)
Restrictions on public gatherings				-0.0964 * **						0.1001 * **
				(0.000)						(0.000)
Public transport closures					-0.1963 * **					0.0220
					(0.000)					(0.393)
Stay-at-home orders						-0.1167 * **				0.2838 * **
						(0.000)				(0.000)
Restrictions on internal movement							-0.2432 * **			-0.2955 * **
							(0.000)			(0.000)
International travel controls								-0.1922 * **		-0.1306 * **
								(0.000)		(0.000)
Public information campaigns									-0.3037 * **	-0.2284 * **
									(0.000)	(0.000)
Observations	170,950	170,950	170,950	170,950	170,950	170,950	170,950	170,950	170,950	170,950
Adj. R-Squared	0.360	0.359	0.359	0.358	0.358	0.357	0.360	0.362	0.361	0.364
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Dependent variable = *EDF*.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
School closures	0.0033 * **									0.0036 * **
	(0.000)									(0.000)
Workplace closures		0.0033 * **								0.0039 * **
		(0.000)								(0.000)
Cancellation of public events			0.0040 * **							-0.0034 * *
			(0.000)							(0.029)
Restrictions on public gatherings				0.0021 * **						0.0011
				(0.000)						(0.114)
Public transport closures					0.0032 * **					-0.0028 * *
					(0.000)					(0.033)
Stay-at-home orders						0.0023 * **				-0.0056 * **
						(0.000)				(0.000)
Restrictions on internal movement							0.0042 * **			0.0036 * **
							(0.000)			(0.001)
International travel controls								0.0028 * **		0.0027 * **
								(0.000)		(0.000)
Public information campaigns									0.0037 * **	-0.0043 * **
									(0.000)	(0.000)
Observations	170,950	170,950	170,950	170,950	170,950	170,950	170,950	170,950	170,950	170,950
Adj. R-Squared	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.207
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix G. Regression analyses for firms in countries with less severe COVID-19 conditions

The table reports the regression estimates of the relation between different levels of government response stringency and default risk over time for countries with low exposure to COVID-19. Stringent and less-stringent government responses to COVID-19 are based on the sample median of the government response stringency measure. High and low exposure to COVID-19 is based on the sample median of the country-level ratio of the monthly increase in the number of confirmed COVID-19 cases to the population in March 2020. *DTD* is Merton's (1974) distance-to-default with the parameters estimated using the maximum likelihood method described in Duan et al. (2012). *EDF* is the cumulative normal distribution of the negative distance to default. *GSI* is the government response stringency index developed by Hale et al. (2020). The list of unreported control variables includes *Size, Cash, Profitability, Leverage, Return,* and *Illiquidity.* Country, industry, and year-fixed effects are included unless otherwise stated. All regressions are estimated at the firm-quarter level. All variables are defined in Appendix 1. The *p*-values in paratheses are based on heteroskedasticity-consistent and firm-and-year clustered standard errors. The continuous variables are winsorized at the top and bottom 1% of the sample distribution. The symbols * ** , * *, and * denote the statistical significance at 1%, 5%, and 10%, respectively. The sample period is from April 2020 to June 2021.

Panel A: Stringent COVID-19 response in countries with low exposure to COVID-19.

	Dependent variable = DTD					Dependent variable = EDF				
	Q2/2020	Q3/2020	Q4/2020	Q1/2021	Q2/2021	Q2/2020	Q3/2020	Q4/2020	Q1/2021	Q2/2021
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GSI	10.1718	-20.730 * **	8.2541	22.7109 * *	-13.7076	-0.7556	5.0985	-0.0379	-0.8821	2.0564
	(0.188)	(0.000)	(0.164)	(0.049)	(0.639)	(0.380)	(0.272)	(0.885)	(0.149)	(0.267)
Size	-0.2046 * **	-0.2343 * **	-0.1803 * **	-0.1392 * **	-0.1526 * **	0.0003	0.0001	-0.0004	-0.0003	0.0003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.763)	(0.947)	(0.659)	(0.812)	(0.736)
Cash	3.4399 * **	2.6362 * **	3.0002 * **	2.5503 * **	2.9425 * **	-0.0050	-0.0107 * *	-0.0146 * *	-0.0080	-0.0048
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.270)	(0.032)	(0.012)	(0.188)	(0.394)
Profitability	10.5921 * **	16.6764 * **	14.7574 * **	11.8236 * **	9.0296 * **	-0.2179 * **	-0.3108 * **	-0.3705 * **	-0.0925	-0.2311 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.153)	(0.000)
Leverage	-4.3864 * **	-4.5533 * **	-3.8536 * **	-4.2308 * **	-4.2049 * **	0.0631 * **	0.0479 * **	0.0518 * **	0.0645 * **	0.0485 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Return	0.5700 * **	0.6001 * **	-0.1941 *	0.3711 * **	-0.2925 * *	-0.0282 * **	-0.0217 * **	0.0031	-0.0039	0.0121 * *
	(0.000)	(0.000)	(0.056)	(0.001)	(0.029)	(0.000)	(0.000)	(0.567)	(0.516)	(0.031)
Illiquidity	-11.2187 * *	-11.6121 * *	-15.8164 *	-6.3282 * **	-45.9272 * *	0.9899 * **	0.6464 * *	1.5220	0.1625 * **	2.2841
	(0.013)	(0.011)	(0.057)	(0.000)	(0.011)	(0.007)	(0.039)	(0.118)	(0.010)	(0.137)
Observations	3614	3667	3668	3639	3621	3614	3667	3668	3639	3621
Adj. R-Squared	0.431	0.380	0.373	0.342	0.359	0.153	0.101	0.132	0.072	0.104
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Less stringent COVID-19 response in countries with low exposure to COVID-19.

	Dependent variable = DTD					Dependent variable = EDF				
	Q2/2020	Q3/2020	Q4/2020	Q1/2021	Q2/2021	Q2/2020	Q3/2020	Q4/2020	Q1/2021	Q2/2021
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GSI	-5.9426 * **	-4.4115 * **	-4.3577 * **	-4.2453 * **	-13.7076	0.0473 * *	0.1113 * **	0.0882 * **	0.0703 * **	2.0564
	(0.000)	(0.000)	(0.000)	(0.000)	(0.639)	(0.020)	(0.000)	(0.000)	(0.000)	(0.267)
Size	0.0586 * **	-0.0445 * **	-0.0029	-0.0015	-0.1526 * **	-0.0007	-0.0004	-0.0012 * **	-0.0012 * **	0.0003
	(0.000)	(0.000)	(0.710)	(0.846)	(0.000)	(0.272)	(0.295)	(0.002)	(0.001)	(0.736)
Cash	2.7821 * **	2.1833 * **	1.9276 * **	1.7864 * **	2.9425 * **	-0.0554 * **	-0.0481 * **	-0.0461 * **	-0.0370 * **	-0.0048
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.394)
Profitability	10.8974 * **	12.8830 * **	9.0315 * **	10.1884 * **	9.0296 * **	-0.2377 * **	-0.2229 * **	-0.1951 * **	-0.1693 * **	-0.2311 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-3.9498 * **	-4.0326 * **	-4.0520 * **	-3.9294 * **	-4.2049 * **	0.1257 * **	0.1230 * **	0.1157 * **	0.0981 * **	0.0485 * **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Return	2.1406 * **	-0.5474 * **	-0.3167 * **	-0.2834 * **	-0.2925 * *	-0.0532 * **	-0.0011	-0.0067 *	0.0063	0.0121 * *
	(0.000)	(0.000)	(0.000)	(0.000)	(0.029)	(0.000)	(0.779)	(0.070)	(0.139)	(0.031)
Illiquidity	-3.2171 * **	-1.8952 * **	-1.7192 * **	-2.1670 * **	-45.9272 * *	0.2470 * **	0.1342 * **	0.1303 * **	0.1265 * **	2.2841
	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)	(0.000)	(0.000)	(0.000)	(0.000)	(0.137)
Observations	4717	4887	5171	5212	3621	4717	4887	5171	5212	3621
Adj. R-Squared	0.370	0.375	0.358	0.340	0.359	0.222	0.194	0.179	0.153	0.104
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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