Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Disaster response: The COVID-19 pandemic and insider trading around the world

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ABSTRACT

This paper investigates how corporate insiders respond to the initial COVID-19 outbreaks. Using comprehensive insider transaction data from 25 countries, we document a consistent pattern of insider selling during the month after the first COVID-19 case is confirmed in a given country. Insider selling during these disease outbreaks is less pronounced in countries with higher information disclosure requirements, higher public enforcement index, a more efficient judiciary system, and stronger investor protection. Furthermore, cultural differences and the stringency levels of government responses to the COVID-19 outbreaks help moderate insider panic selling when health disasters strike. The findings suggest that a transparent, reliable business system contributes to rebuilding investor trust and corporate resilience during crises.

1. Introduction

Infectious diseases have become significant threats to humans and have posed unprecedented disruptions to the global economy and financial markets in recent decades; however, their initial impacts remain uncertain. For example, the global markets continued to perform well until late February 2020, even though the coronavirus pandemic (COVID-19), which originated in China in late December 2019, had spread to many countries, such as Australia, Canada, Germany, France, Korea, Japan, Italy, the United Kingdom, and the United States (US) by January 2020. By the end of February 2020, the COVID-19 pandemic affected around 100 countries, with nearly 100,000 confirmed cases. Interestingly, the US stock markets peaked on February 19th, 2020, while Chinese stock markets experienced an upward trend in February 2020, even after China's central government imposed a lockdown in the city of Wuhan.[1] This evidence shows that most market participants underestimated the impact of the initial COVID-19 outbreaks on the global financial

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[1] In March 2020, the global stock markets dropped substantially, especially after the WHO declared COVID-19 a pandemic on March 11th, 2020. For instance, the US stock market dropped about 34% (Jackwerth, 2020), and stock markets in Europe and Japan plunged over 20% below the previous year's peaks.

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markets.

This paper focuses on a unique group of market participants, corporate insiders, by examining their trading behaviors during the initial COVID-19 epidemic and how each country's informational and cultural conditions altered these behaviors. As discussed in the literature, corporate insiders have superior knowledge about firms' future fundamentals and can forecast stock price movements following their stock transactions (Jiang & Zaman, 2010; Lakonishok & Lee, 2001; Seyhun, 1986, 1992). Moreover, recent studies also show that economic uncertainty can reduce corporate transparency (Bird, Karolyi, & Ruchti, 2017) and increase the information asymmetry between insiders and outsiders (Li, 2020; Nagar, Schoenfeld, & Wellman, 2019), making private information more valuable (Chiang, Chung, & Louis, 2017). Following these literature trends, we expect corporate insiders, who differ from most market participants, to implement the contrarian investment policy at the start of the COVID-19 pandemic. Furthermore, we hypothesize that their trading can impact a country's institutional environment.

Using the detailed daily insider transactions covering 25 countries from 2017 to 2020, we observe a consistent pattern of insider selling during the month in which the first COVID-19 case was confirmed in a given country. The findings are robust across different measures of trading direction and hold after accounting for a range of fundamental firm measures. The results are inconsistent with the trading patterns of most capital market participants in the initial COVID-19 outbreaks; however, these findings are consistent with the hypothesis that macroeconomic uncertainty increases the information asymmetry between insiders and outsiders as well as the value of private information (Chiang et al., 2017; Li, 2020; Nagar et al., 2019), which increases the likelihood that insiders can arbitrage their superior information status.

We next investigate the impact of COVID-19 outbreaks on insider transactions across industries. If corporate insiders better understand the COVID-19 impact on their companies, we expect their trading behaviors to differ among industries because some industries are more affected by the pandemic than others (Guan et al., 2020; McKinsey & Company, 2020). Excluding the food industry, which produces essential goods for daily consumption and thus might not be heavily impacted by the pandemic, we find that insiders bought less and sold more during COVID-19 outbreaks across all Fama and French 17 industries. Moreover, consistent with our expectation, insiders of firms in consumer durable, automobile, and transport industries have the most significant sales during the COVID-19 compared with other industries. In contrast, those in mining and minerals, oil and petroleum products, drugs, soap, and perfumes, and construction sectors exhibit the lowest insider sales across different measures of insider trading direction.

We then examine how a country's institutional environments affect insider trading behavior during the pandemic. Among countries with more stringent responses by the government to COVID-19, insiders tended to sell less during the two months since the first COVID-19 case confirmation date. Additionally, consistent with our argument that economic uncertainty increases the asymmetric information between insiders and outsiders (Li, 2020), insider selling is less pronounced among countries with a higher public enforcement index, a more efficient judiciary system, and more substantial anti-director rights and investor protection. We also observe that, during COVID-19 outbreaks, insiders tended to sell less in countries with high information disclosure requirements. These findings are consistent with a growing body of literature suggesting that strong investor protection and a transparent information environment can reduce the value of private information (Chiang et al., 2017) and mitigate opportunistic insider trades (Fidrmuc, Korczak, & Korczak, 2013; Jagolinzer, Larcker, & Taylor, 2011; Kallunki, Kinnunen, & Martikainen, 2016). The extant literature further suggests that a transparent, reliable business system contributes to rebuilding investor trust and corporate resilience in crises (Lins, Servaes, & Tamayo, 2017; Sapienza & Zingales, 2012), leading to an optimistic outlook about a robust economic recovery post-crisis.

We further study insider behavior through the lens of cultural differences. As discussed in Hofstede (2001), culture significantly affects the acquisition and sharing of information among people, which impacts decision-making. For example, people from individual or masculine cultures tend to make decisions highly based on their information, while people from collective or feminine cultures pay more attention to information sharing. Similarly, people from cultures with high uncertainty avoidance or long-term vision prefer more details and specific plans, have more formal rules, and minimize risks. Cultural characteristics significantly affect decision-making; therefore, we hypothesize that culture can alter the trading behaviors of corporate insiders during the initial COVID-19 outbreak. Consistent with this hypothesis, we find that corporate insiders from individualistic and masculine cultures are likely to sell less during and after the COVID-19 outbreak month. In contrast, those from high uncertainty avoidance and long-term vision cultures tend to sell more during and after the COVID-19 first-case confirmation month. These findings align with prior studies documenting that cultural differences play significant roles in various economic decisions, especially decisions made under uncertainty (Frijns, Hubers, Kim, Roh, & Xu, 2022; Hoang, Nguyen, & Hoang, 2021; Hofstede, 2001; Li, Griffin, Yue, & Zhao, 2013; Meier-Pesti & Penz, 2008; Nevins, Bearden, & Money, 2007).

We continue to examine different types of insider transactions around the pandemic. We follow Cohen, Malloy, & Pomorski, 2012 approach to classify insider trading into routine and non-routine transactions. Because information primarily drives non-routine trading, we focus more on corporate insiders' non-routine trading. We find more non-routine transactions than routine trading around the start of the COVID-19 pandemic, suggesting that insiders with a better understanding of this impact took advantage of the pandemic-induced disruptions for their transactions.

We then turn our attention to insider transactions in the US market, given that it was the worst-hit country during the first year of the COVID-19 pandemic, and several lawmakers' informed trading received increasing attention from investors, practitioners, and policymakers. More importantly, the availability of state-level governments' responses to pandemic data in the US allows us to investigate whether COVID-19 containment and economic support affected insider behavior in sub-nation analyses. We find that insider selling is more pronounced among firms with higher COVID-19 risk, captured by firm-level COVID-19 exposure developed by Hassan, Hollander, van Lent, and Tahoun (2020). Furthermore, insiders tend to be less engaged in panic selling in states with more stringent measures against COVID-19.

Our paper contributes to four strands of literature. First, we contribute to a growing body of literature on informed transactions

during crises. For example, Cziraki (2018) studied insider transactions of bank executives and board directors during the 2007–2008 global financial crisis, finding that sales by insiders in banks with high crisis exposure were particularly strong in the pre-crisis period. Jagolinzer, Larcker, Ormazabal, and Taylor (2020) found that political connections provided corporate insiders with an information advantage during the 2008–2009 financial crisis, which could be exploited for profit. Our study provides extensive cross-country evidence suggesting that insiders generally tended to go short on stocks several weeks before the first COVID-19 cases were confirmed in 25 countries.

Second, to the best of our knowledge, this is the first paper investigating the effects of a country's institutional and cultural environments on the trading behaviors of corporate insiders in the initial COVID-19 epidemic. Our findings provide insights into global insider trading behavior that is largely under-researched (Aussenegg, Jelic, & Ranzi, 2018; Kallunki et al., 2016). We find that the institutional and cultural environments can alter the trading behaviors of corporate insiders worldwide; therefore, we respond to the call by Kallunki et al. (2016) to expand the limited literature on cross-country determinants of insider transactions.

Third, we contribute to the literature on uncertainty, investor behavior, and market reactions following disasters. Li (2020) finds that economic policy uncertainty increases insider trading. Dessaint and Matray (2017) find that corporate managers overreact to ongoing hurricane risk and hold more cash. Rehse, Riordan, Rottke, and Zietz (2019) document that Hurricane Sandy affected investor behavior, resulting in less trading and wider spreads in the real estate investment trusts impacted by the hurricane. Ma, Marshall, Nguyen, Nguyen, and Visaltanachoti (2020) find that insiders trade more when climate disasters strike. Bourdeau-Brien and Kryzanowski (2020) find that natural disasters cause a rise in risk aversion. Gao, Liu, and Shi (2020) show that investors can feel less risk with unexpected "lucky disaster experiences" (e.g., disasters with lower actual fatalities than expected). Barrios and Hochberg (2020) suggest that political partisanship contributes to understanding individuals' risk perception during a pandemic, while An, Hou, and Lin (2022) find that firms and households more exposed to an epidemic disease tend to have less access to external financing. Ma, Marshall, Nguyen, Nguyen, and Visaltanachoti (2022) show that market returns and individual stocks improve more when climate disasters occur. Bordalo, Coffman, Gennaioli, and Shleifer (2020) find that risk perception associated with COVID-19 falls sharply with age. More recently, Chundakkadan and Nedumparambil (2022) and Su, Liu, and Fang (2022) show that search volume of the pandemic and pandemic-induced fear negatively affect stock market returns. Thakerngkiat, Nguyen, Nguyen, and Visaltanachoti (2023) find that disaster-induced fear triggers an increase in asset volatility and default risk. Our study suggests that infectious diseases can spread fear among stock market participants and trigger market uncertainty, resulting in panic selling during disease outbreaks.

Fourth, our study points out a new mechanism for insider trading. On the one hand, some previous studies (Lakonishok & Lee, 2001; Seyhun, 1986, 1992) focus on the channel through which insiders have a private information advantage and how they incorporate this information into stock prices. On the other hand, Chiang et al. (2017) document that private information is more valuable under inefficient markets, and Li (2020) shows that uncertainty can increase the information asymmetry between insiders and outsiders. Our paper examines how these channels interact by focusing on incorporating the macro shock into firm-specific information. In more detail, we show that insiders tend to better understand the impact of global health outbreaks on their firms and incorporate that into their trading decisions.

Our study is also related to a growing body of research documenting how cultural differences contribute to individual and corporate risk attitudes. For example, Li et al. (2013) find that individualism (uncertainty avoidance) positively (negatively) impacts corporate managers' risk-taking behavior. Meier-Pesti and Penz (2008) show that individuals in cultures with more masculine attributes tend to take more financial risks than those in less masculine cultures, while An, Chen, Li, and Xing (2018) find that firms in countries with higher individualism have higher stock price crash risk. Rieger (2020) suggests cultural factors can affect stock market participation, a particular risk-taking decision. More recently, Frijns et al. (2022) showed that national culture affects corporate risk-taking worldwide. Pham, Pham, and Truong (2022a, 2022b) show that culture dimensions are associated with corporate misreporting and the pricing of audit services. Our findings suggest that cultural differences can induce an increased heterogeneity in insider trading behavior in times of crisis.

Overall, our study contributes to the emerging literature documenting the adverse impacts of COVID-19 outbreaks and other significant upheavals on various economic outcomes (Baker et al., 2020; Cervellati, Stella, Filotto, & Maino, 2022; Cheng, 2020; Ellul, Erel, & Rajan, 2020; Hansen, 2020; Hasan, Hassan, Rashid, & Alhenawi, 2021; Li, 2022; Ramelli & Wagner, 2020; Spatt, 2020). Accounting and finance scholars promptly uncovered several crises shields that contribute to market resilience during COVID-19 outbreaks (Albuquerque, Koskinen, Yang, & Zhang, 2020; Bae, El Ghoul, Gong, & Guedhami, 2021; Demers, Hendrikse, Joos, & Lev, 2021; Ding, Levine, Lin, & Xie, 2020; Fahlenbrach, Rageth, & Stulz, 2021; Hoang, Arif, & Nguyen, 2022; Nguyen, Pham, & Truong, 2020, Nguyen, Pham, Pham, & Pham, 2022). Our study suggests that a transparent, reliable business system mitigates informed trading and thus contributes to rebuilding investor trust and corporate resilience in a crisis. Furthermore, given that insider trading has been a significant concern for practitioners and regulators for decades (Acharya & Johnson, 2007; Jagolinzer et al., 2011),[2] policymakers might consider this study's findings when designing policies to enhance market integrity and soundness in capital markets worldwide.

The rest of the paper is organized as follows. Section 2 discusses the related literature. Section 3 describes the data, variables' measurements, and descriptive statistics. Section 4 presents the empirical results, and Section 5 concludes.

[2] Though not all insider transactions are illegal, insider trading can cause information efficiency of prices to break down (Laffont & Maskin, 1990), challenging market integrity (Acharya & Johnson, 2007; Krawiec, 2000; Park, 2018).

2. Related literature

2.1. Uncertainty, information advantage, and informed trading

Our paper is directly related to two strands of literature: (1) literature on the relationship between uncertainty and information advantage and (2) literature on information advantage and informed trading. The first strand of literate has recently been discussed. Nagar et al. (2019) document that economic policy uncertainty is positively associated with information asymmetry among investors by increasing bid–ask spreads and reducing stock price reaction to earnings surprises. Bird et al. (2017) show that political uncertainty can reduce corporate transparency by increasing trading costs and decreasing analyst information production. Moreover, Chiang et al. (2017) and Seyhun (1992) find that private information is more valuable under less efficient market conditions. As a result, corporate insiders tend to have more information advantages when the financial markets are more uncertain and less efficient.

Unlike the first strand of literature, the relationship between information advantage and informed trading is well established. The extant literature documents that insiders have an information advantage concerning firms' future fundamentals (Jiang & Zaman, 2010; Lakonishok & Lee, 2001; Seyhun, 1992) and can incorporate this advantage into their trading strategies for profit-making, either by having advanced information about future cash flow or identifying mispricing opportunities of other investors. Supporting the former channel, Elliot, Morse, and Richardson (1984) find that insiders tend to make a significant purchase before an extreme increase in future earnings. Similarly, Piotroski and Roulstone (2005) document that insider trading positively correlates with a firm's future earnings performance and book-to-market ratio. Ke, Huddart, and Petroni (2003) find that insiders process the "knowledge of specific and economically significant forthcoming accounting disclosures" about two years before public disclosure. The authors also show that stock sales by insiders increase before a "break in a string of consecutive increases" in firms' quarterly earnings (Ke et al., 2003). More recently, Ali and Hirshleifer (2017) argue that insiders can profit by trading stocks before firms' earnings announcements.

The literature on the relationship between insider trading and mispricing is also broadly documented. For example, Seyhun (1992) finds that insiders tend to go long on stocks after periods of significant price decline but sell stocks following a significant increase in prices. Rozeff and Zaman (1988) document that insiders tend to buy value firms' shares but sell glamour shares. Thus, insiders are contrarian investors with superior information (Alldredge & Cicero, 2015; Lakonishok & Lee, 2001). As a result, insiders can generate abnormal returns (Lin & Howe, 1990).

An increase in insider trading can be found in other distraction periods, such as granting CEO options and cutting dividends (Kempf, Manconi, & Spalt, 2017), earnings disappointments (Billings & Cedergren, 2015), earnings misstatements (Agrawal & Cooper, 2015), the issuing of the Sarbanes–Oxley Act (Brochet, 2010), IPO lockup expiries (Cao, Field, & Hanka, 2004), corporate bankruptcy (Seyhun & Bradley, 1997), or climate disasters (Ma et al., 2020). Gokalp, Keskek, Kumas, and Geiger (2019) find that corporate executives are significant sellers of personal shares before the announcement of auto recalls; however, not all insider transactions generate abnormal profits based on information advantage. For instance, Eckbo and Smith (1998) find that insiders of firms listed on the Oslo Stock Exchange do not earn abnormal returns. Similarly, insiders of financial firms appear to have been unaware of the timing and extent of the 2007–2009 financial collapse (Adebambo, Brockman, & Yan, 2015).

At an aggregate level, Lakonishok and Lee (2001) use insider trading activities of all companies traded on the NYSE, AMEX, and NASDAQ between 1975 and 1995, showing that insiders can predict market movement and aggregate insider trading can be used to time markets. Similarly, Seyhun (1992) documents that insiders sold heavily before the market crash of October 1987 and bought heavily after the crash, which is consistent with the argument that insider profit from public information when other investors are inattentive (Alldredge & Cicero, 2015). Jiang and Zaman (2010) find that aggregate insider trading strongly correlates with aggregate market returns and unexpected cash-flow news.

Economic uncertainty exaggerates the information asymmetry between corporate insiders and outsiders (Nagar et al., 2019) and the value of private information; thus, economic uncertainty increases the likelihood that insiders arbitrage their superior information status (Li, 2020). Consistent with this argument, Ma et al. (2020) show that insiders tend to trade more and reap profits following climate disasters, while Lin, Sapp, Ulmer, and Parsa (2020) document evidence of insider selling several months before the announcement of a cybersecurity breach.

2.2. Informed trading in crises

A growing body of literature focuses on the trading behavior of corporate insiders in crises. For example, Seyhun (1990) found many insider purchases immediately after the 1987 crash. Agrawal and Cooper (2015) examine a sample of firms to determine whether insiders have strong incentives to sell before the revelation of accounting scandals, finding that top insiders tend to sell substantially more during the misstated period. Cziraki (2018) finds abnormal sales by insiders in banks more exposed to a crisis before the 2007–2008 pre-financial crisis. Song and Wang (2020) suggest that the trading of gray institutions before a crisis predicted banks' abnormal returns around the Lehman bankruptcy. Shen, Hui, and Fan (2021) show that REIT insiders reduce their holdings significantly before a financial crisis. Akin, Marín, and Peydró (2020) indicate that bank insiders' sales can predict the cross-section of bank returns during the 2007–2008 crisis. Jagolinzer et al. (2020) show that, during the 2008–2009 financial crisis, corporate insiders can exploit their information advantage from their political connections with profit-making strategies.

Insider trading frequently occurring in pre-crisis periods can be attributed to the argument that insiders tend to have a better understanding of the market and their private information is more valuable during periods of significant market disruption (Seyhun, 1992). As a result, insiders can forecast firms' future cash flows and risks concerning changes in economy-wide factors not yet reflected in firms' current stock prices. Furthermore, informed traders can identify mispricing opportunities because of macroeconomic shocks.

The emergence of infectious diseases in the last two decades and the recent COVID-19 outbreaks have imposed unprecedented disruptions and uncertainty (Baker et al., 2020; Bloom, Daniel, & Sevilla, 2018; Bloom, Kuhn, & Prettner, 2020). The extant literature has not thoroughly examined how informed traders respond to disease outbreaks; prior studies mainly focus on the trading behavior of certain groups of investors in the pharmaceutical industry (Berkman & Eugster, 2017; Donadelli, Kizys, & Riedel, 2017)[3] or insider trading of firms with active connections to China (Henry, Plesko, & Rawson, 2022).[4] We attempt to address this literature gap by studying the information content of insider transactions during disease outbreaks.

In a concurrent paper, Anginer, Donmez, Seyhun, and Zhang (2020) show that insiders sold shares in January and February but purchased in late February 2020 in the US, Canada, China, Italy, Spain, and South Korea. Our paper differs from Anginer et al. (2020) in the following ways. First, while Anginer et al. (2020) focus on insider trading during the COVID-19 pandemic, our paper's focus is two-fold. (i) We first examine how insiders respond to all global infectious disease outbreaks when the data is available. (ii) We then study how different institutional backgrounds (e.g., information disclosure requirements, public enforcement, judiciary system, investor protection, and cultural dimensions) moderate insider behavior when health disasters strike. Second, we provide underlying mechanisms for insider transactions during health outbreaks. We hypothesize that the COVID-19 pandemic led to high macroeconomic uncertainty, resulting in high information asymmetry between insiders and outsiders and increasing the value of private information. This situation increases the likelihood that insiders can arbitrage their information advantage. Third, we utilize a novel measure of governments' stringency index to examine whether and to what extent government policy responses affect insider behavior during health disaster outbreaks. Fourth, Anginer et al. (2020) employ the US market crash period (February 20 to March 20, 2020) as a crash period for all six countries in their sample. In contrast, we manually search World Health Organization (WHO) reports for the date when the first infected case was confirmed in each country, which we use as a milestone to define the pre-, during-, and post-pandemic periods for each infectious disease. Finally, we (i) consider different types of insider trading (e.g., routine transaction and non-routine transactions), (ii) provide more extensive checks for robustness, (iii) consider other infectious diseases, and (iv) study the nature of insider transactions conditioned on firm exposure to the health disasters. The following sections present our data, methodology, and empirical setting.

3. Data, variables, and descriptive statistics

3.1. Data

Our data are from several data sources. We obtain insider trading data from the 2iQ Research database, which provides a complete historical insider transaction data set. The database contains around 8 million transactions from over 200,000 insiders across 50 countries, with an average history across all regions of 12 years. Following the market microstructure literature (Beneish & Vargus, 2002; Cohen et al., 2012; Dai, Parwada, & Zhang, 2015; Frankel & Li, 2004), we screen the transactions for open market purchases and sales by insiders; we exclude all other types of transactions including awards, options, trades with corporations, and other transactions. We then aggregate individual insider transactions to firm-level insider data to capture the insider trading pattern around infectious disease outbreaks.

To examine insider behavior during the COVID-19 outbreaks, we use daily insider transaction information for each infectious disease and construct corresponding samples that capture all insider trades before, during, and after the outbreaks. We collect disease outbreak data from the WHO website, including the date of the first confirmed human case of COVID-19, general information on the total number of infected cases, and the death toll caused by the disease to June 30, 2020, at the time of writing this paper. As COVID-19 outbreaks started around late 2019 and early 2020, we collect and construct the COVID-19 insider trading sample from January 2017 (i.e., two years before the outbreak) to June 2020. This timeframe allows us to (i) capture changes in insider trade during the normal and outbreak periods and (ii) account for potential seasonality in insider transactions (Cohen et al., 2012; Jagolinzer et al., 2011). Our sample ends in the second quarter of 2020, the latest available data at the time of writing this paper. After removing countries with low transaction records (i.e., we exclude countries with fewer than 1000 insider transactions during the sample period), 25 countries remain in our sample with 244,909 daily observations around the COVID-19 outbreak. Table 1 presents the number of infected cases and deaths caused by COVID-19 in each sample country.

We obtain firm-level financial data from the COMPUSTAT and CRSP databases for 25 countries and territories from January 2017 to June 2020. We source country characteristics and governance data from several sources. Specifically, we use Djankov et al.'s (2008) revised Anti-Director Rights Index and Public Enforcement Index and Oxford University's COVID-19 Government Tracker Stringency Index (governments' responses to COVID-19). The government response index measures the number and strictness of government policies on the COVID-19 using 21 indicators in 4 areas: (1) **containment and closure policies, (2) economic policies, (3) health system policies, and (4) economic support index**. A higher index value indicates more government responses (more policies) issued.[5]

[3] Berkman and Eugster (2017) find that short sales significantly rise in the days leading to drug development announcements with a poor announcement return. Donadelli et al. (2017) show that disease-related news has a positive sentiment among Wall Street investors.

[4] Henry et al. (2022) show that insiders of firms with operational connections to China profit from frequent stock sales following the beginning of the COVID-19 period. The authors argue that these insiders better understand the implications of publicly available information about COVID-19 and act sooner than those in firms without operational connections to China (Henry et al., 2022).

[5] More detailed information can be found at https://www.bsg.ox.ac.uk/research/covid-19-government-response-tracker.

We collect the efficiency of the judiciary index from La Porta, Lopez-de-Silanes, and Shleifer (2006), which captures the strength of a country's legal enforcement. We obtain the Investor Protection Index and the information disclosure requirement representing business transparency from La Porta et al. (2006). We use four cultural dimension indices developed by Hofstede (2001) to proxy cultural differences between countries. Finally, we adopt a novel consumer panic index (*PANIC*), representing the demand for some essential supermarket goods, developed by Keane and Neal (2021).

3.2. Variables

We follow prior literature and construct three measures of insider trading direction: (i) the net purchase ratio (*N*SPR) proposed by Lakonishok and Lee (2001); (ii) the trade direction ratio (*TDR*); and (iii) the net value purchase ratio (*NVPR*) (Bui, Nguyen, & Pham, 2021). Since we focus on trade direction (i.e., net insider purchase or sale), the measures are computed as follows:

$$Insider\ Trade = \frac{\sum_j Buy_{i,t} - \sum_j Sell_{i,t}}{\sum_j Buy_{i,t} + \sum_j Sell_{i,t}} \quad (1)$$

where *Buy* is the number of insider purchases, the number of insider shares purchased, or the value of firm *i*'s insider shares purchased during day *t*. *Sell* is the number of insider sales, number of insider shares sold, or the value of firm *i*'s insider shares sold during day *t*. Computation eventually generates three measures of net insider trade direction based on the trade frequency (number of insider trades [*TDR*]), trading volume (net insider shares purchased [*NSPR*]), and traded value (net insider purchased value [*NVPR*]). We use these insider trade direction measures to capture the insider trading pattern from different angles, providing a more comprehensive understanding of how corporate insiders react to the COVID-19 pandemic.

As we focus on insider trading during disease outbreaks, it is crucial to define the outbreak periods. We use three dummy variables to capture the pre-, during-, and post-pandemic periods. We chose a 30-day window with the central event as the date of each country's first confirmed infected case. For each country, the pandemic period is 30 days, beginning from when the first infected case was confirmed; the pre-pandemic period (post-pandemic period) is 30 days before (after) the pandemic period. We chose this window for several reasons. First, insiders are likely to act on inside information and trade weeks ahead of the public. Second, information about infectious diseases, unlike other insider information, is not publicly visible until the relevant authority of a given country confirms the first infected case. Insider trading could start around the time of this confirmation before the disease outbreak worsens quickly. In addition, some insiders might grasp the information of the first probable-but-not-yet-confirmed case before the information is made available to the public and, therefore, can trade "ahead of the market." This results in a set of dummy variables for COVID-19 outbreaks: *PRE_COVID19*, *COVID19*, and *POST_COVID19*.

To control for firm-level characteristics associated with informed trading, we follow the literature (Bui et al., 2021; Kallunki et al., 2016; Lakonishok & Lee, 2001; Piotroski & Roulstone, 2005; Rozeff & Zaman, 1988) and use several commonly-used control variables. They include firm size (*LOGSIZE*), measured as the natural logarithm of the book value of total assets; financial leverage (*LEVERAGE*), defined as the ratio of total debts to total assets; the price-to-earnings per share ratio (*PRICE_TO_EARNINGS*); the price-to-book value per share ratio (*PRICE_TO_BOOK*); and the return-to-asset ratio (*ROA*). We use firm fundamental data sourced from the COMPUSTAT database in the most recent quarter. To alleviate the potential impact of outliers, we winsorize all continuous variables at the 1st and 99th percentiles.

3.3. Descriptive statistics

We start our analysis by considering whether capital market participants pay increasing attention to insider transactions during health disaster outbreaks. We follow Da, Engelberg, and Gao (2011) to capture investor attention promptly, using Google search queries for infectious disease and insider trading keywords. As a search is a revealed attention measure (Da et al., 2011), if a person searches for infectious disease and insider trading on Google, they are undoubtedly paying attention to these topics; Appendix A3 shows the Google search index (SVI) for these two keywords from January 2017 to June 30, 2020, indicating that investors generally pay more attention to insider transactions during the COVID-19 outbreaks.

Table 2 presents the sample distribution by country/territory and descriptive statistics of this study's variables. In Panel A, Table 2, we show that 46.18% of insider trades in the sample are from the US, followed by Canada (13.42%), China (6.15%), Malaysia (5.89%), and the Republic of Korea (4.26%). Other countries/territories in the sample constitute smaller portions, ranging from 0.15% (Russia) to 2.92% (Thailand).

Panel B of Table 2 summarizes the average values of the three insider trading measures for the COVID-19 outbreaks in each country and the entire sample. In China and the US, the first and the most affected countries by COVID-19, respectively, the insider trading measures consistently indicate a sell direction. In contrast, corporate insiders tend to buy more stocks than they sell. The statistics in Panel B, Table 2 suggest a vast variation in insider trading direction across countries.

Panel C, Table 2, presents the descriptive statistics of variables used in this study. For example, the average *TDR*, *NSPR*, and *NVPR* values for the full sample range from −0.110 to −0.109, suggesting that insiders worldwide prefer to sell rather than purchase during a health disaster. The logarithm of firm size ranges from 2.81 to 27.33, while leverage is from 0.00% to 79.60%. Similarly, the average return on asset (ROA) is −0.40%, and the average price to earnings is 68.66.

Table 1
COVID-19 outbreaks.

Country	COVID-19		Population Density (2018)	Disease Prevalence Index
	Infected cases	Deaths		
Australia	24,602	104	3.25	−0.25
Canada	103,250	8522	4.08	−1.31
China	85,227	4648	148.35	1.03
Egypt	66,754	2872	98.87	0.44
France	156,930	29,730	122.30	−0.46
Germany	194,259	8973	237.31	−0.87
Greece	3390	191	83.27	0.08
Hong Kong	1206	7	7096.19	0.27
India	566,840	16,893	454.94	0.94
Indonesia	55,092	2805	147.75	0.63
Italy	240,436	34,744	205.42	0.16
Malaysia	8637	121	95.96	0.50
New Zealand	1178	22	18.39	−0.98
Philippines	36,438	1255	357.69	0.50
Republic of Ireland	25,462	1735	70.65	−0.45
Republic of Korea	12,800	282	529.36	−0.11
Russia	647,849	9320	8.82	−0.39
Singapore	43,661	26	7952.99	0.31
South Africa	144,264	2529	47.63	0.11
Spain	249,255	28,394	93.68	−0.05
Sweden	67,667	5310	24.98	−0.98
Switzerland	31,569	1681	215.47	−1.08
Thailand	3171	192	135.90	0.64
United Kingdom	283,545	40,341	274.71	−1.01
United States	2,452,048	125,318	35.71	−0.89

This table presents information on COVID-19 outbreaks from January 2017 to June 2020 in 25 countries and territories. "-" means no outbreak of the corresponding disease in the given country or territory. The number of infected cases and death toll by country are updated until June 30, 2020. The Historical Disease Prevalence Index is from Murray and Schaller (2010).

4. Empirical findings

4.1. Univariate analysis

We conduct a mean difference test for each insider trade direction measure between the during-pandemic period and the average of the pre- and post-pandemic periods. Table 3 presents the results of this test, indicating in the first row that, on average, insiders sell 38% more during the COVID-19 month compared with other periods. The *p*-values are less than 0.00, significant at the 1% level. Table 3 demonstrates that the insider selling patterns at the start of the COVID-19 outbreaks are persistent in most countries in our sample; however, there is evidence of insider buying in Hong Kong, Indonesia, and Switzerland.

Overall, the results in Table 3 show that insiders are likely to sell more during a month starting when a country confirms its first case (i.e., the during-pandemic period) than in the pre- and post-outbreak periods.

4.2. Regression analysis

We examine the insider trade direction during disease outbreaks using regression models where we can simultaneously control for firm fundamentals and time fixed effects. We use the following regression model:

$$InsiderTrade_{i,t} = PRE_t + PANDEMIC_t + POST_t + CONTROL_{i,t} + \delta_i + \phi_i + \varepsilon_{i,t} \quad (2)$$

where $InsiderTrade_{i,t}$ refers to the three measures of insider trade direction of firm *i* during time *t*. *PANDEMIC* refers to the COVID-19 dummy defined in the previous section, and $CONTROL_{i,t}$ is the vector of firm characteristic variables. δ_i and ϕ_i are the firm fixed effects and year-month fixed effects, respectively. Guided by prior studies (Kallunki et al., 2016; Lakonishok & Lee, 2001; Piotroski & Roulstone, 2005), we control for a range of firm-level characteristics that can affect informed trading, including firm size (*LOGSIZE)*, leverage ratio (*LEVERAGE)*, the price-to-earnings ratio (*PRICE_TO_EARNING)*, price-to-book ratio (*PRICE_TO_BOOK*), and return-to-asset ratio (*ROA*). We use firm fixed effects and year-month fixed effects to control for firm-specific heterogeneity and time-specific unobservable factors that may be related to insider transactions. We also include country-month fixed effects to account for country-specific factors during a given year-month (Angrist & Pischke, 2008). Table 4 presents the results of the regression analysis.

Table 4 shows the estimated results of insider trading behavior around COVID-19 outbreaks. We report the results for regression models without (Columns 1–3) and with the control variables (Columns 4–6). The results in Columns 1–3 report significantly negative *PRE_COVID-19* and *COVID-19* coefficients across all insider direction measures, suggesting that insiders start selling a month before the first confirmed case date until a month after that date. The coefficients of the *COVID-19* dummy are significantly stronger than that of

Table 2
Descriptive statistics.

Panel A. Sample distribution by country/territory

No.	Country / Territory	N	Shares of total (in %)
1	Australia	4390	1.79
2	Canada	32,879	13.42
3	China	15,065	6.15
4	Egypt	946	0.39
5	France	4080	1.67
6	Germany	1924	0.79
7	Greece	1072	0.44
8	Hong Kong	891	0.36
9	India	6960	2.84
10	Indonesia	5279	2.16
11	Italy	2583	1.05
12	Malaysia	14,419	5.89
13	New Zealand	608	0.25
14	Philippines	2127	0.87
15	Republic of Ireland	1289	0.53
16	Republic of Korea	10,426	4.26
17	Russia	373	0.15
18	Singapore	3.126	1.28
19	South Africa	1452	0.59
20	Spain	1107	0.45
21	Sweden	5770	2.36
22	Switzerland	2492	1.02
23	Thailand	7162	2.92
24	United Kingdom	5380	2.20
25	United States	113,109	46.18
	Total	**244,909**	**100**

Panel B. Insider trading variables by country/territory

Country/Territory	*TDR*	*NSPR*	*NVPR*
Australia	0.518	0.518	0.518
Canada	0.231	0.228	0.228
China	−0.660	−0.664	−0.664
Egypt	0.728	0.727	0.727
France	0.040	0.038	0.040
Germany	0.617	0.617	0.617
Greece	0.851	0.842	0.842
Hong Kong	0.779	0.779	0.779
India	−0.084	−0.086	−0.086
Indonesia	0.423	0.405	0.405
Italy	0.378	0.373	0.373
Malaysia	0.417	0.416	0.417
New Zealand	0.636	0.636	0.636
Philippines	0.616	0.627	0.627
Republic of Ireland	0.053	0.063	0.063
Republic of Korea	0.301	0.309	0.309
Russia	0.051	0.103	0.117
Singapore	0.381	0.374	0.374
South Africa	0.566	0.557	0.557
Spain	0.607	0.607	0.607
Sweden	0.454	0.447	0.447
Switzerland	0.413	0.508	0.508
Thailand	0.622	0.623	0.623
United Kingdom	0.242	0.239	0.239
United States	−0.669	−0.669	−0.669

Panel C. Summary statistics

Variable	N	Mean	Std.dv	Min	Max
Firm-level variables					
TDR	244,909	−0.177	0.974	−1.000	1.000
NSPR	244,909	−0.179	0.976	−1.000	1.000
NVPR	244,909	−0.178	0.976	−1.000	1.000

(*continued on next page*)

Table 2 (*continued*)

Panel C. Summary statistics					
Variable	N	Mean	Std.dv	Min	Max
LOGSIZE	244,909	12.835	7.594	2.810	27.331
LEVERAGE	244,909	0.180	0.187	0.000	0.796
ROA	244,909	−0.004	0.055	−0.276	0.109
PRICE_TO_EARNINGS	244,909	68.663	545.084	−1274.948	5016.935
PRICE_TO_BOOK	244,909	4.220	27.303	0.000	273.364
COVID_RISK	119,526	0.005	0.046	0.000	1.817
NRT	244,909	0.719	0.449	0.000	1.000
Macro-level variables					
COVID-19	42	0.014	0.116	0.000	1.000
PRE_COVID-19	42	0.021	0.143	0.000	1.000
POST_COVID-19	42	0.039	0.193	0.000	1.000
GOV_RESPONSE	42	5.333	17.874	0.000	100.000
ENFORCE	42	0.777	0.189	0.217	0.900
JUDICIARY	42	8.996	1.850	2.5000	10.000
ADR	42	4.350	1.133	1.000	5.000
INV_PRT	42	0.830	0.248	0.000	1.000
DISCLOSE	42	0.906	0.141	0.333	1.000
IDV	42	69.186	28.907	14.000	91.000
UAI	42	47.525	13.957	8.000	100.000
LTO	42	40.880	21.804	7.000	100.000
MAS	42	56.027	11.567	5.000	70.000
PANIC	42	0.075	0.345	0.000	7.874
US State-level variables					
STATE_RESPONSE	2268	36.856	26.121	0.000	85.260
CONTAINMENT_INDEX	2268	38.296	26.778	0.000	87.120

Panel A shows the sample distribution by country/territory; N is the number of firm-month observations. The study period is from January 2017 to June 2020, covering the pre-COVID-19 and the pandemic's start.

Panel B presents the average value of insider trading measures in our sample for each country and territory. The insider trading variables are (i) the Trade Direction Ratio (TDR); (ii) the Net Purchase Ratio (*NSPR*); and (iii) the Net Value Purchase Ratio (*NVPR*). *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded. *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value; "-" means that there was no outbreak of the corresponding disease in the given country or territory or there was no insider trade documented during the month of the first confirmed case.

Panel C presents the descriptive statistics of firm-level, macro-level, and US state-level variables used in this study. Variables descriptions are in Appendix A1. The study period is from January 2017 to June 2020, covering the pre-COVID-19 and the pandemic's start.

PRE_COVID-19, indicating significant selling during the COVID-19 outbreaks once a country confirms its first case. In more detail, during the month of the first confirmed COVID-19 case, the TDR dropped by 6.9%, the net purchase ratio (NSPR) dropped by 7.1%, and the NVPR dropped by 7.2% after controlling for firm characteristics, time, and country effects. Table 4 shows that the coefficient of *POST_COVID-19* is positive and significant, revealing that insiders are likely to buy more than sell in the month after the first-case confirmation. Statistically, the net purchase ratio and NVPR increase by 9.0% and 8.8%, respectively, after considering the effect of the control variables.[6]

Table 4 shows consistent results across different model specifications, indicating a pattern of insider selling during the three infectious disease outbreaks. Our evidence illustrates the overwhelming panic among investors in capital markets during the COVID-19 outbreaks (Albulescu, 2020; Haroon & Rizvi, 2020). Furthermore, our results indicate that insiders, who have superior private information about their firms, can better incorporate macro shock into their trading decisions.

[6] In our further analysis, we re-perform the regression of Model (2) for the cases of MERS and H1N1 outbreaks using a similar research setting for each disease. We find similar insider trading patterns during the outbreaks of MERS and H1N1. We present the results of these additional analyses in Appendix A8. Throughout the paper, we focus on the COVID-19 health outbreaks because (i) the uncertainty accelerated by COVID-19 is far beyond that generated by other infectious diseases (Baker et al., 2020) and (ii) data for the cross-sectional analysis surrounding the health outbreaks are not available for the previous infectious diseases. Furthermore, to ensure that our empirical findings are not driven by the large portion of insider trades in the US (46.18% of the total observations in our sample), we re-estimate the baseline regression after excluding all observations from the United States. The estimation results are reported in Appendix A9. In general, the results align with those reported in the full sample regression in Table 4, thus mitigating the concern that our results are driven by insider trading in the US We acknowledge the referee to suggest this topic.

Table 3
Insider trading around the COVID-19 outbreaks: Univariate analysis.

	COVID-19: Average of (PRE-COVID19, POST-COVID19)		
	TDR	NSPR	NVPR
All countries	**−0.379*****	**−0.380*****	**−0.380*****
Australia	−0.284***	−0.284***	−0.284***
Canada	−0.237***	−0.236***	−0.235***
China	−0.245***	−0.245***	−0.245***
Egypt	0.138**	0.134**	0.134**
France	−0.298***	−0.302***	−0.300***
Germany	−0.214***	−0.211***	−0.211***
Greece	0.001	0.008	0.007
Hong Kong	0.226**	0.219**	0.219**
India	−0.565***	−0.570***	−0.570***
Indonesia	0.186***	0.170***	0.167***
Italy	−0.166**	−0.170**	−0.170**
Malaysia	−0.176***	−0.173***	−0.173***
New Zealand	0.458***	0.455***	0.454***
Philippines	−0.084*	−0.066	−0.066
Republic of Ireland	0.787***	0.796***	0.796***
Republic of Korea	−0.333***	−0.329***	−0.329***
Russia	−0.456***	−0.390**	−0.380**
Singapore	−0.220***	−0.223***	−0.223***
South Africa	0.203**	0.188**	0.188**
Spain	−0.095	−0.094	−0.094
Sweden	−0.108***	−0.108***	−0.108***
Switzerland	0.504***	0.500***	0.500***
Thailand	−0.206***	−0.203***	−0.203***
United Kingdom	−0.147***	−0.147***	−0.146***
United States	−0.467***	−0.469***	−0.469***

This table presents the mean difference tests of insider trading variables before, during, and after the month when the first case of COVID-19 was confirmed in a given country. The insider trading measures include (i) the Trade Direction Ratio (*TDR*), (ii) the Net Purchase Ratio (*NSPR*), and (iii) the Net Value Purchase Ratio (*NVPR*) in the month of the first confirmed case of a particular health disaster. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded. *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable that equals 1 if the insider trading measures are in the month of the first COVID-19 confirmed case in a country and 0 otherwise. *PRE* is a dummy variable equal to 1 if insider trading measures are in the month before the date of the first confirmed case of the disease in a country and 0 otherwise. *POST* is a dummy variable equal to 1 if insider trading measures are present in the month following the date of the first confirmed case of the disease in the country, and 0 otherwise; "-" means that there was no outbreak of the corresponding disease in the given country or territory, or there was no insider trade documented during the month of the first confirmed case. ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

4.3. Insider trading around COVID-19 outbreaks across industries

The devastating impact of the COVID-19 pandemic has been witnessed worldwide and, as Baker et al. (2020, p. 742) note, *"no previous infectious disease outbreak, including the Spanish Flu, has affected the stock market as forcefully as the COVID-19 pandemic."* The COVID-19 pandemic can be considered a once-in-100-year event, globally impacting all aspects of society, politics, and the economy (Goodell, 2020). The uncertainty accelerated by COVID-19 is far beyond that generated by other infectious diseases, such as the Middle East Respiratory Syndrome (MERS) or H1N1 influenza (Baker et al., 2020).

Fig. 1 presents the cumulative stock market returns of the countries and territories in our sample most and least affected by COVID-19.[7] Given the unprecedented consequences of the COVID-19 pandemic,[8] we conduct further analyses focusing on its adverse impact on insider trading when uncertainty has emerged from the disease outbreaks.

Some industries can be more affected by a pandemic than others (McKinsey & Company, 2020); therefore, we examine the impact of COVID-19 outbreaks on insider transactions across industries. Table 5 reports the differences in insider trading direction between the COVID-19 period and the average value of pre- and post-COVID-19 periods across the Fama-French 17 industries.

Generally, Table 5 shows that insiders buy less and sell more during COVID-19 in all industries except the food industry, which produces essential goods for daily consumption; thus, it might not be as impacted by the pandemic. The *p*-values of the coefficients are

[7] The classification is based on the number of COVID-19 infected cases by country to June 30, 2020, the time of writing the paper.

[8] We illustrate the impact of the COVID-19 pandemic on economic policy uncertainty and market volatility in Appendices A4 and A5. Appendix A4 presents the global economic policy uncertainty index from 1997 to 2020, while Appendix A5 presents the market volatility index in the US, the country worst hit by COVID-19. The global economic uncertainty surrounding the COVID-19 pandemic exceeds that of the 2008–2009 Global Financial Crisis or the Asian Financial Crisis in 1997–1998; however, market volatility during the COVID-19 pandemic is similar to that of the 2008–2009 Mortgage Crisis.

Table 4
Insider trading around COVID-19 outbreaks.

Variable	Regression without control variables			Regression with control variables		
	(1)	(2)	(3)	(4)	(5)	(6)
	TDR	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*
PRE_COVID-19	−0.055*	−0.057*	−0.057*	−0.050	−0.052*	−0.052*
	(−1.784)	(−1.820)	(−1.835)	(−1.636)	(−1.673)	(−1.686)
COVID-19	−0.075***	−0.077***	−0.078***	−0.069***	−0.071***	−0.072***
	(−2.968)	(−3.015)	(−3.065)	(−2.737)	(−2.785)	(−2.831)
POST_COVID-19	0.089***	0.087***	0.085***	0.092***	0.090***	0.088***
	(5.332)	(5.177)	(5.091)	(5.507)	(5.352)	(5.270)
LOGSIZE				−0.041***	−0.041***	−0.041***
				(−12.922)	(−12.879)	(−12.962)
LEVERAGE				0.128***	0.127***	0.127***
				(5.458)	(5.383)	(5.404)
ROA				−0.029	−0.033	−0.033
				(−0.572)	(−0.653)	(−0.659)
PRICE_TO_EARNINGS				−0.000***	−0.000***	−0.000***
				(−2.964)	(−2.844)	(−2.858)
PRICE_TO_BOOK				0.000	0.000	0.000
				(0.957)	(0.862)	(0.881)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	243,032	243,032	243,032	243,032	243,032	243,032
Number of countries	25	25	25	25	25	25
Adjusted R-squared	0.598	0.595	0.595	0.599	0.596	0.596

This table reports the regression results of insider trading measures on the event window variables. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded. *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable equal to 1 if insider trading measures are in the month of the first confirmed COVID-19 case in a country and 0 otherwise. *PRE_COVID-19* is a dummy variable that equals 1 if the insider trading measures are present in the month starting on the date of the first confirmed case of COVID-19 in a country and 0 otherwise. *POST_COVID-19* is a dummy variable that equals 1 if insider trading measures are present in the month starting on the date of the first confirmed case of COVID-19 in a country and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio. *ROA* is the return-on-assets ratio. *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio. *PRICE_TO_BOOK* is the price-to-book value per share ratio. The sample period is from January 2017 to June 2020. Firm fixed effects, year-month fixed effects, and country ×year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses. ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

smaller than 0.00 and significant at the 1% level. Insiders of firms in consumer durables, automobiles, and transport industries exhibit the most significant sales during COVID-19 compared with other industries. Industries with the lowest sales by insiders are mining and minerals, oil and petroleum products, drug-soap-perfumes-tobacco, and construction material sectors. The results confirm the devastating consequences of COVID-19 and the heightened risk aversion exacerbated by the pandemic, which triggered insider selling in anticipation of a stock market plummet.[9]

Unsurprisingly, insiders tend to sell more in the automobile and consumer durables sectors since the demand for transport decreases, and employees tend to reduce non-essential consumption during health disaster outbreaks due to concerns about job security. Interestingly, retail stores, fabricated products, and textile apparel and footwear sectors are not among the industries hard hit by COVID-19, partially because of online sales expectations. For example, online sales in the US grew by over 100% in March and up to 275% in April 2020 as consumers ordered more online for delivery.[10] Overall, Table 5 conclusively shows a clear pattern of insider selling and confirms the tremendous negative impact of the COVID-19 pandemic on the global economic outlook.

4.4. The impact of government response and institutional settings during the pandemic

The empirical results reported in Tables 4 and 5 indicate that insiders sell more during the month starting from the country's first confirmed case of COVID-19 (the *COVID-19* month). We further investigate whether various institutional characteristics and governments' responses to the pandemic affect the impact of COVID-19 on insider transactions.[11] These further analyses are motivated by two literature strands. These include (i) growing evidence from the health and psychological literature that the way each government

[9] Industries hit hardest by COVID-19 include transport, retail, and travel (https://www.usatoday.com/story/money/2020/03/20/us-industries-being-devastated-by-the-coronavirus-travel-hotels-food/111431804/, retrieved on May 20, 2020).
[10] Digital sales boost as fueled by COVID-19 (https://www.usatoday.com/story/money/2020/05/20/target-earnings-2020-digital-sales-grow-coronavirus/5226791002/, retrieved on May 20, 2020).
[11] We thank the Oxford COVID-19 Government Response Tracker for providing the governments' responses data.

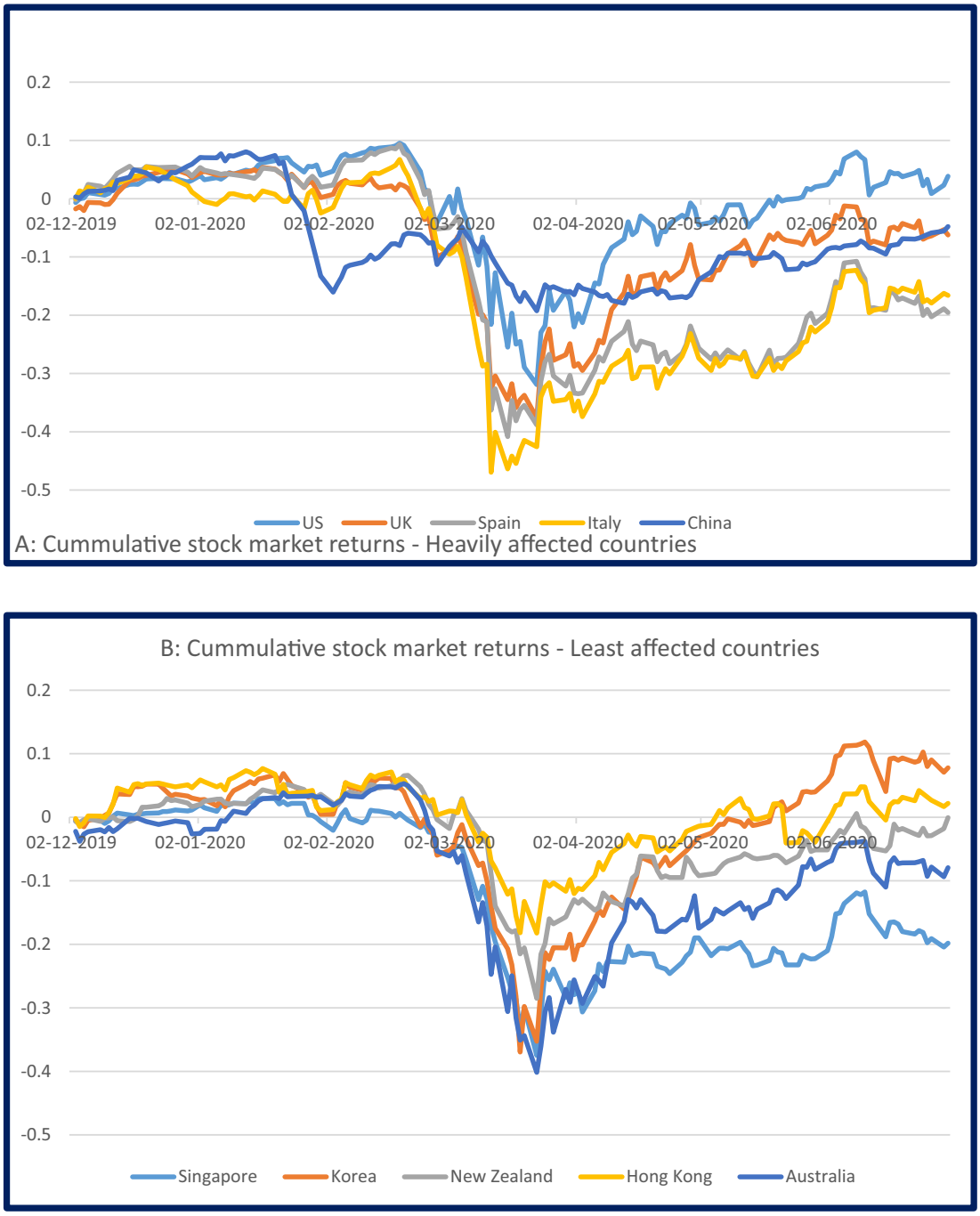

Fig. 1. Cumulative stock market returns in the most and least affected countries during COVID-19 from December 2019 to June 2020.
This figure plots the cumulative stock market returns of the countries and territories most and least affected by COVID-19 in our sample. The classification is based on the number of COVID-19 infected cases by country to June 30, 2020.

responds to local COVID-19 outbreaks can help reduce virus transmission and the adverse consequences of disease outbreaks (Al Saidi et al., 2020; Hale, Websrer, Perherick, Phillips, & Kira, 2020; Haug et al., 2020; Nguyen, Pham, Pham, & Pham, 2022; Nguyen, Pham, & Truong, 2023; Sergent & Stajkovic, 2020). Additionally, (ii) variations in institutional backgrounds across countries may affect insider transactions (Bui et al., 2021; Kallunki et al., 2016).

To test the possibility that institutional features matter for insider transactions during the pandemic, we collect data on various country characteristics and report the test results in Tables 6 and 7. The coefficients of COVID-19 across all model specifications in Table 6 (Columns 1 to 9) are negative and statistically significant, consistently supporting the insider selling pattern during the COVID-

Table 5
Insider trading around COVID-19 outbreaks across industries.

Industry		COVID-19: Average of (PRE-COVID19, POST-COVID19)		
		TDR	*NSPR*	*NVPR*
Food	Diff	−0.056	−0.051	−0.051
	t-stat	(−1.077)	(−0.980)	(−0.981)
Mining and Minerals	Diff	−0.163***	−0.169***	−0.169***
	t-stat	(−3.728)	(−3.843)	(−3.844)
Oil and Petroleum Products	Diff	−0.257***	−0.243***	−0.242***
	t-stat	(−4.114)	(−3.841)	(−3.828)
Textiles, Apparel, and Footwear	Diff	−0.401***	−0.390***	−0.390***
	t-stat	(−4.632)	(−4.454)	(−4.453)
Consumer Durables	Diff	−0.616***	−0.627***	−0.628***
	t-stat	(−8.140)	(−8.260)	(−8.283)
Chemicals	Diff	−0.473***	−0.475***	−0.475***
	t-stat	(−8.726)	(−8.761)	(−8.761)
Drugs, Soap, Perfumes, Tobacco	Diff	−0.305***	−0.309***	−0.311***
	t-stat	(−4.913)	(−4.982)	(−5.013)
Construction and Construction Materials	Diff	−0.214***	−0.213***	−0.213***
	t-stat	(−4.170)	(−4.111)	(−4.110)
Steel Works	Diff	−0.490***	−0.498***	−0.498***
	t-stat	(−5.439)	(−5.530)	(−5.531)
Fabricated Products	Diff	−0.379***	−0.372***	−0.371***
	t-stat	(−3.966)	(−3.873)	(−3.866)
Machinery and Business Equipment	Diff	−0.410***	−0.410***	−0.411***
	t-stat	(−10.377)	(−10.348)	(−10.358)
Automobiles	Diff	−0.590***	−0.600***	−0.601***
	t-stat	(−7.209)	(−7.330)	(−7.341)
Transport	Diff	−0.507***	−0.510***	−0.510***
	t-stat	(−7.369)	(−7.362)	(−7.363)
Utilities	Diff	−0.399***	−0.334**	−0.334**
	t-stat	(−2.669)	(−2.218)	(−2.217)
Retail Stores	Diff	−0.310***	−0.305***	−0.305***
	t-stat	(−4.316)	(−4.222)	(−4.221)
Banks, Insurance Companies, and other Financial Institutions	Diff	−0.456***	−0.458***	−0.458***
	t-stat	(−17.401)	(−17.375)	(−17.370)
Others	Diff	−0.361***	−0.360***	−0.360***
	t-stat	(−15.422)	(−15.312)	(−15.321)

This table presents the differences in insider trading variables before, during, and after the month of the first confirmed COVID-19 case across the Fama and French 17 industries. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded, and *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month starting on the date of the first confirmed COVID-19 case in a country and 0 otherwise. *PRE* is a dummy variable equal to 1 if insider trading measures are present in the month before the month of the first confirmed case of the disease in a country and 0 otherwise. *POST* is a dummy variable that equals 1 if insider trading measures are present in the month after the month in which the first COVID-19 case was confirmed in a country; otherwise, it is 0. ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

19 outbreak.

In Table 6, Columns 1–3, we examine how governments' stringent responses to COVID-19 moderate insiders' selling motives. The interaction terms between the three dummy variables (i.e., pre-, during-, and post-) and the stringency index are our variables of interest. The positive, significant coefficients on the interaction terms *COVID-19* × *GOV_RESPONSE* suggest that insiders sold less during the two months since the first confirmed COVID-19 case date in countries with more stringent government responses to COVID-19. Moreover, the interaction term of *POST_COVID-19* and *GOV_RESPONSE* is also significant, implying that insiders in countries with more government responses to COVID-19 tend to buy more after the first month of the COVID-19 pandemic. We find that the effect of government response policies becomes visible from the first-case confirmation date and contributes to mitigating insider selling practices on a global scale.

In Table 6, Columns 4–6, we consider the impact of public enforcement on insider trading. The Public Enforcement Index, developed by Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008), represents the strictness of punishment for law violations in a given country. We find that public enforcement does not affect insider trading before the first confirmed case; however, it helps reduce insider sales during the COVID-19 period and increase insider purchases after the first month of the outbreak. These results suggest that stringent punishment of any public infringement of COVID-19 containment helps reduce contagious transmission, leading to better virus containment and, hence, less panic selling among insiders. This optimism is factored into insider buying rather than selling during the COVID-19 period with increasing values of the coefficients of the *COVID-19* × *ENFORCE* to *POST_COVID-19* × *ENFORCE* interaction terms (i.e., 0.280 to 0.354, respectively, for *TDR* in Column 4).

Next, we examine whether and the extent to which the judiciary system's efficiency in a country diminishes the selling motives of insiders. An efficient judiciary system is vital to the development of a country because it can uphold social values, guarantee financial

market development, and contribute to economic performance (Falavigna, Ippoliti, & Manello, 2019; Ippoliti & Tria, 2020). The coefficients of the *COVID-19* × *JUDICIARY* and *POST_COVID-19* × *JUDICIARY* interaction terms are positively significant across different insider trading measures, suggesting that well-functioning judiciaries significantly impact insider trading. An efficient judiciary system can assure good resilience and firm growth after a pandemic; thus, insiders tend to buy rather than sell during a COVID-19 outbreak, and this effect is particularly strong during the post-COVID-19 period.

We further consider whether a country's business laws, such as high anti-director rights, investor protection law, and information disclosure requirements, impact insider trading during COVID-19. This analysis is motivated by literature documenting the significant impacts of countries' information environment and other institutional features on financial market outcomes (Cho, El Ghoul, Guedhami, & Suh, 2014; Djankov, McLiesh, & Shleifer, 2007; Eleswarapu & Venkataraman, 2006; Healy & Palepu, 2001; Houston, Lin, Lin, & Ma, 2010; La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998; Marshall, Nguyen, Nguyen, & Visaltanachoti, 2021; Nadarajah, Duong, Ali, Liu, & Huang, 2020; White, 2020). Table 7 presents the results of this test.

Consistent with the previous findings, these country characteristics have no significant impact on insider trading before a country's first confirmed case date since the interaction terms between *PRE_COVID-19*, and the characteristics are all statistically insignificant. In Table 7, Columns 1–6, we regress the indices of anti-director rights and investor protection on insider trading measures. Anti-director rights and investor protection are paramount to developing a country's financial markets because they ensure that shareholders' and creditors' rights are protected against expropriation by controlling shareholders and managers.

The coefficients of the *COVID-19* × *ADR* and *POST_COVID-19* × *ADR* interaction terms are significantly positive, indicating that insider selling is less pronounced in countries with stringent anti-director rights and strong investor protection. The results are consistent with prior studies, showing that strong investor protection can reduce opportunistic insider trading (Bhattacharya & Daouk, 2002; Kallunki et al., 2016).

Finally, we consider the requirements for information disclosure in Table 7, Columns 7–9. As La Porta et al. (2006) note, disclosure plays a key role in financial development since a reliable disclosure system can reflect investor sentiment, thus boosting investment and financial market development. We find that the coefficients of the *COVID-19* × *DISCLOSE* and *POST_COVID-19* × *DISCLOSE* interaction terms are all positive and statistically significant, suggesting that insider selling during COVID-19 is less pronounced among countries with high information disclosure requirements. This result might be attributable to the notion that a transparent, reliable business system can contribute to economic resilience after crises, especially after the unprecedented severity and exponential contagion of COVID-19 (Albulescu, 2020; Haroon & Rizvi, 2020).

We further examine whether cultural differences contribute to insider trading behavior heterogeneity during a pandemic. This analysis is motivated by a large body of literature documenting cultural dimensions in decision-making and ethical values (Cline, Williamson, & Xiong, 2021; Hofstede, 2001; Li et al., 2013; Meier-Pesti & Penz, 2008; Nevins et al., 2007). Specifically, Li et al. (2013) document a positive (negative) association between individualism (uncertainty avoidance) and corporate managers' risk-taking behavior. Nevins et al. (2007) show that long-term orientation positively affects ethical values in businesses, while Meier-Pesti and Penz (2008) use a sample with more masculine attributes to indicate that such individuals are likely to take more financial risks than their counterparts.

To test the possibility that culture impacts insider trading around the COVID-19 outbreaks, we use four cultural dimension indices developed by Hofstede (2001) to proxy cultural differences between countries and territories. These include individualism (*IDV*), uncertainty avoidance (*UAI*), long-term orientation (*LTO*), and masculinity (*MAS*). These dimensions demonstrate the cultural differences among countries, which impact the information acquisition and sharing among corporate insiders, as discussed in the Introduction. We incorporate these four cultural variables into the interaction terms with the event dummies to analyze the impact of culture on corporate insider transactions around disease outbreaks. Table 8 presents the results of these analyses.

Table 8, Columns 1–4, shows the insider trading measure (*TDR*) on each interaction term between the four cultural dimensions and the event dummies. In Column 1, the coefficients of the interaction terms *COVID-19* × *IDV* and *POST_COVID-19* × *IDV* are positive and significant at the 1% level, indicating that corporate insiders from individualistic cultures tend to buy rather than sell during and after the COVID-19 month. We also find positive, statistically significant coefficients of the interaction terms, *COVID-19* × *MAS* and *POST_COVID-19* × *MAS*, in Column 4, suggesting that corporate insiders from masculine cultures also sell less and buy more during and after the COVID-19 month. In contrast, the coefficients of the interaction terms *COVID-19* × *UAI* and *POST_COVID-19* × *UAI* (Column 2), *COVID-19* × *LTO* and *POST_COVID-19* × *LTO* (Columns 2 and 3) are negative and significant at the 1% level, revealing that corporate insiders in countries with higher degrees of uncertainty avoidance and long-term vision are likely to sell more during and after the COVID-19 month.[12] Our findings are consistent with previous studies on the impact of culture on risk-taking decisions.

4.5. Market panic and different types of insider transactions during the COVID-19 outbreak

This subsection examines possible mechanisms underlying insider selling during the month starting from the first confirmed COVID-19 date (the *COVID-19* month). We conduct two tests. First, we investigate whether COVID-19-induced panic induces insider transactions during the *COVID-19* outbreaks. Second, we study the nature of insider trading by considering different types of insider transactions.

[12] The results remain qualitatively unchanged when we use NSPR and NVPR as the proxy of insider trading in the regression (untabulated for brevity but available upon request).

Table 6
Insider trading around COVID-19 outbreaks: The impact of government response policies and public enforcement.

VARIABLE	Government response to COVID-19			Public enforcement			Efficiency of judiciary systems		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TDR	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*
PRE_COVID-19	−0.073**	−0.072**	−0.073**	0.007	0.009	0.012	0.002	−0.004	−0.005
	(−2.228)	(−2.180)	(−2.210)	(0.082)	(0.109)	(0.140)	(0.015)	(−0.028)	(−0.040)
COVID-19	−0.111***	−0.111***	−0.113***	−0.248***	−0.226***	−0.225***	−0.234**	−0.225**	−0.231**
	(−3.748)	(−3.695)	(−3.764)	(−3.586)	(−3.226)	(−3.217)	(−2.310)	(−2.197)	(−2.260)
POST_COVID-19	0.065***	0.065***	0.063***	−0.140***	−0.129***	−0.130***	−0.167***	−0.162***	−0.170***
	(2.932)	(2.904)	(2.796)	(−3.533)	(−3.235)	(−3.253)	(−3.346)	(−3.203)	(−3.379)
PRE_COVID-19 × GOV_RESPONSE	−0.008	−0.010	−0.010						
	(−1.447)	(−1.601)	(−1.608)						
COVID-19 × GOV_RESPONSE	0.003**	0.002**	0.002**						
	(2.184)	(2.034)	(2.066)						
POST_COVID-19 × GOV_RESPONSE	0.001*	0.001*	0.001*						
	(1.913)	(1.755)	(1.829)						
PRE_COVID-19 × ENFORCE				−0.064	−0.071	−0.076			
				(−0.550)	(−0.600)	(−0.639)			
COVID-19 × ENFORCE				0.280***	0.245**	0.242**			
				(2.960)	(2.565)	(2.537)			
POST_COVID-19 × ENFORCE				0.354***	0.334***	0.333***			
				(5.939)	(5.568)	(5.550)			
PRE_COVID-19 × JUDICIARY							−0.004	−0.004	−0.004
							(−0.295)	(−0.263)	(−0.251)
COVID-19 × JUDICIARY							0.023*	0.022*	0.023*
							(1.956)	(1.825)	(1.884)
POST_COVID-19 × JUDICIARY							0.034***	0.033***	0.034***
							(5.204)	(5.012)	(5.161)
LOGSIZE	−0.040***	−0.040***	−0.041***	−0.046***	−0.046***	−0.046***	−0.046***	−0.045***	−0.046***
	(−12.868)	(−12.827)	(−12.909)	(−14.011)	(−13.929)	(−14.021)	(−13.974)	(−13.895)	(−13.987)
LEVERAGE	0.128***	0.126***	0.127***	0.115***	0.114***	0.114***	0.115***	0.114***	0.114***
	(5.444)	(5.369)	(5.390)	(4.906)	(4.831)	(4.852)	(4.902)	(4.825)	(4.846)
ROA	−0.029	−0.033	−0.033	−0.039	−0.044	−0.044	−0.039	−0.044	−0.044
	(−0.568)	(−0.648)	(−0.654)	(−0.764)	(−0.856)	(−0.861)	(−0.764)	(−0.856)	(−0.861)
PRICE_TO_EARNINGS	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
	(−2.961)	(−2.841)	(−2.854)	(−2.800)	(−2.733)	(−2.744)	(−2.822)	(−2.754)	(−2.765)
PRICE_TO_BOOK	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.949)	(0.853)	(0.872)	(1.326)	(1.220)	(1.243)	(1.322)	(1.217)	(1.239)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	243,032	243,032	243,032	227,909	227,909	227,909	227,909	227,909	227,909
Adjusted R-squared	0.599	0.596	0.596	0.609	0.606	0.606	0.609	0.606	0.606

This table reports the regression results of the impact of government responses to the COVID-19 pandemic and public enforcement on insider trading measures during the pandemic. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded. *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month starting from the date of the first confirmed COVID-19 case in a country and 0 otherwise. *PRE_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month before the month starting from the date of the first confirmed case of the disease in a country, and 0 otherwise. *POST_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month following the month of the first confirmed case of the disease in a country and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio, and *ROA* is the return-on-assets ratio. *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio, and *PRICE_TO_BOOK* is the price-to-book value per share ratio. *GOV_RESPONSE* is the government response index from the University of Oxford's Coronavirus Government Response Tracker (OxCGRT), as in Hale et al. (2020). *ENFORCE* is the Public Enforcement Index (Djankov et al., 2008). *JUDICIARY* is the efficiency of the judiciary index of the International Country Risk Guide, as in La Porta et al. (2006). Firm fixed effects, year-month fixed effects, and country × year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses; ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

Table 7
The impact of investor protection on insider trading around COVID-19 outbreaks.

Variable	Anti-director rights			Investor protection			Information disclosure requirements		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TDR	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*
PRE_COVID-19	−0.045	−0.053	−0.052	−0.032	−0.033	−0.033	0.303	0.289	0.294
	(−0.494)	(−0.568)	(−0.564)	(−0.387)	(−0.401)	(−0.398)	(1.388)	(1.311)	(1.335)
COVID-19	−0.257***	−0.243***	−0.246***	−0.226***	−0.209***	−0.212***	−0.537***	−0.509***	−0.506***
	(−3.421)	(−3.192)	(−3.237)	(−3.343)	(−3.057)	(−3.103)	(−3.051)	(−2.872)	(−2.858)
POST_COVID-19	−0.156***	−0.147***	−0.152***	−0.125***	−0.116***	−0.120***	−0.559***	−0.535***	−0.533***
	(−3.774)	(−3.529)	(−3.653)	(−3.281)	(−3.016)	(−3.137)	(−4.508)	(−4.312)	(−4.301)
PRE_COVID-19 × ADR	0.005	0.007	0.007						
	(0.241)	(0.297)	(0.292)						
COVID-19 × ADR	0.057***	0.052***	0.053***						
	(2.991)	(2.734)	(2.770)						
POST_COVID-19 × ADR	0.072***	0.069***	0.070***						
	(5.968)	(5.666)	(5.754)						
PRE_COVID-19 × INV_PRT				0.008	0.007	0.006			
				(0.073)	(0.062)	(0.058)			
COVID-19 × INV_PRT				0.251***	0.225**	0.228**			
				(2.835)	(2.515)	(2.550)			
POSTCOVID-19 × INV_PRT				0.330***	0.313***	0.317***			
				(5.680)	(5.350)	(5.432)			
PRECOVID-19 × DISCLOSE							−0.386	−0.373	−0.379
							(−1.571)	(−1.505)	(−1.531)
COVID-19 × DISCLOSE							0.536***	0.502**	0.498**
							(2.699)	(2.514)	(2.494)
POST_COVID-19 × DISCLOSE							0.744***	0.714***	0.711***
							(5.189)	(4.977)	(4.955)
LOGSIZE	−0.046***	−0.046***	−0.046***	−0.046***	−0.046***	−0.046***	−0.046***	−0.046***	−0.046***
	(−13.994)	(−13.913)	(−14.006)	(−13.999)	(−13.918)	(−14.011)	(−14.012)	(−13.931)	(−14.024)
LEVERAGE	0.115***	0.114***	0.114***	0.115***	0.114***	0.114***	0.116***	0.115***	0.115***
	(4.905)	(4.829)	(4.850)	(4.906)	(4.830)	(4.851)	(4.935)	(4.857)	(4.878)
ROA	−0.039	−0.044	−0.044	−0.039	−0.044	−0.044	−0.039	−0.044	−0.044
	(−0.765)	(−0.857)	(−0.862)	(−0.764)	(−0.856)	(−0.861)	(−0.765)	(−0.857)	(−0.862)
PRICE_TO_EARNINGS	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
	(−2.817)	(−2.748)	(−2.760)	(−2.813)	(−2.744)	(−2.756)	(−2.824)	(−2.755)	(−2.766)
PRICE_TO_BOOK	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(1.328)	(1.222)	(1.245)	(1.328)	(1.222)	(1.244)	(1.343)	(1.237)	(1.259)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country × year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	227,909	227,909	227,909	227,909	227,909	227,909	227,909	227,909	227,909
Adjusted R-squared	0.609	0.606	0.606	0.609	0.606	0.606	0.609	0.606	0.606

This table reports the regression results of the impact of investor protection on insider trading around COVID-19 outbreaks. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded, and *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month starting from the date of the first confirmed COVID-19 case in a country and 0 otherwise. *PRE_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month before the month of the first confirmed case of the disease in a country and 0 otherwise. *POST_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month following the month of the first confirmed case of the disease in the country and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio, *ROA* is the return-on-assets ratio, and *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio. *PRICE_TO_BOOK* is the price-to-book value per share ratio. *ADR* is the revised Anti-director Rights Index (Djankov et al., 2008), *INV_PRT* is the Investor Protection Index in La Porta et al. (2006), and *DISCLOSE* is the information disclosure requirement in La Porta et al. (2006). Firm fixed effects, year-month fixed effects, and country × year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses; ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

Table 8
The impact of cultures on insider trading around COVID-19 outbreaks.

VARIABLE	(1)	(2)	(3)	(4)
	TDR	TDR	TDR	TDR
PRE_COVID-19 × IDV	−0.000			
	(−0.276)			
COVID-19 × IDV	0.002**			
	(2.535)			
POST_COVID-19 × IDV	0.003***			
	(4.889)			
PRE_COVID-19 × UAI		0.003		
		(1.415)		
COVID-19 × UAI		−0.003**		
		(−2.353)		
POSTCOVID-19 × UAI		−0.004***		
		(−4.923)		
PRECOVID-19 × LTO			0.000	
			(0.224)	
COVID-19 × LTO			−0.003***	
			(−3.241)	
POST_COVID-19 × LTO			−0.003***	
			(−5.629)	
PRE_COVID-19 × MAS				−0.002
				(−0.720)
COVID-19 × MAS				0.007***
				(2.775)
POST_COVID-19 × MAS				0.008***
				(5.009)
PRE_COVID-19	−0.007	−0.184*	−0.043	0.085
	(−0.105)	(−1.742)	(−0.696)	(0.521)
COVID-19	−0.159***	0.134	0.083*	−0.406***
	(−2.922)	(1.540)	(1.659)	(−3.033)
POST_COVID-19	−0.032	0.335***	0.253***	−0.289***
	(−1.088)	(6.180)	(7.212)	(−3.827)
LOGSIZE	−0.041***	−0.041***	−0.041***	−0.041***
	(−12.520)	(−12.526)	(−12.535)	(−12.514)
LEVERAGE	0.120***	0.120***	0.120***	0.120***
	(4.594)	(4.603)	(4.598)	(4.595)
ROA	−0.048	−0.047	−0.048	−0.048
	(−0.880)	(−0.873)	(−0.885)	(−0.883)
PRICE_TO_EARNINGS	−0.000***	−0.000***	−0.000***	−0.000***
	(−2.871)	(−2.844)	(−2.852)	(−2.867)
PRICE_TO_BOOK	0.001**	0.001**	0.001**	0.001**
	(2.562)	(2.563)	(2.563)	(2.561)
Firm fixed effects	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes
Country × year-month fixed effects	Yes	Yes	Yes	Yes
Observations	224,550	224,550	224,550	224,550
Adjusted R-squared	0.595	0.595	0.595	0.595

This table reports the regression results of the impact of different cultural dimensions on insider trading around COVID-19 outbreaks. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month starting from the date of the first confirmed COVID-19 case in a country and 0 otherwise. *PRE_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month before the month of the first confirmed case of the disease in a country and 0 otherwise. *POST_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month following the month of the first confirmed case of the disease in the country and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio. *ROA* is the return-on-assets ratio. *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio. *PRICE_TO_BOOK* is the price-to-book value per share ratio. *IDV*, *UAI*, *LTO*, and *MAS* are the cultural indices indicating the country's individualism, uncertainty avoidance, long-term orientation, and masculinity, respectively. (Hofstede, 2001). Firm fixed effects, year-month fixed effects, and country × year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses; ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively. The results remain qualitatively unchanged after substituting *TDR* with other insider trading measures, including *NSPR* and *NSPR*.

Table 9
Panic insider trades during COVID-19 outbreaks.

Variable	(1)	(2)	(3)
	TDR	NSPR	NVPR
COVID-19 × PANIC	−0.036**	−0.034**	−0.033**
	(−2.327)	(−2.322)	(−2.321)
PANIC	0.040***	0.038***	0.038***
	(4.433)	(4.173)	(4.147)
COVID-19	−0.085***	−0.085***	−0.085***
	(−3.534)	(−3.525)	(−3.545)
LOGSIZE	−0.035***	−0.035***	−0.035***
	(−10.859)	(−10.797)	(−10.881)
LEVERAGE	0.099***	0.096***	0.097***
	(4.151)	(4.039)	(4.068)
ROA	0.004	0.001	0.001
	(0.072)	(0.012)	(0.023)
PRICE_TO_EARNINGS	−0.000**	−0.000**	−0.000**
	(−2.320)	(−2.320)	(−2.331)
PRICE_TO_BOOK	−0.000	−0.000	−0.000
	(−0.202)	(−0.279)	(−0.261)
Firm fixed effects	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes
Country × year-month fixed effects	Yes	Yes	Yes
Observations	233,038	233,038	233,035
Adjusted R-squared	0.604	0.601	0.601

This table reports the regression results of insider trading measures on measures of market panic during the month of the COVID-19 outbreak. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded, and *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month starting from the date of the first confirmed COVID-19 case in a state and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio. *ROA* is the return-on-assets ratio. *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio. *PRICE_TO_BOOK* is the price-to-book value per share ratio. *PANIC* is the consumer panic index developed by Keane and Neal (2021). Firm fixed effects, year-month fixed effects, and country × year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses; ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

To measure the COVID-19-induced market panic, we adopt a novel consumer panic index (*PANIC*) developed by Keane and Neal (2021).[13] This measure demonstrates the demand for some important supermarket goods, providing a good proxy for the impact of the COVID-19 pandemic on households' daily lives. We create the interaction between *PANIC* and the *COVID-19* dummy and then regress it against insider trading measures (*TDR*, *NSPR*, and *NVPR*).[14] Table 9 presents the results of this test.

Table 9 reports the regression results for each insider trading measure (TDR, NSPR, and NVPR) on *COVID-19 × PANIC* and all control variables as in the baseline models in Table 4. The *COVID-19 × PANIC* coefficients are negative and statistically significant at the 1% level, suggesting that market panic induced insider transactions during the COVID-19 month.

We follow Cohen et al. (2012) and classify all insider transactions into routine and non-routine trades to explore the possibility that the insider selling pattern during the COVID-19 month is mainly because of routine rather than opportunistic trades. Specifically, we define a routine trader as an insider who placed a trade in the same calendar month for at least three consecutive years (Cohen et al., 2012). We group all insider trades that fall outside the "routine" category and label them as non-routine insider trades. We then create a dummy variable, *NRT*, that equals 1 if there is at least one non-routine insider trade during a trade date and 0 otherwise. The descriptive statistics in Panel C of Table 2 show that the mean of *NRT* is 0.719, meaning that non-routine insider trades occur in 71.9% of the firm-month observations in our sample. We argue that insiders' significant net selling pattern during the COVID-19 outbreaks is driven by non-routine insider trades because routine insider trades are likely not informed trades (Cohen et al., 2012). To verify this argument, we re-estimate the baseline model using the subsample of non-routine insider trades (NRT = 1). Table 10 presents the test results.

Table 10 regresses the three insider trading measures on the COVID time dummies (i.e., *PRE_COVID-19*, *COVID-19*, and *POST_COVID-19*) using the same regression settings as in Table 4. The *COVID-19* coefficient ranges from −0.109 to −0.092 and is statistically significant at the 1% level across all regression specifications from Columns 1 to 6. The results suggest that selling is the dominant pattern of NRT during the COVID-19 month. Moreover, the coefficients of COVID-19 in the subsample regression are more negative than those reported in the full sample regression in Table 4 (ranging from −0.078 to −0.069). This result suggests that insiders' selling

[13] The authors developed the daily index of consumer panic based on Google search inquiries. We thank Michael Keane and Timothy Neal for generously sharing the data.
[14] We only include a during-pandemic dummy in the model because of the availability of the market panic data.

Table 10
Non-routine insider trades during the COVID-19 outbreaks.

VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)
	TDR	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*
PRE_COVID-19	−0.117***	−0.118***	−0.118***	−0.113***	−0.113***	−0.113***
	(−3.120)	(−3.121)	(−3.123)	(−2.994)	(−2.997)	(−2.997)
COVID-19	−0.113***	−0.114***	−0.115***	−0.107***	−0.109***	−0.109***
	(−3.640)	(−3.676)	(−3.688)	(−3.446)	(−3.482)	(−3.492)
POST_COVID-19	0.063***	0.062***	0.062***	0.066***	0.065***	0.065***
	(3.414)	(3.351)	(3.315)	(3.578)	(3.514)	(3.482)
LOGSIZE				−0.044***	−0.045***	−0.045***
				(−12.166)	(−12.148)	(−12.171)
LEVERAGE				0.116***	0.122***	0.122***
				(3.728)	(3.911)	(3.907)
ROA				−0.097	−0.097	−0.098
				(−1.556)	(−1.558)	(−1.576)
PRICE_TO_EARNINGS				−0.000***	−0.000***	−0.000***
				(−2.766)	(−2.590)	(−2.599)
PRICE_TO_BOOK				0.000	0.000	0.000
				(1.309)	(1.190)	(1.202)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	174,112	174,112	174,109	174,112	174,112	174,109
Adjusted R-squared	0.582	0.579	0.579	0.583	0.580	0.580

This table reports the regression results of insider trading measures on non-routine trades surrounding the COVID-19 outbreak. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded. *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month starting from the date of the first confirmed COVID-19 case in a state and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio. *ROA* is the return-on-assets ratio. *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio. *PRICE_TO_BOOK* is the price-to-book value per share ratio. The definition of routine trades is adopted from Cohen et al. (2012). Firm fixed effects, year-month fixed effects, and country × year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses. ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

pattern during the COVID-19 outbreaks is likely driven by NRT rather than their counterparts.[15]

Collectively, the findings from the market panic test and the non-routine insider trading test lend support to insider panic selling during the outbreaks of COVID-19. Market panic significantly impacts the trading behavior of capital market participants, implying that during the COVID-19 month, COVID-19-induced sentiment affects corporate insiders and stimulates them to sell rather than buy. This result shows that insiders with better information about their companies than the outside market can take advantage of a COVID-induced upheaval for profit-generating transactions.

4.6. Insider trading during the pandemic in the worst-hit country

This section focuses on insider transactions in the US during COVID-19 for two reasons. First, the US was the country worst hit by COVID-19 in 2020.[16] The number of COVID-19 cases in the US increased substantially from June to November 2020, reaching 12 million confirmed cases in November 2020.[17] Second, informed trading by several lawmakers in this market received increasing attention from academics and practitioners during the crisis.[18]

We examine the trading behaviors of insiders conditioned on a firm's exposure to the COVID-19 health outbreaks. To facilitate this test, we use a novel measure of firm-level COVID-19 risk developed by Hassan et al. (2020). The authors propose text-based measures of the costs, benefits, and risks of listed firms in the US associated with the spread of COVID-19 and identify firms and sectors that are more or less exposed to the pandemic. Firm-level COVID-19 risk measures allow us to examine how insiders incorporate their firms' exposure to COVID-19 into their trading behaviors.

Table 11 reports the regression results of firm-level COVID-19 risks on insider transactions. The coefficients of the *PRE_COVID-19* × *COVID_RISK* and *COVID-19* × *COVID_RISK* interaction terms are significantly negative across the three measures of insider direction, showing that insiders in a firm with a higher level of COVID-19 risk tend to sell more during a pandemic. In addition, firm-level COVID-

[15] We acknowledge the referee for suggesting this point.
[16] Information on the COVID-19 pandemic can be found at https://www.bbc.com/news/world-us-canada-53780196 (retrieved October 30, 2020).
[17] The US Center for Disease Control's report can be found at: https://covid.cdc.gov/covid-data-tracker/#cases_casesper100k (retrieved November 1, 2020). The data are visualized in Appendix A6.
[18] Information on US Congressional insider trading can be found at: https://www.washingtonpost.com/local/legal-issues/justice-dept-ends-coronavirus-insider-trading investigations-into-us-sens-loeffler-inhofe-and-feinstein/2020/05/26/.html (retrieved October 10, 2020).

Table 11
The impact of firm-level COVID-19 risk on insider trading in the United States during the pandemic.

Variable	Firm-level COVID-19 risk		
	(1)	(2)	(2)
	TDR	*NSPR*	*NVPR*
PRE_COVID-19 × COVID_RISK	−0.497*	−0.490*	−0.490*
	(−1.754)	(−1.732)	(−1.732)
COVID-19 × COVID_RISK	−0.812***	−0.810***	−0.810***
	(−3.324)	(−3.321)	(−3.321)
POST_COVID-19 × COVID_RISK	−0.274	−0.265	−0.266
	(−1.121)	(−1.087)	(−1.090)
PRE_COVID-19	−0.129*	−0.149*	−0.149*
	(−1.678)	(−1.924)	(−1.924)
COVID-19	0.045	0.029	0.029
	(0.685)	(0.433)	(0.434)
POST_COVID-19	0.265***	0.253***	0.253***
	(4.878)	(4.626)	(4.625)
LOGSIZE	−0.102***	−0.103***	−0.103***
	(−73.387)	(−73.388)	(−73.390)
LEVERAGE	0.317***	0.316***	0.316***
	(27.195)	(27.033)	(27.035)
ROA	−0.825***	−0.829***	−0.829***
	(−13.847)	(−13.894)	(−13.895)
PRICE_TO_EARNINGS	−0.028	−0.029	−0.029
	(−0.797)	(−0.802)	(−0.802)
PRICE_TO_BOOK	−3.896***	−3.912***	−3.912***
	(−8.089)	(−8.057)	(−8.057)
State fixed effects	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes
State × year-month fixed effects	Yes	Yes	Yes
Observations	92,837	92,837	92,837
Adjusted R-squared	0.194	0.194	0.194

This table reports the regression results of the firm-level COVID-19 risk on insider trading during the pandemic in the US *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded. *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month starting from the date of the first confirmed COVID-19 case in the US and 0 otherwise. *PRE_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month before the month of the first confirmed case of the disease in the US and 0 otherwise. *POST_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month following the month of the first confirmed case of the disease in the US and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio. *ROA* is the return-on-assets ratio. *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio. *PRICE_TO_BOOK* is the price-to-book value per share ratio. *COVID_RISK* is the firm-level COVID-19 risk measure developed by Hassan et al. (2020). State fixed effects, year-month fixed effects, and state × year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses; ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

19 risks do not affect insider transactions during the post-COVID-19 period, evidenced by the insignificant coefficient of the interaction term *POST_COVID-19 × COVID_RISK*. Interestingly, the *COVID-19 × COVID_RISK* coefficient is double that of *PRE_COVID-19 × COVID_RISK* (−0.812 vs. −0.497, respectively), suggesting that selling by insiders in firms that are more exposed to COVID-19 is stronger during the 30 days after the first confirmed COVID-19 case in the US. These findings are consistent with the conjecture that risk-averse corporate insiders tend to hedge when firm risk exposure increases (Anderson & Puleo, 2020; Cheng & Lo, 2006; Shen, Hui, & Fan, 2021; Shen, Wang, & Zhou, 2021), further confirming our primary finding of insiders' selling during the COVID-19 outbreaks as a firm's COVID-19 risk increases.

Furthermore, we examine the impact of US states' response to COVID-19 on insider trading behavior during the COVID-19 pandemic. We collect US states' responses to pandemic data from the Oxford COVID-19 Government Response Tracker, which has data measuring policy responses to the pandemic across all 50 US states. The tracker systematically records government responses to coronavirus based on 17 indicators, such as school closures and travel restrictions. It aggregates policy responses into an index between 1 and 100 (high level) to reflect the level of state government action, including the stringency index, state economic support index, and COVID-19 containment measure index.

By observing the time-varying variations in the state governments' responses to COVID-19, we find that though US states responded relatively similarly in the first weeks of the pandemic, they began to diverge gradually after that, and state responses differ significantly across regions (see Appendix A7 for details), which might affect insider transactions. Therefore, we examine how the state COVID-19 containment measures and economic support programs affect the insiders' trading behavior in the US since containment measures and economic support programs can contribute to regaining investors' confidence, creating momentum for future economic resilience of

Table 12
The impact of state government responses on insider trading during the COVID-19 outbreaks in the United States.

Variable	State government's economic support (*STATE_RESPONSE*)			COVID-19 containment measures at state-level (*CONTAINMENT_INDEX*)		
	(1)	(2)	(3)	(4)	(5)	(6)
	TDR	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*
PRE_COVID-19	−0.189***	−0.208***	−0.208***	−0.297***	−0.316***	−0.316***
	(−2.682)	(−2.953)	(−2.953)	(−3.954)	(−4.203)	(−4.202)
COVID-19	0.004	−0.013	−0.013	−0.170**	−0.187**	−0.187**
	(0.067)	(−0.218)	(−0.218)	(−2.322)	(−2.538)	(−2.537)
POSTCOVID-19	0.235***	0.222***	0.222***	0.099*	0.084	0.084
	(4.677)	(4.414)	(4.411)	(1.650)	(1.404)	(1.403)
PRECOVID-19 × STATE_RESPONSE	0.023	0.024	0.024			
	(0.752)	(0.776)	(0.776)			
COVID-19 × STATE_RESPONSE	0.015	0.016	0.016			
	(0.790)	(0.820)	(0.819)			
POSTCOVID-19 × STATE_RESPONSE	0.004***	0.005***	0.005***			
	(3.193)	(3.383)	(3.381)			
PRECOVID-19 × CONTAINMENT_INDEX				0.057	0.057	0.057
				(0.763)	(0.763)	(0.763)
COVID-19 × CONTAINMENT_INDEX				0.017***	0.017***	0.017***
				(3.202)	(3.150)	(3.150)
POSTCOVID-19 × CONTAINMENT_INDEX				0.009***	0.009***	0.009***
				(5.317)	(5.435)	(5.434)
LOGSIZE	−0.137***	−0.136***	−0.136***	−0.137***	−0.136***	−0.136***
	(−107.575)	(−107.267)	(−107.272)	(−107.532)	(−107.225)	(−107.229)
LEVERAGE	0.152***	0.151***	0.151***	0.152***	0.151***	0.151***
	(13.475)	(13.418)	(13.418)	(13.466)	(13.409)	(13.409)
ROA	−0.865***	−0.872***	−0.872***	−0.864***	−0.871***	−0.871***
	(−17.474)	(−17.586)	(−17.575)	(−17.456)	(−17.568)	(−17.556)
PRICE_TO_EARNINGS	−0.058	−0.058	−0.058	−0.060	−0.061	−0.061
	(−0.822)	(−0.827)	(−0.827)	(−0.844)	(−0.849)	(−0.849)
PRICE_TO_BOOK	0.078	0.070	0.070	0.060	0.052	0.052
	(0.118)	(0.106)	(0.106)	(0.091)	(0.078)	(0.078)
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
State × year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	111,826	111,826	111,826	111,826	111,826	111,826
Adjusted R-squared	0.231	0.231	0.231	0.231	0.231	0.231

This table reports the regression results of insider trading measures on the event window variables in the United States. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded, and *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month starting from the date of the first confirmed COVID-19 case in a state and 0 otherwise. *PRE_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month before the month of the first confirmed case of the disease in a state and 0 otherwise. *POST_COVID-19* is a dummy variable equal to 1 if insider trading measures are present in the month following the month of the first confirmed case of the disease in the state and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio. *ROA* is the return-on-assets ratio. *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio. *PRICE_TO_BOOK* is the price-to-book value per share ratio. *STATE_RESPONSE* and *CONTAINMENT_INDEX* are the state government's Economic Support Index and the Containment and Health Index from the University of OxCGRT, as in Hale et al. (2020). State fixed effects, year-month fixed effects, and state × year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses; ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

the state and the whole country. Table 12 presents the effect of state governments' economic support and containment measures on insider trading in the US.

Table 12 demonstrates that the influence of state economic support and containment measures on insider transactions varies across different COVID-19 periods. The results in Columns 1–3 show that states' economic support packages do not significantly influence insider trading in two months before and after the first confirmed COVID-19 case in the US. The interaction term of *POST_COVID-19* x *STATE_RESPONSE* positively correlates with three measures of insider trading. The *p*-values of these coefficients are less than 0.01 and significant at any conventional level. These results show that more insider purchases after the first month of the COVID-19 pandemic are associated with a state with higher economic support. Table 12, Columns 4–6 report the effect of state-level COVID-19 containment measures on insider trading. We find no significant effect of state containment measures on insider transactions during the pre-COVID-19 period in the US; however, the coefficients of the *COVID-19* × *CONTAINMENT_INDEX* and *POSTCOVID-19* × *CONTAINMENT_INDEX* interaction terms are positive and statistically significant. This result suggests that insiders in states with more stringent containment measures tend to purchase more than those with lenient measures against COVID-19.

5. Conclusion

Never in recent history have epidemiology and public health attracted as much global interest as in 2020. Although the far-reaching impacts of COVID-19 have been intensively documented among almost all countries worldwide, less is known about the trading behavior of corporate insiders during different infectious outbreaks. As insider trading is of paramount importance to investors' confidence and market integrity during times of high uncertainty, this study investigates the trading reaction of insiders around the COVID-19 health crisis.

Using universal daily detailed insider transactions, we find that insiders tend to sell more during a month after the first confirmed case in each country. This pattern of insider selling is consistent across different measures of trading direction and holds after considering a range of fundamental firm measures. This finding confirms the overwhelming panic among capital market participants during health disease outbreaks. Furthermore, we document differences in trading direction after a month since the first confirmed case. Our empirical evidence shows significant net buyers in the month following COVID-19 outbreaks in 2020. Consistent with the hypothesis that uncertainty increases the information asymmetry between insiders and outsiders and the value of private information, our evidence indicates that insiders can attempt to reduce exposure to the COVID-19 pandemic by selling their stocks before they are priced in the market.

Furthermore, we find that the impact of COVID-19 on insider trading behaviors depends on the industry and macro-environment factors. Insiders buy less and sell more during COVID-19 outbreaks across all industries except the food industry. Insiders of firms in consumer durables, automobile, and transport industries have the most significant sales during COVID-19; the lowest insider sales are seen in the mining and minerals, oil and petroleum products, drugs, soap, and perfumes, and construction sectors. In addition, insider selling is less pronounced in countries with more stringent responses to COVID-19; similar patterns also occur in countries with higher public enforcement indices, more efficient judiciary systems, and stronger anti-director rights and investor protection. The empirical results for the US market reveal that insider selling is more pronounced among firms with higher COVID-19 risk.

This study offers timely empirical evidence on how insiders worldwide respond to a significant upheaval triggered by a health crisis and hence contributes to the emerging literature concerning the impact of infectious outbreaks on various health and economic outcomes. This study's findings have several important implications for firms, investors, and lawmakers across the globe. For example, firms in industries that experience large stock sales by insiders during infectious outbreaks could consider enhancing their internal monitoring systems during times of high uncertainty. Such action may mitigate insiders' stock manipulation and retain investors' confidence (Davidson & Stevens, 2013; Murphy & Fu, 2019; Wu & Tuttle, 2014), which can contribute to the firm's resilience during a pandemic.

This study's findings imply that investors can consider a certain level of preparedness for overwhelming selling in capital markets worldwide if a similar pandemic occurs, which can partially reduce the adverse consequences of infectious outbreaks on their wealth. Finally, our empirical results demonstrate that country institutional settings significantly influence corporate insider behavior. Therefore, policymakers can capitalize on our research findings by imposing appropriate policies on capital market participants (e.g., corporate insiders vs. outside investors) to lessen the adverse impacts of infectious diseases on the global economy. Building an efficient judiciary system, enhancing investor protection and the public enforcement framework, and improving information disclosure and stringent responses to outbreaks could contribute to limiting insiders' opportunistic transactions. These strategies would maintain market integrity and regain public trust and confidence during crises, promoting economic recovery in the post-pandemic period.

Credit author statement

Khanh Hoang: Data curation, Programming, Writing- original draft, Reviewing.
Cuong Nguyen: Conceptualization, Methodology, Supervision, Writing- original draft preparation.
Harvey Nguyen: Data curation, Programming, Methodology, Visualization, Investigation, Reviewing and Editing.
Lai Van Vo*: Investigation, Methodology, Writing- original draft, Reviewing and Editing.

Declaration of Competing Interest

None.

Data availability

The authors do not have permission to share data.

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Appendix A

A.1. Variable description

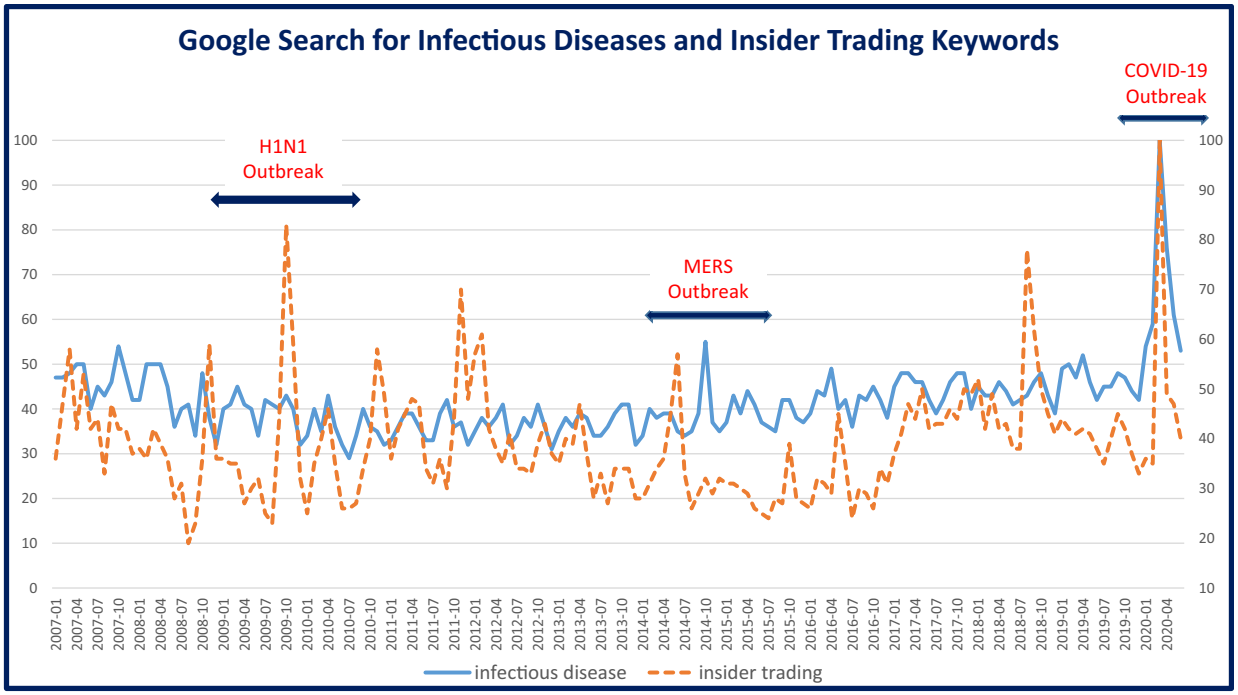
Variable	Description	Data source
TDR	The Trade Direction Ratio equals the difference between the number of insider purchases and insider sales scaled by the sum of insider trades.	2iQ
NSPR	The net Shares Purchased Ratio equals the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded.	2iQ
NVPR	The net Value Purchased Ratio equals the difference between insider purchase value and insider sale value, scaled by the total insider trade value.	2iQ
LOGSIZE	Natural logarithm of the book value of total assets	COMPUSTAT
LEVERAGE	Debts-to-assets ratio	COMPUSTAT
ROA	Return-on-assets ratio	COMPUSTAT
PRICE_TO_EARNINGS	Price-to-earnings ratio	COMPUSTAT and CRSP
PRICE_TO_BOOK	Price-to-book value ratio	COMPUSTAT and CRSP
COVID-19	This dummy variable equals 1 if insider trading measures are present 30 days from the date of the first confirmed COVID-19 case in a country and 0 otherwise.	WHO
PRE_COVID-19	This dummy variable equals 1 if insider trading measures are present 30 days before the *COVID-19* period in a country and 0 otherwise.	WHO
POST_COVID-19	This dummy variable equals 1 if insider trading measures are present 30 days following the *COVID-19* period in a country and 0 otherwise.	WHO
MERS	This dummy variable equals 1 if insider trading measures are present 30 days from the date of the first confirmed MERS case in a country and 0 otherwise.	WHO
PRE_MERS	This dummy variable equals 1 if insider trading measures are present 30 days before the *MERS* period in a country and 0 otherwise.	WHO
POST_MERS	This dummy variable equals 1 if insider trading measures are present 30 days following the *MERS* period in a country and 0 otherwise.	WHO
H1N1	This dummy variable equals 1 if insider trading measures are present 30 days from the date of the first confirmed H1N1 case in a country and 0 otherwise.	WHO
PRE_H1N1	This dummy variable equals 1 if insider trading measures are present 30 days before the *H1N1* period in a country and 0 otherwise.	WHO
POST_H1N1	This dummy variable equals 1 if insider trading measures are present 30 days following the *H1N1* period in a country and 0 otherwise.	WHO
GOV_RESPONSE	The government response index from the University of OxCGRT, as in Hale et al. (2020)	OxCGRT
ENFORCE	The public enforcement index (Djankov et al., 2008).	Djankov et al. (2008)
JUDICIARY	The Efficiency of the Judiciary System Index from the International Country Risk Guide as in La Porta et al. (2006)	La Porta et al. (2006)
ADR	The revised Anti-director Rights Index (Djankov et al., 2008)	Djankov et al. (2008)
INV_PRT	The Investor Protection Index in La Porta et al. (2006)	La Porta et al. (2006)
DISCLOSE	The Information Disclosure Requirement index in La Porta et al. (2006)	La Porta et al. (2006)
IDV	Individualism index	Hofstede (2001)
UAI	Uncertainty avoidance index	Hofstede (2001)
LTO	Long-term orientation index	Hofstede (2001)
MAS	Masculinity index	Hofstede (2001)
STATE_RESPONSE	The Economic Support Index for US states from the University of OxCGRT in Hale et al. (2020)	OxCGRT
CONTAINMENT_INDEX	The Containment and Health Index from the University of OxCGRT in Hale et al. (2020)	OxCGRT
COVID_RISK	The firm-level COVID-19 risk measure developed by Hassan et al. (2020)	Hassan et al. (2020)

A.2. Institutional settings of 25 countries and territories in this study

Country	Government response to COVID-19	Public enforcement index	Efficiency of judiciary systems	Anti-director rights index	Investor protection index	Disclosure requirements index	Individualism index	Uncertainty avoidance index	Long-term orientation index	Masculinity index
Australia	41.25	0.90	10.00	4.0	0.78	0.75	90	51	21	61
Canada	41.70	0.80	9.25	4.0	0.96	0.92	80	48	36	52
China	66.01	–	–	–	–	–	20	30	87	66
Egypt	49.73	0.30	6.50	3.0	0.20	0.50	25	80	7	45
France	58.54	0.77	8.00	3.5	0.47	0.75	71	86	63	43
Germany	47.57	0.22	9.00	3.5	0.46	0.42	67	65	83	66
Greece	37.29	0.32	7.00	2.0	0.32	0.33	35	100	45	57
Hong Kong	52.11	0.87	10.00	5.0	0.85	0.92	25	29	61	57
India	49.54	0.67	8.00	5.0	0.77	0.92	48	40	51	56
Indonesia	40.12	0.62	2.50	4.0	0.51	0.50	14	48	62	46
Italy	61.59	0.48	6.75	2.0	0.20	0.67	76	75	61	70
Malaysia	46.65	0.77	9.00	5.0	0.73	0.92	26	36	41	50
New Zealand	43.23	0.33	10.00	4.0	0.46	0.67	79	49	33	58
Philippines	54.39	0.83	4.75	4.0	0.81	0.83	32	44	27	64
Rep. of Ireland	45.55	0.37	8.75	5.0	0.48	0.67	70	35	24	68
Rep. of Korea	50.53	0.25	6.00	4.5	0.36	0.75	18	85	100	39
Russia	46.94	–	–	4.0	0.43	–	39	95	81	36
Singapore	44.93	0.87	10.00	5.0	0.77	1.00	20	8	72	48
South Africa	48.01	0.25	6.00	5.0	0.60	0.83	65	49	34	63
Spain	49.31	0.33	6.25	5.0	0.55	0.50	51	86	48	42
Sweden	23.96	0.50	10.00	3.5	0.39	0.58	71	29	53	5
Switzerland	49.03	0.33	10.00	3.0	0.30	0.67	68	58	74	70
Thailand	39.01	0.72	3.25	4.0	0.37	0.92	20	64	32	34
United Kingdom	44.16	0.68	10.00	5.0	0.78	0.83	89	35	51	66
United States	41.91	0.90	10.00	3.0	1.00	1.00	91	46	26	62

This appendix table presents the institutional setting data of the countries and territories in our sample, including the mean of the daily government response index from January to June 2020 (Hale et al., 2020). Data is from the University of OxCGRT, the Public Enforcement Index (Djankov et al., 2008), and the efficiency of the judiciary index of the International Country Risk Guide, as reported in La Porta et al. (2006). Additional data are from the revised Anti-director Rights Index (Djankov et al., 2008), the Investor Protection Index in La Porta et al. (2006), the disclosure requirements index in La Porta et al. (2006), and the cultural indices indicating the country's individualism, uncertainty avoidance, long-term orientation, and masculinity (Hofstede, 2001).

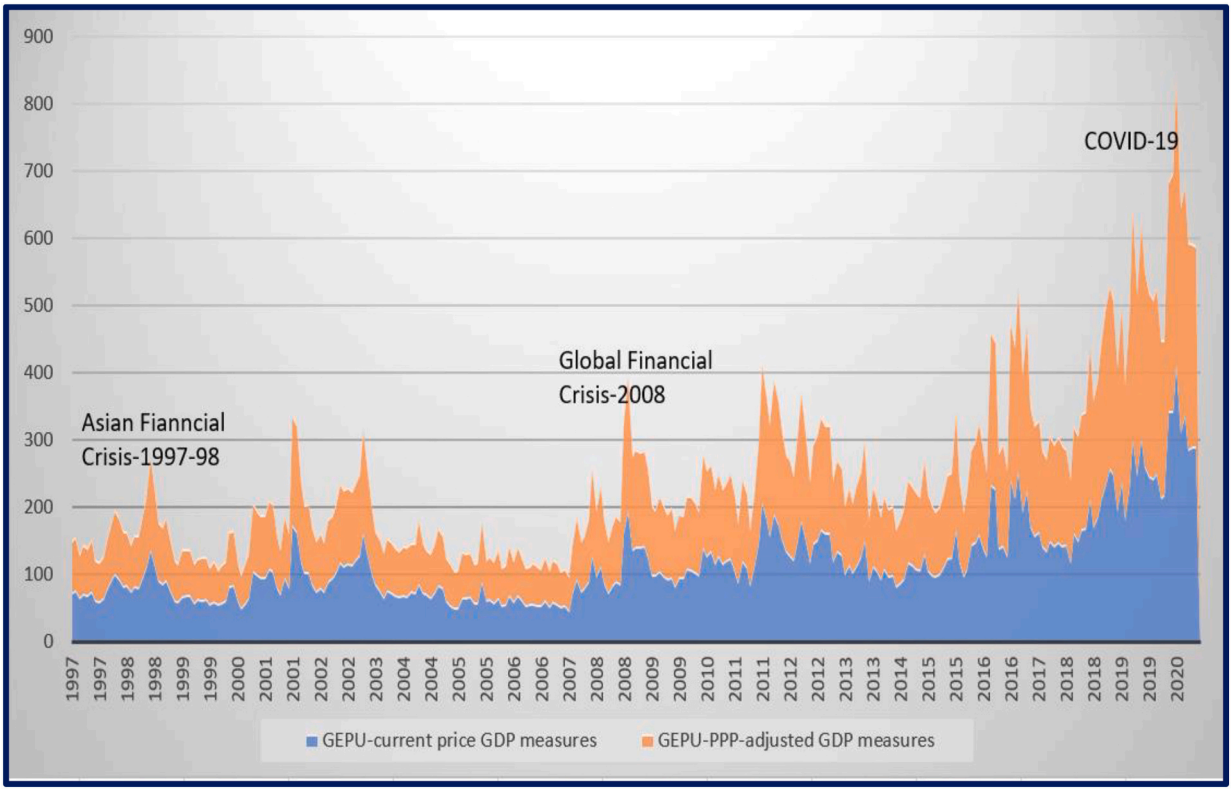
A.3. The frequencies from a Google search for the keywords infectious diseases and insider trading



This figure plots the Google search index (SVI) for infectious diseases and insider trading keywords from January 2007 to June 30, 2020.

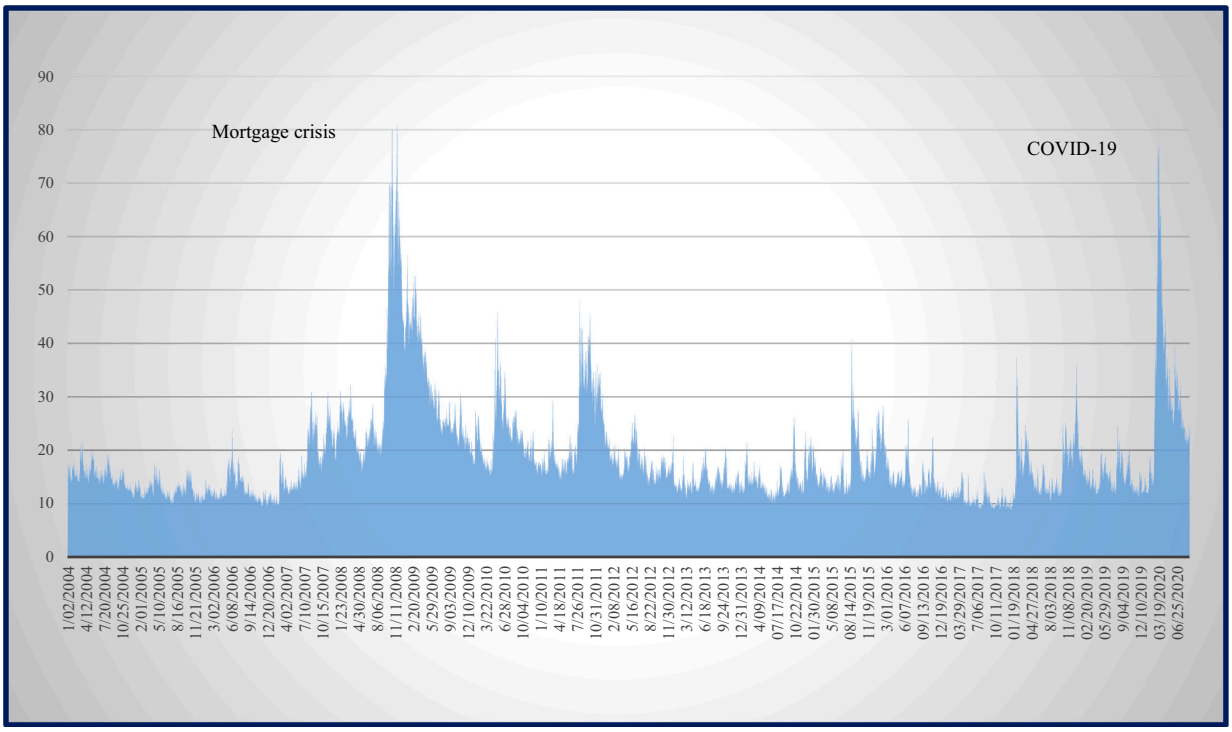
Source: Google Trends and the authors' estimations.

A.4. Global economic policy uncertainty index



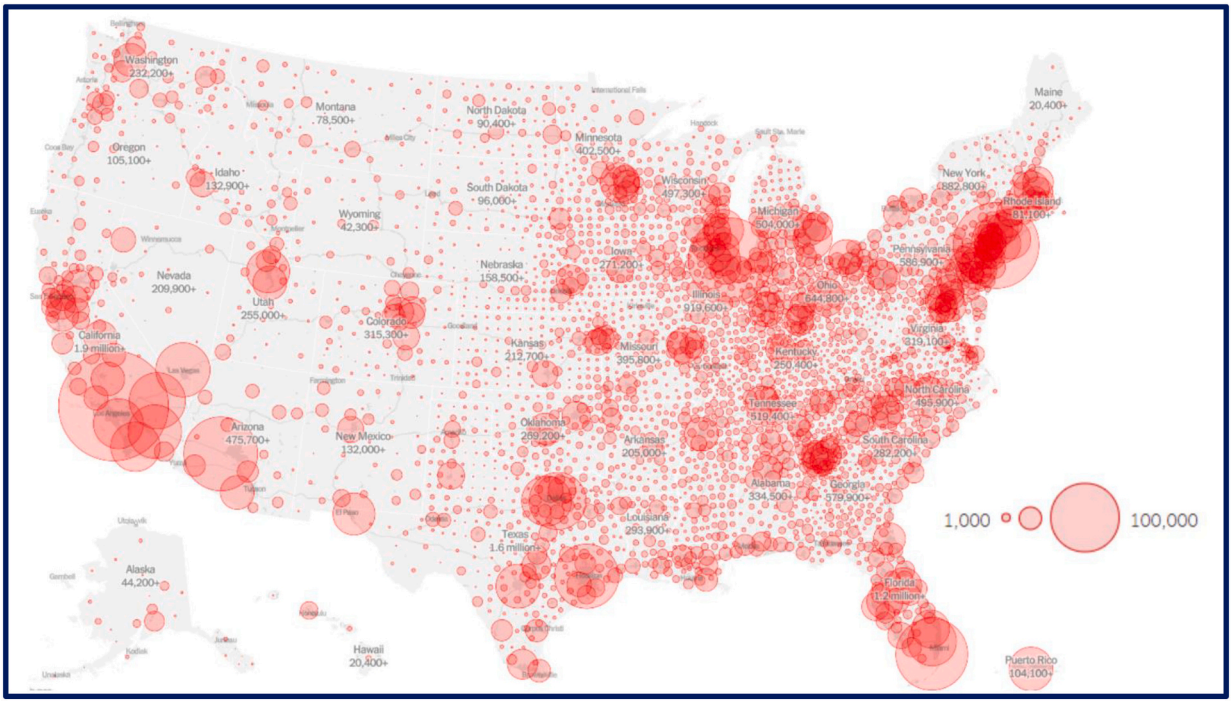
This figure plots the Global Economic Policy Uncertainty Index from 1997 to 2020.

A.5. Market volatility in the United States



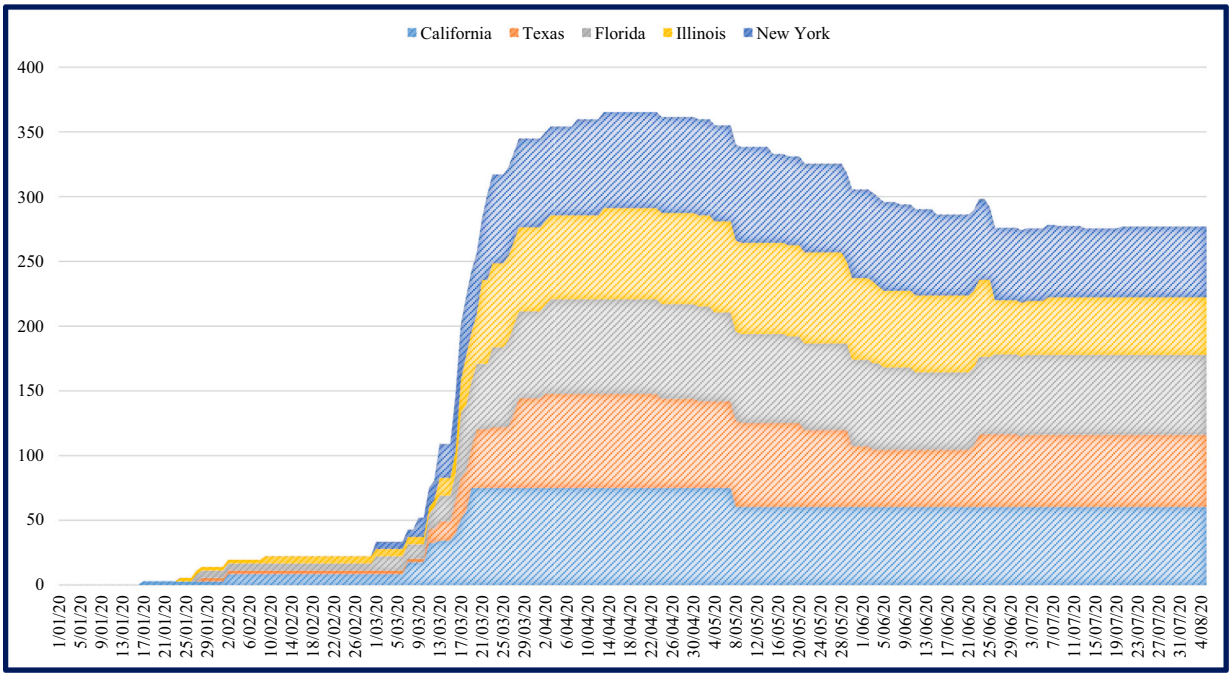
This figure plots the market volatility index in the United States from 2004 to 2020.

A.6. The COVID-19 outbreaks in the United States: The number of infected cases by state



This figure illustrates the total number of COVID-19 infected cases by state in the United States on June 30, 2020 (retrieved from the New York Times on November 1, 2020).

A.7. The Stringency Index of the five hardest-COVID-19-hit states in the United States



This figure presents the state government's response to the COVID-19 outbreaks in the most affected states of the United States. The data period is from January 2020 to August 2020.

Source: University of OxCGRT, as in Hale et al. (2020).

A.8. Insider trading patterns during the outbreaks of MERS and H1N1 worldwide

Variable	Regression without control variables			Regression with control variables		
	(1)	(2)	(3)	(4)	(5)	(6)
	TDR	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*
PRE_MERS	−0.074***	−0.074***	−0.074***	−0.072***	−0.071***	−0.071***
	(−3.244)	(−3.203)	(−3.201)	(−3.153)	(−3.113)	(−3.110)
MERS	−0.048	−0.056*	−0.054*	−0.046	−0.054*	−0.052*
	(−1.566)	(−1.807)	(−1.759)	(−1.500)	(−1.742)	(−1.693)
POST_MERS	−0.008	−0.012	−0.011	−0.005	−0.008	−0.008
	(−0.355)	(−0.499)	(−0.486)	(−0.198)	(−0.344)	(−0.329)
LOGSIZE				−0.039***	−0.039***	−0.039***
				(−15.277)	(−15.282)	(−15.383)
LEVERAGE				0.220***	0.219***	0.220***
				(10.865)	(10.806)	(10.838)
ROA				−0.314***	−0.320***	−0.322***
				(−5.860)	(−5.960)	(−5.990)
PRICE_TO_EARNINGS				0.000	0.000	0.000
				(0.002)	(0.091)	(0.046)
PRICE_TO_BOOK				0.001***	0.001***	0.001***
				(4.967)	(4.810)	(4.865)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

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(*continued*)

Variable	Regression without control variables			Regression with control variables		
	(1)	(2)	(3)	(4)	(5)	(6)
	TDR	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*
Observations	295,136	295,136	295,136	295,136	295,136	295,136
Number of countries	13	13	13	13	13	13
Adjusted R-squared	0.532	0.529	0.530	0.533	0.531	0.531

Panel B: Insider trading around the H1N1 outbreak (Jan 2007–Dec 2010)

Variable	Regression without control variables			Regression with control variables		
	(1)	(2)	(3)	(4)	(5)	(6)
	TDR	*NSPR*	*NVPR*	*TDR*	*NSPR*	*NVPR*
PRE_H1N1	−0.191***	−0.192***	−0.192***	−0.183***	−0.185***	−0.185***
	(−10.894)	(−10.922)	(−10.917)	(−10.555)	(−10.584)	(−10.581)
H1N1	−0.120***	−0.122***	−0.122***	−0.110***	−0.112***	−0.111***
	(−6.160)	(−6.222)	(−6.196)	(−5.635)	(−5.699)	(−5.675)
POST_H1N1	−0.053***	−0.053***	−0.053***	−0.045***	−0.046***	−0.046***
	(−3.163)	(−3.206)	(−3.183)	(−2.725)	(−2.770)	(−2.748)
LOGSIZE				−0.071***	−0.072***	−0.071***
				(−30.388)	(−30.251)	(−30.197)
LEVERAGE				0.126***	0.129***	0.130***
				(6.037)	(6.175)	(6.200)
ROA				−0.153***	−0.155***	−0.154***
				(−3.687)	(−3.716)	(−3.687)
PRICE_TO_EARNINGS				−0.000	−0.000	−0.000
				(−0.027)	(−0.319)	(−0.348)
PRICE_TO_BOOK				0.001***	0.001***	0.001***
				(6.241)	(6.463)	(6.436)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	341,044	341,044	341,044	341,044	341,044	341,044
Number of countries	25	25	25	25	25	25
Adjusted R-squared	0.516	0.513	0.513	0.519	0.516	0.516

This table reports the regression results of insider trading surrounding the outbreaks of MERS and H1N1 worldwide. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded. *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *MERS* is a dummy variable equal to 1 if insider trading measures are present in the month starting on the first confirmed MERS case in a country and 0 otherwise. *H1N1* is a dummy variable equal to 1 if insider trading measures are present in the month starting on the date of the first confirmed swine flu case in a country and 0 otherwise. *PRE_MERS* and *PRE_HIN1* are dummy variables equal to 1 if the insider trading measures are present in the month starting on the date of the first confirmed case of the corresponding diseases in a country and 0 otherwise. *POST_MERS* and *POST_HIN1* are dummy variables equal to 1 if insider trading measures are present in the month starting on the date of the first confirmed case of the corresponding diseases in a country and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio. *ROA* is the return-on-assets ratio. *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio. *PRICE_TO_BOOK* is the price-to-book value per share ratio. Panel A reports the regression results of the baseline model around the MERS outbreaks from January 2012 to December 2016. Panel B reports the regression results of the baseline model around the H1N1 outbreak from January 2004 to December 2010. Firm fixed effects, year-month fixed effects, and country × year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses. ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

A.9. Robustness check: Excluding US firms

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TDR	NSPR	NVPR	TDR	NSPR	NVPR
PRE_COVID-19	−0.030	−0.028	−0.028	−0.030	−0.027	−0.028
	(−0.785)	(−0.705)	(−0.715)	(−0.771)	(−0.693)	(−0.702)
COVID-19	−0.132***	−0.129***	−0.131***	−0.131***	−0.128***	−0.130***
	(−4.011)	(−3.889)	(−3.937)	(−3.970)	(−3.849)	(−3.895)
POST_COVID-19	0.035*	0.035*	0.033*	0.036*	0.035*	0.033*
	(1.934)	(1.908)	(1.802)	(1.949)	(1.922)	(1.818)

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	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TDR	NSPR	NVPR	TDR	NSPR	NVPR
LOGSIZE				−0.013***	−0.013***	−0.013***
				(−3.980)	(−3.880)	(−3.979)
LEVERAGE				0.136***	0.138***	0.140***
				(3.321)	(3.353)	(3.399)
ROA				0.076	0.074	0.073
				(1.033)	(1.006)	(0.991)
PRICE_TO_EARNINGS				−0.000***	−0.000***	−0.000***
				(−3.579)	(−3.461)	(−3.475)
PRICE_TO_BOOK				−0.000	−0.000	−0.000
				(−0.952)	(−1.051)	(−1.028)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country × year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	130,199	130,199	130,196	130,199	130,199	130,196
Adjusted R-squared	0.487	0.484	0.484	0.487	0.484	0.484

This table reports the regression results of insider trading measures on the event window variables after excluding observations of firms in the United States. *TDR* is the difference between the number of insider purchases and insider sales, scaled by the sum of insider trades. *NSPR* is the difference between the number of insider shares purchased and insider shares sold, scaled by the sum of insider shares traded. *NVPR* is the difference between insider purchase value and insider sale value, scaled by the total insider trade value. *COVID-19* is a dummy variable equal to 1 if insider trading measures are in the month of the first confirmed COVID-19 case in a country and 0 otherwise. *PRE_COVID-19* is a dummy variable that equals 1 if the insider trading measures are present in the month starting on the date of the first confirmed case of COVID-19 in a country and 0 otherwise. *POST_COVID-19* is a dummy variable that equals 1 if insider trading measures are present in the month starting on the date of the first confirmed case of COVID-19 in a country and 0 otherwise. *LOGSIZE* is the natural logarithm of the book value of total assets. *LEVERAGE* is the debt-to-assets ratio. *ROA* is the return-on-assets ratio. *PRICE_TO_EARNINGS* is the price-to-earnings per share ratio. *PRICE_TO_BOOK* is the price-to-book value per share ratio. The sample period is from January 2017 to June 2020. Firm fixed effects, year-month fixed effects, and country × year-month fixed effects are included in all models. The *t*-statistics computed using standard errors robust to heteroscedasticity are reported in parentheses. ***, **, and * denote the significance levels of 1%, 5%, and 10%, respectively.

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