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Corporate Diversification and Stock Risk: Evidence from a Global Shock

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Abstract

We investigate the impact of corporate diversification on stock risk. For identification, we exploit an exogenous shock on volatility expectations related to COVID-19 lockdowns resulting in a period of high volatility. We show that firms that diversify only internationally experience a lower post-shock increase in daily volatility. However, diversifying only by business segment leads to a higher increase in post-shock daily volatility. Our main results are robust to different proxies for international and business diversification and daily volatility. Overall, these findings provide a more nuanced picture of the potential impact of corporate diversification on stock risk.

JEL classification : G12; G14

Keywords : Volatility, Stock Risk, Pandemic, Diversification

Declarations of interest: none

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1 Introduction

The literature has failed to reach a consensus regarding the relationship between corporate diversification[1] and firm and stock risk (Mansi & Reeb 2002, Hund et al. 2010, Mammen et al. 2021). A potential reason for such heterogeneous results is the difficulty in allowing for the potential endogeneity of corporate diversification (Campa & Kedia 2002). The type of corporate diversification (geographic or by industry) might also play a role (Denis et al. 2002).

In this paper, we exploit an exogenous shock on volatility expectations (as proxied by the *VIX*) triggered by the outbreak of the COVID-19 pandemic in early 2020 to study the impact of corporate diversification on stock risk in the US stock market. In fact, the outbreak of COVID-19 was largely unanticipated and wreaked havoc on global stock markets, leading to a drop by 30% on stock markets in the US and Europe (Gormsen & Koijen 2020). Therefore, the probability that companies changed their diversification strategies because of the shock in such a short period is low (Kuppuswamy & Villalonga 2016). For these reasons, we can exploit the shock to implement a difference-in-differences strategy, similar to Albuquerque et al. (2020).[2] In particular, we investigate how corporate diversification affects stock risk following the shock.

Our research is important because it is difficult to establish, *a priori*, whether corporate diversification exacerbates or mitigates stock risk following a widespread shock to the economy. Moreover, corporate diversification can lead to different economic outcomes, depending on whether it is based on international sales or on business-segment diversification. Both types of diversification can lead to coinsurance effects (Hann et al. 2013) because a drop in demand from one country (or business segment) can be offset by an increase in demand in other countries (or business segments). However, they also present dissimilarities.

For example, international corporate diversification can allow US investors to indirectly invest in countries whose stock markets present significant entry barriers to US investors. This type of

[1] For convenience, in the rest of the paper we use the term "corporate diversification" to refer to both international and business diversification. International diversification refers to the presence of foreign sales or operations. Business diversification involves sales or operations along with multiple business segments.

[2] Moreover, focusing on the short term reduces the impact of potential confounding events.

advantage is unique to international diversification because there are no entry barriers to US investors for stocks listed on US stock exchanges, regardless of whether they are issued by firms that are diversified by business segment or not. Moreover, firms that diversify by business tend to differ from internationally-diversified firms along several dimensions (Martin & Sayrak 2003, Duchin 2010, Gopalan & Xie 2011).

With specific respect to the global shock that we use for identification (the COVID-19 outbreak), since COVID-19 is a global phenomenon, the benefits of international diversification might have decreased. However, diversifying internationally might still be beneficial if the market perceives that the fall in domestic demand deriving from COVID-19 can be (at least partly) offset by exports to countries affected to a lower extent by the outbreak or just recovering from it. The costs of coordinating across borders might, however, offset the benefits of international diversification (Mammen et al. 2021).

Diversification based on business segments might also play a role. Firms whose business spans across several industries might be less exposed to the economic impact of COVID-19 because of the coinsurance effect, and thus business diversification could reduce stock risk. However, firms that diversify by business tend to have lower *Tobin's q* (Martin & Sayrak 2003, Gopalan & Xie 2011) and cash holdings (Duchin 2010), and for this reason they might be more likely to be negatively affected by a sudden negative shock. Moreover, the outbreak of COVID-19 caused a rapid decline in stock prices due to a downward revision in growth expectations (Gormsen & Koijen 2020), and such a decrease could have offset the coinsurance effect of business diversification.

To estimate the impact of corporate diversification on stock risk, we focus on the period before and after Monday, February 24, 2020 – the trading day after lockdown measures were imposed on towns in Northern Italy.[3] This event kicks off a sharp decline in the US stock market (Albuquerque et al. 2020, Baker et al. 2020, Ibikunle & Rzayev 2020) and an increase

[3] https://www.ft.com/content/5ec9aeae-56a1-11ea-a528-dd0f971febbc.

in volatility expectations, and constitutes an exogenous shock that allows us to test whether corporate diversification affects stock risk following a pandemic outbreak. Figure 1 reports the trend over time in the CBOE Volatility Index (*VIX*) and shows a sharp increase of the *VIX* from the week starting February 24, 2020, through to the week including March 17, 2020, when a peak of the Index is reached. Thereafter, the Figure highlights a gradual decline, which is possibly attributable to the fiscal stimulus package firstly announced and then approved by the US policy-making bodies (Ramelli & Wagner 2020).[4]

[insert Figure 1 here]

The shock on volatility expectations shown in Figure 1 is likely to have caused an increase in realized volatility for the average stock in the month following the shock. However, corporate diversification might have dampened or exacerbated the impact of the COVID outbreak on stock risk. This is what we explore in our paper.

We are the first to show that international diversification mitigates stock risk in the presence of negative shocks. On the other hand, business diversification reinforces the increase in daily volatility following the shock. Our findings also reveal that the mechanism underlining our results is attributable to differences in firms' vulnerability to negative shocks, as proxied by *Tobin's q* and cash holdings, in line with financial distress theory (Opler et al. 1999). Specifically, we observe that international diversification mitigates the effect of the outbreak on volatility, especially for firms with high *Tobin's q* and cash holdings. Conversely, business diversification has a positive impact on stock volatility after the shock, especially for firms with high vulnerability to negative shocks due to low *Tobin's q* and cash holdings. We interpret this finding as evidence that investors perceive firms diversifying only by business segment to be particularly vulnerable to demand shocks in the short term, given their lower *Tobin's q* ratios[5] and cash holdings,

[4] https://uk.reuters.com/article/usa-stocks/us-stocks-wall-street-gains-ahead-of-senate-vote-on-2-trillion-aid-package-idUKL4N2BI4LJ.

[5] In particular, firms that are in financial distress tend to have a higher loading on the High-Minus-Low (HML) factor, (Campbell et al. 2008), and thus firms with a low market-to-book ratio (resulting in a lower *Tobin's q*) might be more exposed to bankruptcy once the crisis hits.

coupled with their inability to tap foreign demand.

Our contribution to the literature is threefold. First, we add to the literature regarding the effects of corporate diversification on firm risk. Previous literature argues that corporate diversification is associated with lower firm risk (Mansi & Reeb 2002). However, the nature of this pandemic crisis – which has led to a sudden collapse of global trade[6] – might have been particularly detrimental to companies that diversify their operations internationally. For example, Ding et al. (2021) suggest that the COVID-19 outbreak affected mostly the stock returns of companies with customers or suppliers in countries that are more negatively affected by the COVID-19 outbreak (i.e., with a higher number of confirmed infections). Ramelli & Wagner (2020) find more nuanced results. They observe that the stock returns of US companies with exposure to China were more negatively affected in the period from January 2 to February 21, 2020, but experienced better stock returns from February 24 onward. In contrast to these papers, we focus on the impact of corporate diversification on stock risk, using the outbreak of COVID-19 as an exogenous shock in our tests. Moreover, neither of these papers examine the impact of corporate diversification.

We fill this gap by investigating the impact of international diversification and business diversification on firm-level stock risk. To disentangle the impact of these two different types of corporate diversification, we specifically consider the impact of diversifying only internationally, without diversifying by business segment, and *vice versa* (Denis et al. 2002).

Therefore, our study contributes especially to the scant literature investigating the differences between firms that diversify geographically and firms that diversify by business segment, and how these two types of corporate diversification might affect firm risk (Mammen et al. 2021). Unlike this literature, we show that diversifying internationally might be beneficial when there is a global shock that increases distress risk.

Second, we contribute to the literature regarding the effects of the COVID-19 pandemic on

[6] https://www.bloomberg.com/news/articles/2020-04-08/wto-says-2020-global-trade-collapse-may-be-worst-in-a-generation.

stock markets. While there is already some literature on the impact of the COVID-19 outbreak on the stock returns of US firms (among others, Ramelli & Wagner (2020), Albuquerque et al. (2020)), these studies do not focus specifically on the impact of corporate diversification on stock volatility. In particular, Ramelli & Wagner (2020) estimate the cumulative abnormal returns of US stocks over the outbreak and show that firms with exposure to China underperformed during the first stages of the crisis, but recovered later on as a result of the improvement in the economic outlook of the Chinese economy. However, Ramelli & Wagner (2020) do not specifically examine the impact of international and business diversification on stock risk. Albuquerque et al. (2020) estimate the impact of Environment and Social (ES) scores on the price reaction and stock volatility but do not explore the effect of corporate diversification. We build upon these studies to investigate the importance of two types of corporate diversification, geographic and business diversification, on stock risk.

Third, we contribute to the literature that investigates the relationship between corporate diversification and firm-level variables, such as growth potential (Stowe & Xing 2006) and corporate liquidity (Duchin 2010). Unlike these papers, we examine whether different types of corporate diversification can mitigate or exacerbate stock risk following an unexpected and widespread shock to the economy.

2 Literature review and hypotheses development

In this section, we develop hypotheses concerning the role of corporate diversification in the response of stock risk to the pandemic. Information on corporate diversification is available to market participants, and it is thus plausible that it might affect stock risk (Bushee & Noe 2000, Rajgopal & Venkatachalam 2011).[7]

[7] In the US, companies are required to disclose segment data in their annual reports under Statement of Financial Accounting Standards (SFAS) 131. Berger & Hann (2003) provide evidence that SFAS 131 improved the quality and quantity of segments-related information relative to the old segment reporting standard (SFAS 14), leading to improved monitoring, and Hope et al. (2008) find that geographic segment disclosures under SFAS 131 are value relevant.

The literature provides arguments in favor and against the idea that corporate diversification reduces stock risk. Although many firms pursue both types of diversification at the same time (Denis et al. 2002), the literature suggests that geographic diversification is different from business diversification, as we explain more in detail below. For this reason, in this paper we attempt to disentangle the effects of the two types of diversification by focusing on firms that engage in only one type of diversification.

2.1 Geographic diversification and stock risk

A priori, it is unclear whether geographic diversification should decrease or increase stock risk. On the one hand, geographic diversification should reduce firm risk because it might protect a firm from demand shocks in one country and, for firms with international operations, it may also improve operating flexibility by providing switching options (Belderbos & Zou 2009, Belderbos et al. 2014). Belderbos et al. (2020) provide evidence consistent with the view that foreign entry decisions are determined by the extent to which a particular country exhibits a low correlation in terms of input costs and market demand trends with the other countries in the firm portfolio.

In this paper, however, we focus on geographic diversification in terms of heterogeneity in the markets for a firm's sales, similar to Mammen et al. (2021) and, partly, Fillat & Garetto (2015). Thus, we exclude from our analysis the potential benefits of international diversification arising from improvements in operating flexibility due to switching options from an input-cost perspective (Belderbos & Zou 2009, Belderbos et al. 2014, 2020), because we choose to investigate a short period before and after February 24, 2020, and thus it is unlikely that firms had time to relocate their operations abroad.

However, international diversification might have led to diversification benefits due to a low correlation in market demand trends across countries. In fact, Gande et al. (2009) suggest that international diversification is different from business diversification because international corporate diversification allows investors to reduce the impact of restrictions on foreign investors' holdings in certain countries, which constrain the ability of investors to diversify their securities portfolios internationally. Such restrictions might lead to an inefficient portfolio allocation. Thus, international corporate diversification allows US investors to expand their efficient frontier and reach more favorable risk-return combinations (Errunza & Senbet 1984).

Nonetheless, selling in foreign markets may also increase firm risk because the fixed and sunk entry costs tend to be large and thus, once they enter the market, firms are unlikely to exit without incurring large losses. Moreover, benefits from diversification might be limited because the profits of internationally diversified firms are more sensitive to global shocks (Fillat & Garetto 2015), such as the COVID-19 outbreak. Consistent with the view that stocks of internationally diversified firms are riskier – and riskier stocks yield higher expected returns – Fillat & Garetto (2015) provide evidence of a positive correlation between international diversification and expected returns.

A second potential reason for a positive impact of international diversification on stock risk is that managing cross-border activities is complex because of cultural differences as well as different business practices and laws, and coordinating activities across borders might require higher information processing capabilities and specialized managerial expertise. Consistent with this view, Mammen et al. (2021) show that geographic diversification increases the volatility of stock returns.

Given the conflicting theoretical and empirical results in the literature, whether international diversification absorbs or amplifies stock risk remains an open question. Thus, we test two hypotheses regarding the impact of international diversification on stock risk.

H1a Cross-country risk absorption hypothesis: Following a widespread shock to the economy, international diversification reduces stock risk.

H1b Cross-border risk amplification hypothesis: Following a widespread shock to the economy, international diversification increases stock risk.

2.2 Business diversification and stock risk

Many empirical papers find that corporate diversification usually leads to a firm value discount: the value of diversified firms tends to be lower than the value of focused firms in the corresponding business segments (as identified by the 4-digit SIC).[8] The literature has discussed several potential reasons for a diversification discount: agency costs (Denis et al. 1997), inefficient allocation of capital expenditures across business-segments (among others, Rajan et al. (2000)), and firm maturity (Levinthal & Wu 2010, Hund et al. 2010). Other studies, nonetheless, suggest that the diversification discount is an artifact of measurement error (Whited 2001, Mansi & Reeb 2002, Villalonga 2004), and self-selection bias (Campa & Kedia 2002).

Hund et al. (2010) find a negative correlation between business diversification and stock risk. Leveraging a theoretical model by Pástor & Veronesi (2003), which predicts that more mature firms have lower uncertainty about mean profitability because of rational learning, Hund et al. (2010) argue that the diversification discount is related to lower uncertainty about mean profitability for diversified firms – for convenience, we call this "rational learning hypothesis".[9] While Hund et al. (2010) highlight that the risk-reduction effect of diversification by business segment should affect idiosyncratic volatility, there is also evidence that even the systematic component of stock risk might decrease. According to Hann et al. (2013), business-segment diversification leads to a coinsurance effect across business segments that decreases the cost of equity capital via a reduction in systematic risk related to the business cycle.

A negative correlation between business diversification and stock risk is also consistent with the theory and empirical evidence presented by Mammen et al. (2021), who use a resource-based view (RBV) to frame their arguments. In a nutshell, they claim that diversifying by business allows firms to exploit their resources, such as brand image, to expand their customer base in

[8] Corporate diversification can either carry value-enhancing or value-reducing effects (Berger & Ofek 1995). While the former translates into a premium in terms of firm value, the latter leads to a discount.

[9] However, the results in Table 5 and 6 of Hund et al. (2010) show that the relationship between volatility in profitability and the excess value is not always negative and significant. Thus they conclude that the diversification discount is only partly attributable to higher uncertainty about the mean for standalone firms.

new business segments. Moreover, firms can also allocate resources obtained in new markets to the most productive business segments. The latter argument is related to the theoretical framework of Levinthal & Wu (2010), who argue that the diversification discount in mature firms is a byproduct of non-scale free capabilities in profit-maximizing firms.[10] The theoretical predictions put forward by Mammen et al. (2021) are confirmed by empirical results.

Despite these considerations, there might also be a positive relationship between business diversification and stock risk. This is possible because operating across different segments might result in higher coordination costs. Moreover, in the case of a widespread adverse shock to the economy, such as the one that we exploit for identification, the coinsurance effect of business diversification might decrease substantially, and firms that diversify only by business might experience a stronger increase in stock risk than other firms.

A positive correlation between diversification by business segment and stock risk could also be related to the diversification discount. In fact, risk-averse investors might penalize stocks of business-diversified firms if they believe that these stocks are riskier, leading to lower market value for business-diversified firms than for focused firms. Related to this issue is the potential misallocation of resources in internal capital markets. This phenomenon happens when firms do not allocate resources across business segments on the basis of the quality of their potential projects, and thus stronger segments subsidize weaker ones. Such a "cross-subsidization hypothesis" is confirmed, among others, by Scharfstein (1998), Rajan et al. (2000), and Martin & Sayrak (2003): business-diversified firms invest too much in low *Tobin's q* segments and too little in those with high *Tobin's q*.

Importantly, these arguments based on the "cross-subsidization hypothesis" are in direct opposition to those based on the "rational learning hypothesis" described above (Hund et al. 2010). However, the results reported by Hund et al. (2010) do not fully support the "rational

[10]Non-scale free capabilities, such as product development expertise, have opportunity costs, while scale free capabilities, such as brand image, do not. The presence of opportunity costs forces profit-maximizing firms to allocate resources to those business segments that are more productive.

learning hypothesis" (as explained in footnote 9).

There could be other reasons for a positive correlation between business diversification and stock risk. For example, firms that decide to diversify their business might simultaneously increase the riskiness of their assets (Che & Liebenberg 2017), leading to a positive correlation between business diversification and stock risk. Moreover, firms that diversify by business segment tend to have a lower *Tobin's q* (Martin & Sayrak 2003, Gopalan & Xie 2011) and cash holdings (Duchin 2010, Bakke & Gu 2017) than other firms.[11] A low *Tobin's q* can lead to a higher risk of financial distress (Lindenberg & Ross 1981, John 1993, Opler et al. 1999). Similarly, a low level of cash holdings, all other things being equal, reduces the ability of a firm to withstand negative shocks (Lins et al. 2010).

Thus, similar to international diversification, business diversification might also have an ambiguous impact on stock risk. Our hypotheses are thus as follows.

H2a Cross-segment risk-absorption hypothesis: Following a widespread shock to the economy, business diversification reduces stock risk.

H2b Cross-segment risk amplification hypothesis: Following a widespread shock to the economy, business diversification increases stock risk.

2.3 Differences between international and business diversification

In the section above, we have used previous literature to develop hypotheses regarding the impact of international and business diversification on stock risk. Some of the arguments are valid for both types of diversification. For example, from a mathematical standpoint, exploiting low correlation in market demand across different markets should be beneficial regardless of how the market is defined (country or business-segment). Thus, the coinsurance effect could, in theory, occur via either type of diversification. Similarly, coordination costs, which might increase stock risk, might be present in both business-diversified and internationally diversified

[11] These findings are confirmed in our sample, as reported in Table 2.

firms. However, in practice, the two types of diversification might lead to different economic outcomes because of several reasons, which we discuss below.

First of all, consistent with the "imperfect world capital markets" theory, international corporate diversification can allow US investors to benefit from a low correlation between the US stock market returns and the returns of foreign stock markets when there are substantial entry barriers to US investors who want to buy stocks on that particular stock market (Gande et al. 2009). However, this type of benefit does not extend to business-segment diversification due to the absence of differential entry barriers for US investors on US stock exchanges. In other words, all other things being equal (e.g., same US stock exchange, same trading volume, same bid-ask spread), buying stocks on a US stock exchange in a focused firm carries exactly the same transaction costs for a US investor as buying stocks in a business-diversified firm. Thus, business diversification might not be valuable to US investors because they should be able to diversify their portfolios by themselves: they can buy US stocks of standalone firms across different industries (Berger & Ofek 1995, Dastidar 2008).

Secondly, the literature on business diversification finds that business-diversified firms tend to have a lower *Tobin's q* and cash holdings than focused firms. Such an empirical finding does not necessarily extend to international diversification. In fact, there is evidence that firms that diversify their sales internationally tend to have a higher *Tobin's q* (Chang & Wang 2007) and tend to hoard cash in periods of economic downturn (Benkraiem et al. 2020). In a preliminary analysis of our sample (reported in Section 3.3), we find that internationally-diversified (business-diversified) firms tend to have, on average, a higher (lower) *Tobin's q* and cash holdings than focused firms. As mentioned above, a lower *Tobin's q* implies higher financial distress (Lindenberg & Ross 1981, John 1993, Opler et al. 1999). Likewise, a low level of cash holdings can reduce the ability of a firm to absorb negative shocks (Lins et al. 2010). Thus, lower (higher) *Tobin's q* and cash holdings might result in a higher (lower) stock risk for business-diversified (internationally-diversified) firms.

3 Methodology and Data

In this section, we describe our econometric strategy and our sample. In Section 3.1, we illustrate the methodology employed in our main analysis, which is based on daily measures of volatility similar to Albuquerque et al. (2020). In Section 3.2, we explain the main characteristics of our sample and our sample selection criteria. In Section 3.3, we report the results of a preliminary analysis concerning the main characteristics of firms that engage in different types of corporate diversification.

3.1 Difference-in-differences regressions

To estimate the impact of the shock kicked off by the sudden increase in the *VIX* on stock risk we rely on a difference-in-differences approach. Similar to Albuquerque et al. (2020), we consider as a proxy for daily volatility the difference between the highest daily price (Compustat item "prchd") and lowest daily price ("prcld") divided by their average:

$$DailyVol = \frac{(High - Low)}{(High + Low)/2} \tag{1}$$

We use a dummy for the COVID-19 outbreak period, *COVID*, which is equal to one between February 24 to March 17, 2020 and is equal to zero between January 2 and February 21, 2020. We then interact this dummy with the proxies for diversification. Following the literature (Denis et al. 2002, Campa & Kedia 2002, Fillat & Garetto 2015), we use dummies to estimate the impact of diversification. Since the purpose of this paper is to disentangle the impact of international diversification from that of business diversification, we employ the following dichotomous variables: a dummy that is equal to one if a firm engages only in international diversification, *Only International*, but not by business segment, and zero otherwise; a dummy that is equal to one if a firm diversifies only by business segment, *Only Business*, but not internationally, and zero otherwise.

Using dummies, rather than continuous variables, enables us to use a difference-in-differences approach based on *Only International* and *Only Business*. We estimate the following regressions:

$$DailyVol_{it} = a_0 + a_1 COVID_t \times Only\ International_i + \gamma_i + \nu_t + e_{it}$$
$$DailyVol_{it} = a_0 + a_1 COVID_t \times Only\ Business_i + \gamma_i + \nu_t + e_{it} \quad (2)$$

where i identifies each firm (the dummies *Only International* and *Only Business* are time-invariant) and t the days. We add day fixed effects (ν_t) to allow for events occurring during the sample period unrelated to the COVID-19 outbreak. We also include stock fixed effects (γ_i) to consider time-invariant firm-specific characteristics that we cannot capture in our dataset. In our main tables, we also show what happens to our results if we extend the time period up to March 31 to consider the impact of the announcement of fiscal measures after March 17, similar to Albuquerque et al. (2020). Thus, we let the variable *COVID* be equal to one until March 31, and we also construct a control variable, named *FISCAL*, equal to one for the period when fiscal measures were implemented (from March 18 to March 31, 2020), and zero otherwise (Albuquerque et al. 2020). Including this dummy allows us to achieve a cleaner identification of the impact of the COVID-19 outbreak. We cluster the standard errors at the firm and day level (Albuquerque et al. 2020).

To identify firms that diversify internationally, we use data on geographic segments, for which in Compustat Segments the item "stype" is equal to "GEOSEG". We define firms as internationally-diversified if the item "sales" in Compustat Segments is positive and the item "geotp" is equal to 3, indicating foreign sales (Abdi & Aulakh 2018). Using foreign sales to define international diversification is standard in the literature (Wiersema & Bowen 2011).

In Compustat Segments, the item "stype" is equal to "BUSSEG" for business segments. Following Hund et al. (2010), we consider a firm as diversified by business segment if it reports more than one business segment.

3.2 Data

We collect stock price data from Compustat Capital IQ North America Daily database, available from the Wharton Research Data Services (WRDS). We then apply a number of filters that are standard in the corporate finance literature. First, we consider all common stocks (for which the Compustat item "tcpi" is equal to zero) that are traded on the NYSE, AMEX, and NASDAQ exchanges (Compustat codes 11, 12, and 14). Second, we exclude cases for which prices are below \$5 and above \$1,000 (Bali et al. 2017). Then, we match these data with the prices and adjustment factors needed to compute stock returns (items "prccd", "prchd", "prcld", "trfd" and "ajexdi"). The resulting dataset is then merged with the latest accounting data available from Compustat Capital IQ Fundamentals Quarterly (items "atq", "niq", "ceq", "che", "dltt", "dlc", "sale", "cogs", "xsga", "dvpsx_f", and "prcc_f"). Finally, following the literature on corporate diversification (Fillat & Garetto 2015),[12] we add data from the Compustat Segments database to compute our measures of corporate diversification (items "sales", "ias", "sid", "geotp" and "stype"). Consistent with previous literature (Thomas 2002, Colla et al. 2013) we drop from our sample firms in the financial services industry (SIC 6000–6999) and regulated utilities (SIC 4900–4949).

After applying our selection criteria, we end up with a sample of 2,287 firms and a maximum number of daily observations equal to 128,959 in our regressions. Table 1 shows summary statistics of the main variables employed in our main analysis, as well as alternative proxies for stock risk: *ImpliedVol*, the implied volatility of options with an absolute value of delta equal to 0.50, *Negative Skewness*, the difference between the implied volatility of Out-of-The-Money (OTM) puts, and At-The-Money (ATM) calls, and *Positive Skewness*, the difference between the implied volatility of OTM calls and ATM puts.[13] We use these alternative proxies for stock risk in robustness checks and extensions.

[12] We refer the reader to Fillat & Garetto (2015) for a more detailed description of the Compustat Segments database.

[13] We define OTM puts (calls) as those with a delta between –0.375 and –0.125 (0.125 and 0.375), and ATM puts (calls) as those with a delta between –0.625 and –0.375 (0.375 and 0.625), as in Kim & Zhang (2014).

[insert Table 1 here]

3.3 Preliminary analysis

As a preliminary analysis, we investigate whether diversified and undiversified firms differ substantially in terms of structural differences that affect firm value (i.e., whether there is a diversification discount/premium).

Given its relevance in the literature on corporate diversification (Berger & Ofek 1995, Whited 2001, Campa & Kedia 2002, Villalonga 2004, Dastidar 2008, Custódio 2014), we start by assessing whether diversified firms trade at a discount or at a premium. Following Berger & Ofek (1995), we estimate the excess value of business-diversified firms by considering the natural logarithm of the actual firm value divided by imputed firm value. The actual value is equal to the total book value of debt plus the market value of equity (total capital). The imputed value is the sum of the imputed values of each segment. Each segment's imputed value is the segment's sales multiplied by the median, at the industry level, of the ratio of total capital to sales of standalone firms.[14] Following the literature, we consider the 4-digit SICs to define the segments over which we compute the median. When there are fewer than five standalone firms for a given 4-digit SIC, we calculate the industry median considering the 3-digit SIC. Likewise, if there are fewer than five standalone firms for a 3-digit SIC, we use the corresponding 2-digit SIC definition. Overall, while for firms that diversify only by business segment we find an average diversification discount of 11.6% – consistent with the literature – firms that diversify only internationally display an average diversification premium of 17%.

We also investigate the impact of exposure to risk factors and other firm-specific characteristics that might affect the probability that a firm diversifies by country or by business segment. Given the sudden increase in volatility expectations in the week starting on 24 February (see Figure 1), we use an asset-pricing model that allows for a factor related to changes in VIX, ΔVIX_t, as in

[14]Standalone firms are firms reporting sales in one business segment only.

Ang et al. (2006):[15]

$$R_{it} - R_{ft} = \alpha_i + \beta_{im}(R_{mt} - R_{ft}) + \beta_{VIX}\Delta VIX_t + \epsilon_{it} \quad (3)$$

where R_{it} is the stock return for stock i on day t, R_{mt} is the return on the market portfolio proxy and R_{ft} is the risk-free rate proxy. We retrieve daily data for the risk-free rate and the market excess return from Kenneth French's website. The model parameters are estimated over the period January 2, 2019 – December 31, 2019, similar to Ramelli & Wagner (2020). We require at least 30 observations in the estimation period for each stock.

Table 2 reports the main characteristics of firms that diversify internationally or by business segment and also provides t-tests to establish whether firms that choose to diversify are inherently different from firms that do not. In addition to the variables already mentioned, we consider: *Size*, which is the natural logarithm of total assets; cash holdings to total assets (Gu 2017), denoted *Cash Holdings*; *Tobin's q*, defined as the ratio of the market value of assets (i.e., the book value of assets minus the book value of equity plus the market value of equity) to the book value of assets (Custódio 2014); *Leverage*, calculated as the sum of long-term plus short-term debt divided by total assets (Lins & Servaes 1999, Fauver et al. 2004); *Operating Leverage*, computed as annual operating costs (i.e., cost of goods sold plus selling, general and administrative expense) divided by total assets (Novy-Marx 2011); firm age (*Age*), which is the natural logarithm of the number of years since the firm is available in Compustat (Hund et al. 2010); and the *Dividend-Price ratio*, calculated as dividends per share divided by share price (Hund et al. 2010). All variables, except for *Size* and *Age*, are winsorized at the 1st and 99th percentiles.

We observe a stark difference between firms that diversify only internationally and those that diversify by business segment. Indeed, firms that diversify only internationally are younger and smaller than those that diversify only by business segment, and they also carry a lower

[15] We avoid using other factors, such as those in Carhart (1997), because they could create too much noise in the estimation (Ang et al. 2006) – we thank an anonymous reviewer for bringing this issue to our attention. Our main results, nonetheless, remain unaltered even when we use the factors in Carhart (1997) in our analysis.

dividends-to-price ratio. Firms that diversify only internationally also display a higher *Tobin's q*, suggesting that firms that diversify only by business have lower growth potential (Cao et al. 2006, Duchin 2010, Kogan & Papanikolaou 2014) and greater vulnerability to negative shocks, since a lower *Tobin's q* implies a higher distress risk. This result is also consistent with previous literature suggesting that business diversification tends to result in lower *Tobin's q* (Martin & Sayrak 2003, Gopalan & Xie 2011). These statistics on firm age, size, dividends and growth potential or distress risk (as proxied by *Tobin's q*) reveal that, overall, firms that diversify only by business tend to be more mature than firms that diversify only internationally, consistent with Hund et al. (2010). Firms that diversify only internationally have larger cash holdings and tend to be less risky: they have lower leverage and operating leverage. Finally, firms that diversify only internationally exhibit a higher sensitivity to changes in the market portfolio (β_{im}) but a lower sensitivity to the *VIX* factor (β_{VIX}) than firms that diversify only by business segment. Again, this preliminary finding seems to indicate that business-diversified firms might be more sensitive to changes in volatility expectations, and thus they might be riskier than internationally-diversified firms.

[insert table 2 here]

4 Empirical Analysis and Results

In this section, we report our main results and further tests aiming to investigate the mechanism through which corporate diversification might influence stock risk. In particular, we discuss our main results and related robustness checks in Section 4.1. In Section 4.2, we investigate the potential channels underlying our results. Specifically, we consider the importance of vulnerability to negative shocks, exposure to specific countries and world regions, and the primary macro-sector of the company.

4.1 Main Results

Table 3 reports the results of our difference-in-differences regressions on *DailyVol*. In Panel A, we report the results using both firm and day fixed effects, as for equation 2. In Panel B, we report for robustness the results without firm fixed effects, adding the following control variables: *Leverage*, *Size*, *Book-to-Market*, *Cash Holdings*, and *ROE*.[16]

In Columns (1) and (3), we consider the whole quarter by including the interactions with the dummies *COVID* and *FISCAL*. In Columns (2) and (4), the end date of the sample period is March 17, and thus the dummy *FISCAL* is excluded. The results reported in Columns (1) and (2) suggest that diversifying only by country dampens the impact of the COVID outbreak: the coefficients on the interaction term *COVID * Only International* are negative and significant. The size of the coefficients is very similar in the two specifications: −0.0024 in Column (1) and −0.0023 in Column (2). These results are consistent with H1a: following a widespread shock to the economy, international diversification reduces stock risk.

The results for *COVID * Only Business*, reported in Columns (3) and (4), suggest that diversifying only by business leads to a higher volatility during the COVID-19 outbreak. The coefficient on *COVID * Only Business* in Column (4) remains similar to that in Column (3) after excluding *FISCAL * Only Business*.

Regressions reported in Panel B of Table 3 – which exclude firm fixed effects – confirm the results provided in panel A, thus ruling out the possibility that the inclusion of firm fixed effects drives our main findings.[17]

Overall, the results reported in this section suggest that international diversification had a

[16] We thank an anonymous reviewer for this suggestions. These variables are time-invariant during the sample period, and for this reason we cannot use firm fixed effects in these regressions. They are defined as follows: *Leverage* is the sum of long-term plus short-term debt divided by total assets; *Size* is the natural logarithm of total assets; *Book-to-Market* is the ratio of the book value of assets to the market value of assets (the book value of assets minus the book value of equity plus the market value of equity); *Cash Holdings* is the ratio of cash to total assets; *ROE* is the return on equity.

[17] Table A1 in the Internet Appendix shows model specifications (without firm and day fixed effects) including interactions of firm characteristics with the *COVID* and *FISCAL* dummies. This approach helps alleviate potential concerns that the *COVID***Only International* and *COVID***Only Business* interactions are unintentionally picking up differential effects of other firm characteristics pre- and post-*COVID*. We are grateful to an anonymous reviewer for pointing this out.

negative impact on stock risk during the COVID outbreak, consistent with H1a, while business diversification increased daily volatility, consistent with H2b.[18]

Our findings support the view that investing in internationally-diversified firms might be beneficial to US investors because it allows to exploit different demand trends across countries, even for those countries whose stock markets present entry barriers to US investors.

On the other hand, relying only on business diversification might reduce the ability of firms to mitigate the impact of global shocks that affect different countries in different periods, such as the COVID-19 outbreak. The coinsurance effect of diversifying by business segments might not be beneficial to US investors, as it might be achieved relatively easily by investing in stocks of focused firms in different industries (Berger & Ofek 1995, Dastidar 2008). Moreover, as shown in Section 3.3, business-diversified firms tend to have a lower *Tobin's q* and low cash holdings than other firms (Martin & Sayrak 2003, Duchin 2010, Gopalan & Xie 2011), and thus they might be more vulnerable to adverse macroeconomic shocks.

The tests in this section do not specifically investigate the mechanism through which diversification affects stock risk and, in particular, vulnerability to negative shocks and the effects deriving from being exposed to certain countries and/or industries. For this reason, we provide more tests about the role of vulnerability to negative shocks and exposure to different markets in Section 4.2.

[insert table 3 here]

We now present further analyses aimed at checking the validity of our empirical framework. In particular, our inferences might be invalid if our data does not satisfy the parallel trend assumption and if there is self-selection bias: firms that decide to diversify, either by country or by segment, might be systematically different from firms that do not. Moreover, we also

[18] Our main findings are corroborated if we take the exposure to foreign suppliers into consideration in our analyses. Specifically, Table A2 in the Internet Appendix shows that our results do not change appreciably if we run our regressions on a subsample that only includes firms that rely on foreign suppliers, as defined by Hoberg & Moon (2017).

offer tests utilizing alternative proxies for our main variables (proxies for stock volatility and corporate diversification). The results of these robustness checks are reported in the Internet Appendix.

We start by providing tests for the parallel trend assumption, which essentially requires similar trends in the dependent variable for the treatment and control group during the pre-treatment period (i.e., before February 24, 2020). Since differences in the levels of *DailyVol* across groups are eliminated by the stock fixed effects in our estimations (Lemmon & Roberts 2010), we test specifically for the existence of different linear trends across firms in the treatment and control group as suggested by Kahn-Lang & Lang (2020). We do this for the period from 20 January to February 21 ("Outbreak" period in Ramelli & Wagner (2020)). First, we run the regressions considering, as a dependent variable, the average of *DailyVol* for the treatment and control groups, on the basis of the dummies *Only International* and *Only Business*.[19] Then, we repeat the analysis for the original firm-level values of *DailyVol*. The results shown in Table A3 in the Internet Appendix suggest that, during the pre-treatment period, the time trend in *DailyVol* was similar across treatment and control groups. In particular, the interaction terms between *Time* (a linear time trend) and the dummies *Only International* and *Only Business* are statistically insignificant.

We complement these parallel trend tests with a visual illustration. Figures A1 and A2 show the pre- and post-treatment weekly trend of *DailyVol* separately for *Only International* equal to one and zero (Figure A1) and for *Only Business* equal to one and zero (Figure A2). These graphs highlight that, before the shock of February 24, 2020, the trends for the two groups are very similar. After the shock, however, internationally-diversified firms experienced a lower increase in daily volatility than those for which *Only International* is equal to zero. Conversely, stocks of firms that diversify by business – which before February 24 were less volatile than

[19] This is similar to showing graphs of the time trend of the average of the dependent variable for the treatment and control group in the pre-treatment period, as is often the case in the financial economics literature (for example, Cipriani & La Spada (2021)).

other firms – become increasingly volatile in the weeks following the shock, and by March 18 they are significantly riskier than firms in the control group. These graphs, thus, suggest that the parallel trend assumption is satisfied and that firms diversifying only by business experience a particularly strong increase in volatility following the COVID-19 shock on February 24. For both graphs, we also observe a sudden decrease in *DailyVol*, in line with the view that the announcement of policy measures by the US government was effective in calming the market.

A second potential threat to our identification strategy is self-selection into the treatment group. As reported in Section 3.2, firms that diversify internationally or by business tend to differ from firms that do not diversify along several dimensions. For this reason, we run a Propensity Score Matching analysis to allow for potential self-selection bias due to observable firm characteristics. We run a probit model where the dependent variable is either *Only International* or *Only Business*, and the independent variables are those that in Table 2 display statistically different means for diversified and focused firms. Then, using a caliper of 0.001, we run our baseline regressions only on the firms in the common support. The results in Table A4 in the Internet Appendix are very similar to those reported in Table 3, suggesting that our inferences are correct.[20]

To improve the robustness of our results, we consider alternative proxies for stock risk. First, we consider implied volatility, and for this reason we collect data from OptionMetrics and replace *DailyVol* with implied volatility in our baseline regressions (*ImpliedVol*). We use at-the-money options with an absolute value of delta equal to 0.50 and an expiry date of 30 days (An et al. 2014). Our results, reported in Table A5 in the Internet Appendix, are very similar to those provided in Table 3, suggesting the variable used to proxy for daily volatility does not affect our

[20]The regressors are the variables for which the t-tests in Table 2 are statistically significant at the 5% for either *Only International* or *Only Business*. Panel B of Table A4 reports the results of post-match t-tests for the same variables used in the probit regressions. Columns (1) and (2) show the mean values for each variable for *Only International*=1 and *Only International*=0, respectively. Columns (3) and (4) show that none of the post-match t-tests rejects the null hypothesis that the differences are zero at the 5% significance level, thus indicating that the two matched groups are similar in all observable dimensions.

main inferences.[21,22]

Then, we estimate the impact of diversification on proxies of extreme downside and upside risk, using data on the volatility smirk (Kim & Zhang 2014). In particular, we calculate the difference between the implied volatility of out-of-the-money (OTM) puts and at-the-money (ATM) calls as a proxy for negative implied skewness (Kim & Zhang 2014), *Negative Skewness*. Similarly, we use the difference between the implied volatility of OTM calls and ATM puts as a proxy for positive implied skewness (*Positive Skewness*). The results displayed in Table A8 in the Internet Appendix indicate a positive impact of business diversification on *Negative Skewness*, and there is also some evidence of an effect on *Positive Skewness*. However, the coefficients on the interaction terms between COVID and *Only International* are insignificant.

Finally, we also present results with two alternative proxies of corporate diversification. For business diversification, we use the number of business segments (*N Seg Bus*) reported by the firm, while for international diversification we use the ratio of foreign sales to total sales (*Foreign Sales*). We do not use the number of geographic segments because firms do not usually disclose the number of countries. Most firms tend to disclose the name of several geographic segments, and this could be either a country or, in many cases, the region where they export (e.g., Europe, Middle-East). Such a lack of consistency in the reporting of the geographic segments is likely to lead to a significant measurement error. On the other hand, the ratio of foreign sales to total sales is likely to provide us with a good measure of the extent to which firms are exposed to international markets. The results, reported in Table A9 in the Internet Appendix, are consistent with our main findings.[23]

[21] The two proxies are highly positively correlated (72%, p-value=0.0000).

[22] The results on *DailyVol* and *ImpliedVol* are further corroborated if we exclude from our sample the stocks that trade below $5 at the beginning of the sample period (i.e., January 2, 2020), instead of at any given day (see Table A6 in the Internet Appendix). Likewise, our results remain very similar if we do not adopt such a lower-bound filtering criterion and include even stocks with a price lower than $5 (see Table A7 in the Internet Appendix).

[23] In Tables A10 and A11, we provide further robustness tests. In the former, we include both dummies, *Only International* and *Only Business* in the same regression; the results are, overall, consistent with those of our main regressions. In the latter, we construct a dummy, *Int & Bus Diversification Dummy*, which is equal to one if a firm diversifies both internationally and by business, and zero if a firm does not diversify at all. All the remaining observations – for which either type of diversification is performed, but without the other – are discarded. The results in Table A11 provide mixed evidence of a negative impact for *COVID * Int & Bus Diversification Dummy*.

4.2 The mechanism

In this section, we dig deeper in our empirical analysis to explore more in detail the channel through which diversification, either geographic or by business, might affect daily volatility.

4.2.1 Vulnerability to adverse macroeconomic shocks

To understand the mechanism underlying our results, we examine the importance of vulnerability to adverse macroeconomic shocks in explaining our findings. Consistently with financial distress theory (Opler et al. 1999), firms with low market valuations and cash holdings are likely to be more vulnerable than better-performing firms when a sudden and unexpected widespread shock – such as COVID-19 – hits the economy.

For this reason, our first proxy for vulnerability to negative shocks is the *Tobin's q* ratio. This ratio is negatively related to the risk of financial distress (Lindenberg & Ross 1981, Opler et al. 1999) and it can proxy for the loss of going-concern value resulting from liquidating a firm's asset (John 1993). A high *Tobin's q* ratio decreases the probability that the value of the firm's assets will be insufficient to pay back the firm's creditors. *Tobin's q* is negatively correlated with the book-to-market ratio, which is often used as a proxy for distress risk (among others, Campbell et al. (2008), Kapadia (2011)). In particular, Kapadia (2011) finds that, when there is news indicating that failure rates will rise, value stocks (i.e., stocks with low market-to-book ratios) underperform growth stocks (i.e., stocks with high market-to-book ratios). Since the news of the lockdown might signal that failure rates will rise, this might have led to an increase in the riskiness of business-diversified firms (which have, on average, lower market-to-book ratios).[24]

As reported in Table 2, firms that diversify internationally tend to have a significantly higher *Tobin's q* than other firms, while firms that diversify only by business segment tend to have a significantly lower *Tobin's q* than other firms.

We run our difference-in-differences analysis on sample splits based on the median value

[24] *Tobin's q* also proxies for firm value Mackey et al. (2017)) or growth potential (Cao et al. 2006, Duchin 2010, Kogan & Papanikolaou 2014).

of this proxy. This analysis can also be interpreted as an investigation of non-linear effects within the group of treated firms, depending on the value of the variable considered in the splits (Benetton & Fantino 2021). We use sample splits instead of interactions because they are easier to interpret (Pool et al. 2012). We expect that if our main results depend on differentials in the risk profile of diversified firms, the negative impact of international diversification on *DailyVol* should be stronger for firms that are less vulnerable to negative shocks (those with a high *Tobin's q*). *Vice versa*, the positive impact of business diversification should be stronger for more vulnerable firms, and thus the coefficient on *COVID * Only Business* should be significant for firms with a low *Tobin's q*.

The results reported in Panel A of Table 4 show that the negative coefficient on *COVID * Only International* is negative and statistically significant only for firms with values of *Tobin's q* above the median. *Vice versa*, the results for *COVID * Only Business* are significant only for firms with values of *Tobin's q* below the median. Thus, it appears that the impact of the COVID-19 outbreak on daily volatility depends on whether international and business diversification occur in firms with a high or low *Tobin's q*. For firms that diversify internationally, a high *Tobin's q* indicates that the firm is able to exploit the staggering impact of the pandemic crisis on different countries to mitigate the effect of the shock. For this reason, only these firms experience a decrease in volatility relative to other firms. This finding supports H1a.

Firms that diversify by business, on the other hand, experience a stronger increase in daily volatility during the COVID-19 crisis only if their *Tobin's q* is low. This result suggests that only firms which are already relatively close to default experience an increase in daily volatility during the period from February 24 to March 17, 2020, consistent with H2b. These findings are robust to the inclusion of *FISCAL * Only International* in Columns (1), (3), (5), and (7).[25]

[25] Because of the importance of the book-to-market ratio as a risk factor related to financial distress (Campbell et al. 2008), we also try sample splits based on the sensitivity of a stock to the HML factor (β_{HML}), estimated using the four-factor model introduced by Carhart (1997), instead of the *Tobin's q*. Our results, available upon request, are consistent with those in Panel A of Table 4. In particular, the negative coefficient on *COVID * Only International* is negative and statistically significant only for firms with values of β_{HML} below the median; *vice versa*, the results for *COVID * Only Business* are significant only for firms with values of β_{HML} above the median.

[insert table 4 here]

As suggested by Duchin (2010), the ability to diversify investment opportunities in different business segments allows diversified firms to have substantially lower cash holdings than stand-alone firms. This negative relationship between corporate liquidity and business diversification is consistent with the results of the t-tests for *Cash Holdings* in Table 2, where we find that firms that diversify only by business tend to have a significantly lower ratio of cash to total assets than other firms. On the other hand, firms that diversify internationally tend to have significantly higher cash holdings. Moreover, Ramelli & Wagner (2020) provide evidence that cash holdings improve the stock performance of US firms during the COVID-19 outbreak. Thus, cash holdings might also be an important source of heterogeneity in the response of stock volatility to the COVID-19 crisis.

For this reason, we also examine the impact of cash holdings in explaining our results. Therefore, we rerun our baseline regressions after splitting the sample on the basis of the median value of *Cash Holdings*, similar to what we have done for *Tobin's q*. The results, reported in Panel B of Table 4, reveal that the interaction term *COVID * Only Business* is positive and significant only for firms with low *Cash Holdings*, while the coefficient on *COVID * Only International* is negative and significant only for firms with high *Cash Holdings*. Thus, the positive impact of diversifying by business segment on *DailyVol* disappears for firms with high *Cash Holdings*, suggesting that the reason for the positive impact of business diversification is limited to those firms with low levels of corporate liquidity. Conversely, firms that diversify internationally benefit from a reduction in volatility, but only if they have high levels of corporate liquidity. These findings corroborate those provided by Ramelli & Wagner (2020) about the importance of cash holdings, for investors, during the COVID-19 crisis.

4.2.2 Which countries are driving our results?

The ability to absorb a negative shock such as the COVID-19 outbreak might be affected by the degree to which a firm is exposed to certain countries and industries. In this section, we examine the contribution of this channel in explaining our results.

Previous literature on the impact of the COVID-19 outbreak on stock markets highlights the role of exposure to individual countries, particularly China and Italy (Ramelli & Wagner 2020, Ding et al. 2021).[26] Since the crisis in Italy might have also affected other European countries, we also examine the exposure to the whole of Europe, rather than only Italy. Considering Europe, instead of only Italy, is important even because some firms might disclose operations in Italy as "Europe", and some might not. This is related to the disclosure requirements of SFAS 131. Thus, the number of firms with exports to Italy is likely to be downward biased.

Table 5 reports the results of regressions using dummies equal to one if a firm exports to China (Column (1)), Europe (Column (2)), or Italy (Column (3)), and zero otherwise. These dummies replace the dummies *Only International* in our main tests. Since firms can be exposed to China and Europe at the same time, in Column (4) we consider the impact of exporting to China, but not to Europe. Similarly, in Columns (5) and (6) we evaluate the impact of exporting to Europe or Italy without exporting to China.

Our findings suggest that exposure to Italy does not seem to affect *DailyVol*.[27] Firms exposed to China and Europe tend to benefit from a reduction in *DailyVol* during the period February 24 – March 17 (*COVID*=1). However, once we consider exposure to Europe net of exposure to China, the coefficient on *COVID * Europe* becomes insignificant at the 5% level (Column (5)). The interaction *COVID * China*, on the other hand, remains significant at the 1% level even

[26]For example, (Ramelli & Wagner 2020) find that firms exposed to China experienced a better stock performance in the period following the lockdown announcement in Italy, plausibly because China was already recovering from the outbreak in that period.

[27]The results for Italy might be insignificant because of the low number of observations for which firms disclose sales to Italy. Because of the SFAS 131 reporting requirements, many of the firms that disclose sales to Europe might be selling to Italy as well. For this reason, the actual impact of being exposed to Italy might be under-estimated.

after excluding firms exposed to Europe. In fact the magnitude of the coefficient increases in Column (4) relative to Column (1).

[insert table 5 here]

We also examine how important the exposure to China, Europe, and Italy is in driving our findings for *Only International*. In Table 6 we report the results of our baseline regression after excluding firms with sales to China, Europe, and Italy (Columns (1)–(3), respectively), and only considering firms with sales to China, Europe, and Italy (Columns (4)–(6)). The results in this table suggest that the coefficients on *COVID * Only International* lose significance once firms exposed to either China or Europe are excluded from our sample. Moreover, while considering only firms with sales to China leaves the coefficient on *COVID * Only International* negative and significant, the coefficients on this interaction term become insignificant once we limit our analysis to firms exporting either to Europe or Italy.

Overall, these findings suggest that the reduction in volatility observed for internationally-diversified firms might be due to a staggered impact of COVID-19 globally. In particular, after February 24, 2021 China had started its economic recovery, while Europe was just being hit by the first COVID-19 wave. These results are also in line with the view that US shareholders of firms exporting to China benefited from international corporate diversification as a way to circumvent barriers to holding Chinese stocks.

[insert table 6 here]

Finally, we investigate the impact of lockdowns across the world to allow for the possibility that this type of event might affect our main inferences. Given that the companies can either disclose the specific country or the macro-region/continent towards which they sell, we proceed as follows. For each macro-region/continent, we identify the country which first experienced a local or national lockdown before March 31, 2020 (end of our sample period).[28] We exclude Asia

[28] We collect this information from: https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker

– because the first Asian country facing a lockdown was China and other countries did not have national lockdowns during our sample period – and Europe because we have already reported the related results in Tables 5 and 6.

The first African country experiencing stringent measures was Rwanda on March 21 (Saturday), so we consider March 23 (Monday) – the first trading day following the announcement – as a date for all companies that export to an African country. We then consider South America, where the first country facing a lockdown was Peru (Sunday, March 15, so we consider Monday, March 16). For Oceania, the first lockdown was in New Zealand on Saturday March 21, followed by a lockdown in Australia on March 24, and thus we consider Monday 23. Finally, we also consider the Middle East, because Iran was one of the countries that experienced a very large number of cases and deaths in the first quarter of 2020, and a lockdown started on March 5.

In the Internet Appendix, Table A12, we report the results of regressions similar to those displayed in Table 6, where we exclude firms that export to each of the identified regions. We also run regressions where we include interaction terms between a dummy that identifies firms that export to a particular region and a dummy that is equal to one from the start date of the lockdown to the end of our sample period (March 31). Overall, the results highlight that the coefficients on *COVID * Only International* remain negative and significant even after excluding firms exporting to these countries, and even after adding interaction terms identifying the impact of the lockdowns in those regions. Therefore, it is unlikely that our findings are due to confounding effects deriving from lockdowns implemented at different points in time in other countries.

The findings in this section support the view that international diversification might allow US investors to exploit a low correlation in market demands across different countries, and it is thus beneficial, in line with the "imperfect world capital markets" theory. In particular, the benefits of international diversification might be more pronounced for those stocks issued by firms that export to countries whose stock markets present significant entry barriers to US investors (Gande et al. 2009), such as China.

4.2.3 Analysis by macro-sectors

Our results for business diversification might be driven by certain sectors. For this reason, we run our regressions again, after excluding firms according to their macro-level industrial group based on their 2-digit SIC. In particular, we consider the following sectors: Mining (SIC codes: 10-14), Construction (15-17), Manufacturing (20-39), Transport (40-47), Communications (48), Wholesale (50-51), Retail (52-59) and Services (70-89).[29]

The results reported in Table 7 suggest that most of the firms in our sample are in the Manufacturing sector. However, excluding firms in each of the sectors above does not affect our main results. Therefore, it does not seem that the positive and significant effect of *Only Business* in Table 3 is driven by firms in certain sectors.

[insert table 7 here]

However, some sectors react worse than others, as shown in Table A13 in the Internet Appendix, which reports the results of regressions where dummies for the primary sector (2-digit SIC) are interacted with the dummies *COVID* and *FISCAL*, and the interaction terms between *Only Business* and the dummies *COVID* and *FISCAL*.[30] Adding these interaction terms does not change the main results for *Only Business*, since the coefficients on *COVID * Only Business* remain positive and significant.

[29] We consider the classification provided by the website: https://siccode.com/. For Agriculture, Forestry and Fishing, SICs 01-09, the number of observations is very low, and there are no firms in our sample that belong to Public Administration, SICs 91-99. For this reason, we exclude firms in these sectors from this analysis.

[30] In particular, the coefficients on the interaction terms between *COVID* and *FISCAL* and the sector dummies suggest that firms in the following sectors experience a stronger increase in volatility during the COVID-19 crisis: Mining, Construction, Transport, Wholesale, and Retail. The coefficients on the triple interaction terms suggest that, for Construction, Communications, and Services, the positive impact of *Only Business* during the crisis is reduced either for COVID=1 (Services), or for *FISCAL*=1 (Communications), or for both periods (Construction).

5 Concluding Remarks

In this paper, we have exploited the announcement of a lockdown in Northern Italian towns in late February 2020 as an exogenous shock to volatility expectations to tease out the impact of corporate diversification on stock risk. Using a difference-in-differences approach, we provide evidence of heterogeneous effects depending on the type of corporate diversification. While firms with international sales are less affected by the COVID-19 outbreak, diversifying only by business exacerbates the impact of the outbreak on daily volatility. This evidence suggests that, despite the potential coordination costs resulting from international diversification and the global nature of the COVID-19 pandemic, international diversification may still benefit firms.

We show that our main results are driven by heterogeneity in firms' vulnerability to negative shock in firm risk. Once we split our sample based on the median value for *Tobin's q* and cash holdings, variables that correlate negatively with distress risk, we obtain a negative and significant impact of international diversification on daily volatility only for firms with a high value of these two variables. On the other hand, the positive impact of business diversification on daily volatility is significant only for firms with a value of either *Tobin's q* or cash holdings below the sample median. These findings support the view that the channel through which the COVID-19 outbreak affects daily volatility is the heterogeneity in firms' vulnerability to adverse macroeconomic shocks.

Overall, these findings are important because they suggest that corporate diversification might have heterogeneous effects on the risk of security portfolios, depending on whether it is achieved via activities in international markets as opposed to business diversification. In particular, firms that diversify only by business segment are more likely to experience an increase in stock risk when a negative shock occurs, regardless of the industry to which they belong, especially if they have low levels of cash holdings and are already suffering from low valuations.

Moreover, the mitigating effect of diversifying geographically rather than by business depends on the specific countries considered. For this reason, firms that export only to certain countries might be exposed to country-specific shocks, and managers should strive to diversify in as many countries as possible and, preferably, in different continents.

Finally, we are careful in extending our inferences to other types of tail-risk events, such as Lehman Brothers' collapse in 2008 or other pandemics. This is an essential caveat because the unprecedented actions taken by national governments worldwide – including heavy restrictions on commercial activity as well as social distancing measures – quickly and severely affected the real economy in a way that other shocks did not (Baker et al. 2020).

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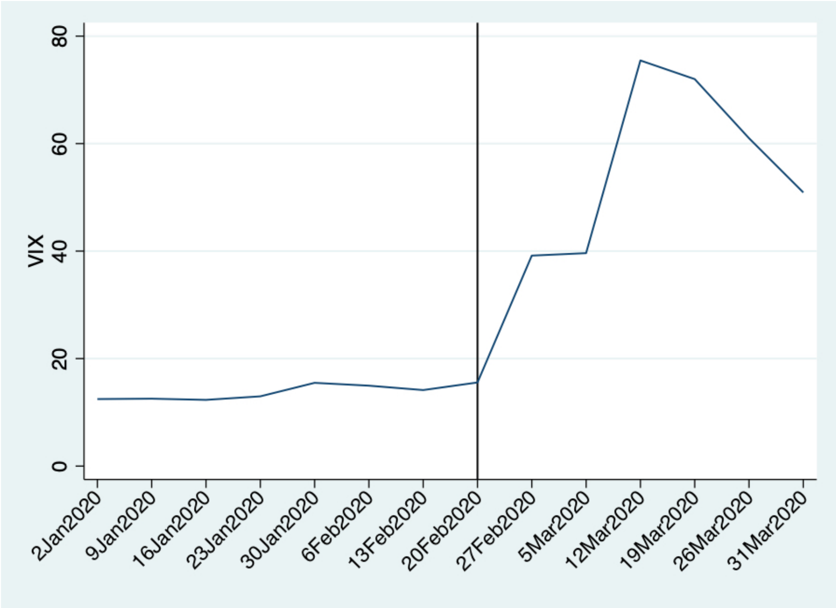
Figure 1: Trend in the *VIX Index*



This chart shows the trend in the *VIX Index*, on a weekly basis, during our sample period (from January 2 to March 31, 2020).

Table 1: Summary statistics

	Obs.	Mean	Median	St. Dev.	p1	p99
DailyVol	128,959	0.059	0.041	0.057	0.001	0.272
ImpliedVol	106,178	0.712	0.622	0.393	0.193	2.011
Negative Skewness	106,178	0.085	0.062	0.201	-0.594	0.682
Positive Skewness	106,178	0.104	0.024	0.275	-0.510	1.104
Only International	128,959	0.270	0.000	0.444	0.000	1.000
Only Business	128,959	0.130	0.000	0.337	0.000	1.000
COVID	128,959	0.414	0.000	0.493	0.000	1.000
FISCAL	128,959	0.146	0.000	0.353	0.000	1.000

This table presents summary statistics of the daily variables employed in our analyses. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. *ImpliedVol* is the daily implied volatility obtained from at-the-money options with an absolute value of delta equal to 0.50 and an expiry date of 30 days (An et al. 2014). *Negative Skewness* is the difference between the implied volatility of out-of-the-money (OTM) puts and at-the-money (ATM) calls. *Positive Skewness* is the difference between the implied volatility of out-of-the-money (OTM) calls and at-the-money (ATM) puts. OTM puts (calls) are defined as those with a delta between –0.375 and –0.125 (0.125 and 0.375), and ATM puts (calls) are defined as those with a delta between –0.625 and –0.375 (0.375 and 0.625), as in Kim & Zhang (2014). *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17.

Table 2: *t*-tests

	(A) Only International = 1	(B) Only Business = 1	*t*-test (A-B)		(C) Only International = 0	(D) Only Business = 0	*t*-test (A-C)		*t*-test (B-D)	
β_{im}	1.298	1.091	-0.207	***	1.240	1.281	-0.058	***	0.190	***
β_{VIX}	0.018	0.021	0.002	***	0.022	0.021	0.004	***	0.000	
Size	6.434	7.059	0.625	***	6.604	6.473	0.170		-0.587	***
Tobin's q	3.272	1.910	-1.363	***	2.529	2.848	-0.743	***	0.939	***
Cash Holdings	0.275	0.120	-0.156	***	0.243	0.271	-0.032	**	0.151	***
Leverage	0.259	0.336	0.077	***	0.274	0.260	0.015		-0.076	***
Operating Leverage	0.757	0.939	0.182	***	0.791	0.759	0.034		-0.180	***
Age	2.779	3.107	0.328	***	2.810	2.757	0.030		-0.350	***
Dividend-Price ratio	0.814	1.854	1.040	***	1.155	0.946	0.341	***	-0.908	***

This table presents *t*-tests aimed at verifying whether the variable means, by group, are statistically different. The groups are defined according to the dummies *Only International* and *Only Business*. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. *Excess value* is defined as in Berger & Ofek (1995). β_{im} and β_{VIX} are estimated according to equation 3, which follows equation (3) from Ang et al. (2006). *Size* is the natural logarithm of total assets. *Tobin's q* is the ratio of the market value of assets (i.e., the book value of assets minus the book value of equity plus the market value of equity) to the book value of assets. *Cash Holdings* is the ratio of cash to total assets. *Leverage* is the sum of long-term plus short-term debt divided by total assets. *Operating leverage* is the ratio of annual operating costs (i.e., cost of goods sold plus selling, general and administrative expense) divided by total assets. *Age* is the natural logarithm of the number of years since the firm is available in Compustat. *Dividend-price ratio* is the ratio of dividends over stock price. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table 3: Difference-in-Differences regressions on *DailyVol*

	(1)	(2)	(3)	(4)
	DailyVol	*DailyVol*	*DailyVol*	*DailyVol*
Panel A				
*COVID * Only International*	-0.0024**	-0.0023**		
	(-2.1124)	(-2.0641)		
*FISCAL * Only International*	-0.0038**			
	(-2.3190)			
*COVID * Only Business*			0.0072***	0.0074***
			(3.6119)	(3.7473)
*FISCAL * Only Business*			0.0121***	
			(4.0592)	
Observations	128,959	110,172	128,959	110,172
Firms	2,287	2,283	2,287	2,283
R-squared	0.604	0.587	0.605	0.587
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

	(1)	(2)	(3)	(4)
	DailyVol	*DailyVol*	*DailyVol*	*DailyVol*
Panel B				
*COVID * Only International*	-0.0045***	-0.0045***		
	(-3.4252)	(-3.4367)		
*FISCAL * Only International*	-0.0052***			
	(-2.8963)			
*COVID * Only Business*			0.0052***	0.0052***
			(2.8376)	(2.8382)
*FISCAL * Only Business*			0.0099***	
			(3.7664)	
Only International	0.0006	-0.0002		
	(0.7397)	(-0.2212)		
Only Business			-0.0041***	-0.0032***
			(-4.4166)	(-3.6891)
Leverage	0.0203***	0.0155***	0.0206***	0.0157***
	(7.0878)	(6.5914)	(7.1847)	(6.7040)
Size	-0.0045***	-0.0042***	-0.0045***	-0.0043***
	(-13.4749)	(-13.4932)	(-13.5147)	(-13.5151)
Book-to-Market	0.0178***	0.0157***	0.0184***	0.0164***
	(8.6297)	(8.5129)	(9.0666)	(8.9717)
Cash Holdings	0.0132***	0.0167***	0.0127***	0.0162***
	(4.5352)	(6.3889)	(4.3573)	(6.1689)
ROE	-0.0032***	-0.0035***	-0.0032***	-0.0035***
	(-3.9701)	(-4.1653)	(-3.9187)	(-4.1085)
Observations	115,896	98,996	115,896	98,996
R-squared	0.513	0.460	0.513	0.460
Day FE	Yes	Yes	Yes	Yes
Firm FE	No	No	No	No
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

This table reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020 (columns (1) and (3)) and from January 2 to March 17, 2020 (columns (2) and (4)). Specifications in *Panel A* include firm fixed effects, whereas specifications in *Panel B* include *Leverage* (the sum of long-term plus short-term debt divided by total assets), *Size* (the natural logarithm of total assets), *Book-to-Market* (the ratio of the book value of assets to the market value of assets (the book value of assets minus the book value of equity plus the market value of equity)), *Cash Holdings* (the ratio of cash to total assets), and *ROE* (the return on equity) instead of firm fixed effects. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table 4: Difference-in-Differences regressions on *DailyVol* – sample splits by *Tobin's q* and *Cash Holdings*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DailyVol	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*
Panel A: split by Tobin's q								
Subsample	Below the median	Below the median	Below the median	Below the median	Above the median	Above the median	Above the median	Above the median
*COVID * Only International*	0.0016	0.0013			-0.0042***	-0.0039***		
	(0.8111)	(0.6710)			(-3.0033)	(-2.7987)		
*FISCAL * Only International*	0.0006				-0.0032			
	(0.1917)				(-1.5537)			
*COVID * Only Business*			0.0083***	0.0085***			0.0035	0.0039
			(3.5432)	(3.6255)			(1.4130)	(1.5894)
*FISCAL * Only Business*			0.0079**				0.0139***	
			(2.2173)				(4.8385)	
Observations	63,434	54,614	63,434	54,614	65,525	55,558	65,525	55,558
Firms	1,138	1,138	1,138	1,138	1,149	1,145	1,149	1,145
R-squared	0.594	0.574	0.596	0.575	0.616	0.598	0.617	0.598
Day FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17
Panel B: split by Cash Holdings								
Subsample	Below the median	Below the median	Below the median	Below the median	Above the median	Above the median	Above the median	Above the median
*COVID * Only International*	0.0017	0.0013			-0.0036**	-0.0032**		
	(0.9358)	(0.7199)			(-2.4298)	(-2.1317)		
*FISCAL * Only International*	0.0010				-0.0017			
	(0.3228)				(-0.8337)			
*COVID * Only Business*			0.0086***	0.0087***			0.0023	0.0027
			(3.5670)	(3.6015)			(1.0391)	(1.2573)
*FISCAL * Only Business*			0.0078**				0.0131***	
			(2.1686)				(3.7757)	
Observations	64,218	54,940	64,218	54,940	64,741	55,232	64,741	55,232
Firms	1,114	1,113	1,114	1,113	1,173	1,170	1,173	1,170
R-squared	0.621	0.594	0.623	0.595	0.587	0.573	0.587	0.573
Day FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

This table reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020 (columns (1), (3), (5), (7)) and from January 2 to March 17, 2020 (columns (2), (4), (6), and (8)). Panel A (B) reports the results of tests carried out on subsamples obtained by splitting the sample according to the median of *Tobin's q* (*Cash Holdings*). *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table 5: Difference-in-Differences regressions on *DailyVol* – results for China, Europe, and Italy

	(1) *DailyVol*	(2) *DailyVol*	(3) *DailyVol*	(4) *DailyVol*	(5) *DailyVol*	(6) *DailyVol*
*COVID * China*	-0.0055***			-0.0095***		
	(-3.3415)			(-3.5508)		
*FISCAL * China*	-0.0015			-0.0047		
	(-0.6948)			(-1.2653)		
*COVID * Europe*		-0.0026**			-0.0024*	
		(-2.0414)			(-1.7257)	
*FISCAL * Europe*		0.0001			-0.0000	
		(0.0524)			(-0.0086)	
*COVID * Italy*			-0.0016			-0.0002
			(-0.5760)			(-0.0413)
*FISCAL * Italy*			0.0069			0.0030
			(1.0562)			(0.2314)
Observations	128,959	128,959	128,959	96,896	117,159	117,159
Firms	2,287	2,287	2,287	1,738	2,088	2,088
R-squared	0.604	0.603	0.603	0.590	0.600	0.600
Day FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample				excl. Europe	excl. China	excl. China

This table reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020. Regressions are run on the full sample (Columns (1)–(3)), and on samples that exclude firms selling to Europe (Column (4)), or to China (Columns (5) and (6)). *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. China equals one if a firm has customers in China, and zero otherwise. Europe equals one if a firm has customers in Europe, and zero otherwise. Italy equals one if a firm has customers in Italy, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust t-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table 6: Difference-in-Differences regressions on *DailyVol* – robustness checks considering sales to China, Europe, and Italy

	(1)	(2)	(3)	(4)	(5)	(6)
	DailyVol	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*
*COVID * Only International*	-0.0018	-0.0023	-0.0024**	-0.0053**	-0.0015	-0.0053
	(-1.4995)	(-1.6063)	(-2.0803)	(-2.3138)	(-0.9715)	(-1.0624)
*FISCAL * Only International*	-0.0036**	-0.0027	-0.0035**	-0.0050	-0.0067***	-0.0330***
	(-2.0531)	(-1.3993)	(-2.1404)	(-1.3098)	(-2.8045)	(-3.2139)
Observations	117,159	96,896	127,366	11,800	32,063	1,593
Firms	2,088	1,738	2,260	199	549	27
R-squared	0.600	0.590	0.603	0.656	0.658	0.687
Day FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	No China	No Europe	No Italy	China only	Europe only	Italy only

This table reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020. Regressions are run on samples that exclude firms selling to China (Column (1)), Europe (Column (2)), or Italy (Column (3)), or on subsamples that only include companies exposed to China (Columns (4)), Europe (Column (5)), or Italy (Column (6)). *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table 7: Difference-in-Differences regressions on *DailyVol* – results excluding firms in certain macro-sectors

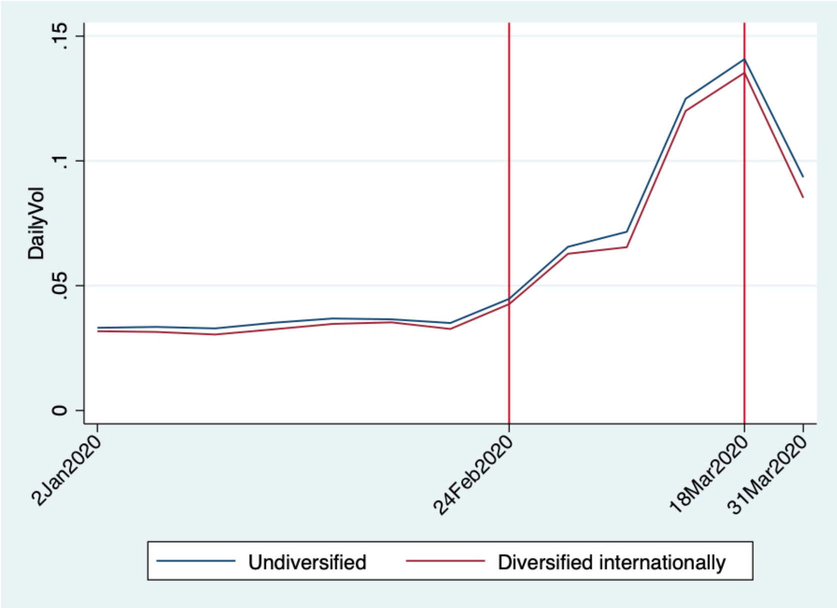
	(1) *DailyVol*	(2) *DailyVol*	(3) *DailyVol*	(4) *DailyVol*	(5) *DailyVol*	(6) *DailyVol*	(7) *DailyVol*	(8) *DailyVol*
*COVID * Only Business*	0.0071***	0.0074***	0.0071***	0.0066***	0.0074***	0.0069***	0.0068***	0.0092***
	(3.6893)	(3.6387)	(3.0959)	(3.3445)	(3.5345)	(3.5519)	(3.3567)	(3.7955)
*FISCAL * Only Business*	0.0121***	0.0124***	0.0102***	0.0120***	0.0134***	0.0117***	0.0113***	0.0125***
	(4.0232)	(4.0308)	(3.1285)	(4.3813)	(4.0771)	(4.1522)	(4.0383)	(3.1829)
Observations	124,159	127,647	60,831	123,127	125,885	124,010	121,380	101,405
Firms	2,186	2,265	1,074	2,183	2,233	2,201	2,152	1,815
R-squared	0.606	0.604	0.612	0.605	0.606	0.604	0.602	0.599
Day FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	excl. *Mining*	excl. *Construction*	excl. *Manufacturing*	excl. *Transport*	excl. *Communications*	excl. *Wholesale*	excl. *Retail*	excl. *Services*

This table reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020. Regressions are carried out on the full sample excluding one macro-sector at a time as reported at the bottom of the table. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. *Mining* includes firms in the SICs 10-14. *Construction* includes firms in the SICs 15-17. *Manufacturing* includes firms in the SICs 20-39. *Transport* includes firms in the SICs 40-47. *Communications* includes firms in the SIC 48. *Wholesale* includes firms in the SICs 50-51. *Retail* includes firms in the SICs 52-59. *Services* includes firms in the SICs 70-89. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust t-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

INTERNET APPENDIX

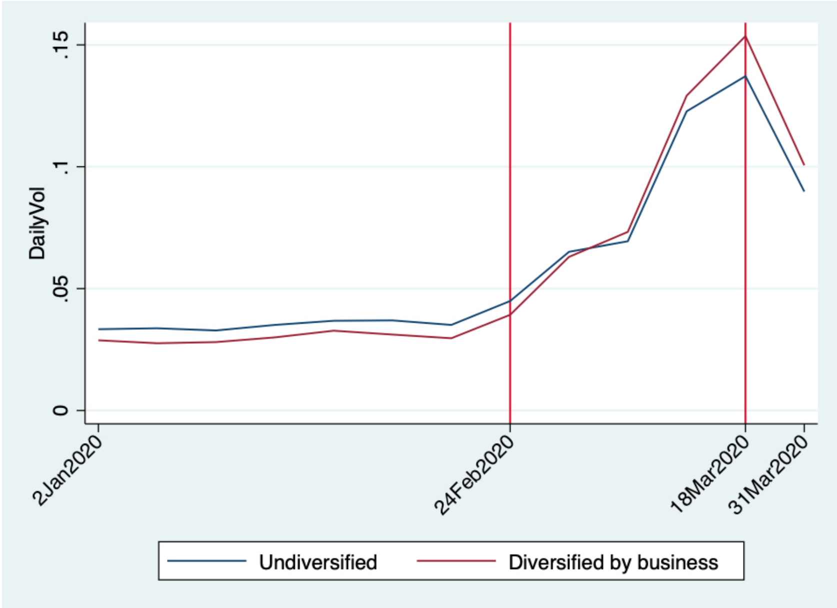
Corporate Diversification and Stock Risk: Evidence from a Global Shock

Figure A1: Parallel trend in *DailyVol* by *Only International*



This Figure illustrates the behavior of the dependent variable (*DailyVol*) during the sample period. Internationally-diversified firms are represented by a red line, while the other firms by a blue line.

Figure A2: Parallel trend in *DailyVol* by *Only Business*



This Figure illustrates the behavior of the dependent variable (*DailyVol*) during the sample period. Business-diversified firms are represented by a red line, while the other firms by a blue line.

Table A1: Difference-in-Differences regressions on *DailyVol* – no day and firm fixed effects

	(1) *DailyVol*	(2) *DailyVol*
*COVID * Only International*	-0.0029**	
	(-2.4142)	
*FISCAL * Only International*	-0.0006	
	(-0.4413)	
*COVID * Only Business*		0.0031**
		(2.1251)
*FISCAL * Only Business*		0.0045***
		(2.6646)
COVID	0.0455***	0.0442***
	(5.6481)	(5.5602)
FISCAL	0.0389***	0.0383***
	(2.9085)	(2.8739)
Only International	-0.0007	
	(-1.0670)	
Only Business		-0.0026***
		(-3.1027)
Leverage	0.0100***	0.0103***
	(6.0033)	(6.1629)
Size	-0.0039***	-0.0040***
	(-13.9418)	(-13.9739)
Book-to-Market	0.0134***	0.0140***
	(9.5694)	(10.0233)
Cash Holdings	0.0180***	0.0175***
	(7.7652)	(7.5899)
ROE	-0.0028***	-0.0028***
	(-3.3956)	(-3.3530)
*COVID * Leverage*	0.0157***	0.0159***
	(4.2628)	(4.3133)
*FISCAL * Leverage*	0.0242***	0.0238***
	(3.1892)	(3.1638)
*COVID * Size*	-0.0004	-0.0004
	(-0.6687)	(-0.7067)
*FISCAL * Size*	-0.0017**	-0.0016**
	(-2.1123)	(-2.0887)
*COVID * Book-to-Market*	0.0045	0.0047
	(1.3196)	(1.4090)
*FISCAL * Book-to-Market*	0.0140***	0.0133***
	(3.1244)	(3.0456)
*COVID * Cash*	-0.0034	-0.0035
	(-0.8001)	(-0.8227)
*FISCAL * Cash*	-0.0220***	-0.0216***
	(-4.0382)	(-3.9956)
*COVID * ROE*	-0.0022	-0.0022
	(-1.3133)	(-1.3130)
*FISCAL * ROE*	0.0037*	0.0037*
	(1.7370)	(1.7107)
Observations	115,896	115,896
R-squared	0.373	0.373
Day FE	No	No
Firm FE	No	No
Sample period	Jan2–Mar31	Jan2–Mar31

This table reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. *Leverage* is the sum of long-term plus short-term debt divided by total assets. *Size* is the natural logarithm of total assets. *Book-to-Market* is the ratio of the book value of assets to the market value of assets (i.e., the book value of assets minus the book value of equity plus the market value of equity). *Cash Holdings* is the ratio of cash to total assets. *ROE* is the return on equity. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust t-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A2: Difference-in-Differences regressions on *DailyVol* for a subsample of firms relying on foreign suppliers

	(1) *DailyVol*	(2) *DailyVol*	(3) *DailyVol*	(4) *DailyVol*
*COVID * Only International*	-0.0065***	-0.0062**		
	(-2.7794)	(-2.6646)		
*FISCAL * Only International*	-0.0075*			
	(-1.8602)			
*COVID * Only Business*			0.0160***	0.0164***
			(3.4491)	(3.5497)
*FISCAL * Only Business*			0.0167**	
			(2.3248)	
Observations	24,308	20,807	24,308	20,807
Firms	439	438	439	438
R-squared	0.611	0.578	0.613	0.580
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

This table reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020 (columns (1) and (3)) and from January 2 to March 17, 2020 (columns (2) and (4)). Regressions are run on a subsample which only includes firms whose suppliers are based abroad, as defined by Hoberg & Moon (2017). *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A3: Linear time trends in the pre-treatment period - January 20–February 21

	(1) *DailyVol*	(2) *DailyVol*	(3) *DailyVol*	(4) *DailyVol*
Time	0.0001	0.0001	0.0001	0.0001
	(1.2720)	(1.4602)	(1.2650)	(1.4682)
Only International	-0.0083		-0.0084	
	(-0.2589)		(-0.6562)	
*Time * Only International*	0.0000		0.0000	
	(0.1949)		(0.4975)	
Only Business		0.0140		0.0142
		(0.4469)		(1.0291)
*Time * Only Business*		-0.0001		-0.0001
		(-0.6133)		(-1.4190)
Sample	Collapsed	Collapsed	Firm-level	Firm-level
Observations	46	46	49,567	49,567
R-squared	0.212	0.534	0.001	0.003

This table reports the results of parallel-trend tests. *Time* is a linear trend. Models (1) and (2) are run considering the average value of *DailyVol* for the treatment and control group, while Models (3) and (4) consider the firm-level values of *DailyVol*. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Firm and day fixed effects are included in specifications (3) and (4), but not for specifications (1) and (2). The constant is included, but not reported. Standard errors are clustered at the firm and day level in specifications (3) and (4), but not in specifications (1) and (2). Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A4: Propensity Score Matching regressions

Panel A: Regression results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DailyVol	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*	*DailyVol*
COVID * Only International	-0.0029***	-0.0028***			-0.0048***	-0.0047***		
	(-2.9209)	(-2.8592)			(-4.5295)	(-4.4842)		
FISCAL * Only International	-0.0029*				-0.0068***			
	(-1.9524)				(-4.2937)			
COVID * Only Business			0.0056***	0.0056***			0.0054***	0.0054***
			(3.7625)	(3.7658)			(3.5086)	(3.5000)
FISCAL * Only Business			0.0103***				0.0087***	
			(4.7671)				(3.8865)	
Observations	121,976	104,130	122,768	104,777	97,838	83,575	102,055	87,123
R-squared	0.622	0.601	0.624	0.602	0.643	0.614	0.645	0.616
Day FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

This table (Panel A) reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020 (columns (1), (3), (5), and (7)) and from January 2 to March 17, 2020 (columns (2), (4), (6), and (8)), on matched samples. The matched samples for Columns (1)–(2) ((3)–(4)) are obtained from pre-match propensity score probit regressions (not shown for brevity) on *Only International* (*Only Business*), and whose regressors are β_{im}, β_{VIX}, *Tobin's q*, *Cash Holdings*, and Dividend-Price ratio. The matched samples for Columns (5)–(6) ((7)–(8)) are obtained from pre-match propensity score probit regressions (not shown for brevity) on *Only International* (*Only Business*), and whose regressors are β_{im}, β_{VIX}, *Tobin's q*, *Cash Holdings*, *Size*, *Leverage*, *Operating Leverage*, *Age*, and *Dividend-Price ratio*. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust t-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A4 continued

Panel B: t-tests after matching

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean		t-test		Mean		t-test	
	Only International=1	*Only International*=0	t	*p-value*	*Only Business*=1	*Only Business*=0	t	*p-value*
β_{im}	1.013	0.995	0.44	0.661	0.849	0.829	0.37	0.715
β_{VIX}	0.004	0.004	-0.06	0.951	0.001	0.001	-0.08	0.934
Tobin's q	2.701	2.716	-0.11	0.912	1.927	1.988	-0.45	0.652
Cash Holdings	0.209	0.209	-0.03	0.977	0.124	0.120	0.31	0.754
Size	6.800	6.881	-0.65	0.513	7.041	7.084	-0.27	0.790
Leverage	0.271	0.265	0.36	0.719	0.319	0.325	-0.32	0.750
Operating Leverage	0.778	0.783	-0.12	0.907	0.882	0.826	0.92	0.359
Age	2.903	2.952	-0.98	0.328	3.092	3.075	0.25	0.799
Dividend-Price ratio	1.016	0.923	0.75	0.456	1.512	1.686	-0.76	0.445

This table (Panel B) presents the difference in control variables between matched pairs. β_{im} and β_{VIX} are estimated according to equation 3, which follows equation (3) from Ang et al. (2006). *Tobin's q* is the ratio of the market value of assets (i.e., the book value of assets minus the book value of equity plus the market value of equity) to the book value of assets. *Cash Holdings* is the ratio of cash to total assets. *Size* is the natural logarithm of total assets. *Leverage* is the sum of long-term plus short-term debt divided by total assets. *Operating leverage* is the ratio of annual operating costs (i.e., cost of goods sold plus selling, general and administrative expense) divided by total assets. *Age* is the natural logarithm of the number of years since the firm is available in Compustat. *Dividend-price ratio* is the ratio of dividends over stock price.

Table A5: Difference-in-Differences regressions on daily implied volatility (*ImpliedVol*)

	(1) *ImpliedVol*	(2) *ImpliedVol*	(3) *ImpliedVol*	(4) *ImpliedVol*
*COVID * Only International*	-0.0399***	-0.0392***		
	(-3.8343)	(-3.7719)		
*FISCAL * Only International*	-0.0414***			
	(-3.8002)			
*COVID * Only Business*			0.0364**	0.0370**
			(2.5945)	(2.6418)
*FISCAL * Only Business*			0.0707***	
			(4.0155)	
Observations	106,178	90,437	106,178	90,437
Firms	1,851	1,850	1,851	1,850
R-squared	0.837	0.842	0.837	0.842
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

This table reports the results of difference-in-differences regressions on daily implied volatility during the first quarter of 2020 (columns (1) and (3)) and from January 2 to March 17, 2020 (columns (2) and (4)). *ImpliedVol* is the daily implied volatility obtained from at-the-money options with an absolute value of delta equal to 0.50 and an expiry date of 30 days (An et al. 2014). The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A6: Difference-in-Differences regressions on daily volatility (*DailyVol*) and daily implied volatility (*ImpliedVol*) – including stocks trading at or above $5 as of January 2, 2020

	(1) *DailyVol*	(2) *DailyVol*	(3) *DailyVol*	(4) *DailyVol*
Panel A				
*COVID * Only International*	-0.0023*	-0.0024*		
	(-1.8125)	(-1.8790)		
*FISCAL * Only International*	-0.0056***			
	(-3.2029)			
*COVID * Only Business*			0.0082***	0.0083***
			(3.3880)	(3.4049)
*FISCAL * Only Business*			0.0130***	
			(3.5760)	
Observations	133,658	112,110	133,658	112,110
R-squared	0.597	0.579	0.599	0.579
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17
	(1) *ImpliedVol*	(2) *ImpliedVol*	(3) *ImpliedVol*	(4) *ImpliedVol*
Panel B				
*COVID * Only International*	-0.0428***	-0.0423***		
	(-3.9735)	(-3.9337)		
*FISCAL * Only International*	-0.0421***			
	(-3.8636)			
*COVID * Only Business*			0.0367**	0.0373**
			(2.2995)	(2.3415)
*FISCAL * Only Business*			0.0801***	
			(4.6743)	
Observations	109,676	92,134	109,676	92,134
R-squared	0.829	0.833	0.829	0.833
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

This table reports the results of difference-in-differences regressions on *DailyVol* (in panel A) and *ImpliedVol* (in panel B) during the first quarter of 2020 (columns (1) and (3)) and from January 2 to March 17, 2020 (columns (2) and (4)). Unlike the sample utilized in the main regressions, the sample employed to run these tests include stocks trading at or above $5 as of January 2, 2020. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. *ImpliedVol* is the daily implied volatility obtained from at-the-money options with an absolute value of delta equal to 0.50 and an expiry date of 30 days (An et al. 2014). The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust t-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A7: Difference-in-Differences regressions on daily volatility (*DailyVol*) and daily implied volatility (*ImpliedVol*) – penny stocks included

	(1) *DailyVol*	(2) *DailyVol*	(3) *DailyVol*	(4) *DailyVol*
Panel A				
*COVID * Only International*	-0.0026*	-0.0027*		
	(-1.9508)	(-1.9844)		
*FISCAL * Only International*	-0.0016			
	(-1.0147)			
*COVID * Only Business*			0.0078***	0.0079***
			(3.3165)	(3.3186)
*FISCAL * Only Business*			0.0121***	
			(3.5932)	
Observations	178,936	150,137	178,936	150,137
R-squared	0.517	0.510	0.518	0.511
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

	(1) *ImpliedVol*	(2) *ImpliedVol*	(3) *ImpliedVol*	(4) *ImpliedVol*
Panel B				
*COVID * Only International*	-0.0448***	-0.0441***		
	(-4.1887)	(-4.1288)		
*FISCAL * Only International*	-0.0382***			
	(-3.5602)			
*COVID * Only Business*			0.0329**	0.0336**
			(2.0300)	(2.0801)
*FISCAL * Only Business*			0.0867***	
			(4.9574)	
Observations	112,685	94,644	112,685	94,644
R-squared	0.830	0.835	0.830	0.835
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

This table reports the results of difference-in-differences regressions on *DailyVol* (in panel A) and *ImpliedVol* (in panel B) during the first quarter of 2020 (columns (1) and (3)) and from January 2 to March 17, 2020 (columns (2) and (4)). The lower bound filtering criterion of $5 is lifted in these tests, so that the sample also includes all penny stocks. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. *ImpliedVol* is the daily implied volatility obtained from at-the-money options with an absolute value of delta equal to 0.50 and an expiry date of 30 days (An et al. 2014). The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A8: Difference-in-Differences regressions on Daily Implied Skewness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	*Negative Skewness*	*Negative Skewness*	*Negative Skewness*	*Negative Skewness*	*Positive Skewness*	*Positive Skewness*	*Positive Skewness*	*Positive Skewness*
*COVID * Only International*	-0.0025	-0.0027			-0.0115	-0.0111		
	(-0.4497)	(-0.4703)			(-1.4232)	(-1.3781)		
*FISCAL * Only International*	-0.0012				-0.0027			
	(-0.1343)				(-0.2831)			
*COVID * Only Business*			0.0171**	0.0173**			0.0205*	0.0207*
			(2.4275)	(2.4388)			(1.6723)	(1.6857)
*FISCAL * Only Business*			0.0034				-0.0130	
			(0.3857)				(-0.9312)	
Observations	106,178	90,437	106,178	90,437	106,178	90,437	106,178	90,437
Firms	1,851	1,850	1,851	1,850	1,851	1,850	1,851	1,850
R-squared	0.181	0.193	0.182	0.194	0.372	0.397	0.372	0.397
Day FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

This table reports the results of difference-in-differences regressions on *Negative Skewness* (columns (1)-(4)) and *Positive Skewness* (columns (5)-(8)) during the first quarter of 2020 (columns (1), (3), (5), (7)) and from January 2 to March 17, 2020 (columns (2), (4), (6), (8)). *Negative Skewness* is the difference between the implied volatility of out-of-the-money (OTM) puts and at-the-money (ATM) calls. *Positive Skewness* is the difference between the implied volatility of out-of-the-money (OTM) calls and at-the-money (ATM) puts. OTM puts (calls) are defined as those with a delta between –0.375 and –0.125 (0.125 and 0.375), and ATM puts (calls) are defined as those with a delta between –0.625 and –0.375 (0.375 and 0.625), as in Kim & Zhang (2014). The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A9: Difference-in-Differences regressions on *DailyVol* – Number of business-segments and foreign sales to total sales ratio

	(1) *DailyVol*	(2) *DailyVol*	(3) *DailyVol*	(4) *DailyVol*
*COVID * N Seg Bus*	0.0008**	0.0009**		
	(2.1341)	(2.3686)		
*FISCAL * N Seg Bus*	0.0025***			
	(4.2408)			
*COVID * Foreign Sales*			-0.0065***	-0.0061***
			(-3.2178)	(-3.0497)
*FISCAL * Foreign Sales*			-0.0027	
			(-1.0016)	
Observations	128,959	110,172	128,959	110,172
Firms	2,287	2,283	2,287	2,283
R-squared	0.604	0.587	0.604	0.587
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample period	Jan2–Mar31	Jan2–Mar17	Jan2–Mar31	Jan2–Mar17

This table reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020 (columns (1) and (3)) and from January 2 to March 17, 2020 (columns (2) and (4)). *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *N Seg Bus* is the number of segments a company is diversified in. *Foreign Sales* is the ratio of foreign sales over total sales. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust t-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A10: Difference-in-Differences regressions on daily volatility (*DailyVol*) and daily implied volatility (*ImpliedVol*) – nested results

	(1) *DailyVol*	(2) *ImpliedVol*	(3) *DailyVol*	(4) *ImpliedVol*
*COVID * Only International*	-0.0012	-0.0353***	-0.0037***	-0.0415***
	(-1.0756)	(-3.5063)	(-2.9251)	(-3.9663)
*FISCAL * Only International*	-0.0019	-0.0303***	-0.0035**	-0.0346***
	(-1.1498)	(-2.9420)	(-2.0186)	(-3.3357)
*COVID * Only Business*	0.0068***	0.0244*	0.0040**	0.0179
	(3.4517)	(1.8048)	(2.2237)	(1.3961)
*FISCAL * Only Business*	0.0115***	0.0604***	0.0087***	0.0493***
	(3.8691)	(3.5177)	(3.3940)	(2.9854)
Only International			-0.0002	0.0088
			(-0.3133)	(0.9768)
Only Business			-0.0040***	-0.0312***
			(-4.3827)	(-2.8190)
Leverage			0.0204***	0.2013***
			(7.1314)	(7.3853)
Size			-0.0045***	-0.0766***
			(-13.4699)	(-21.1889)
Book-to-Market			0.0180***	0.3994***
			(8.7706)	(16.9806)
Cash Holdings			0.0130***	0.1816***
			(4.4994)	(5.9505)
ROE			-0.0032***	-0.0340***
			(-3.9510)	(-3.6597)
Observations	128,959	106,178	115,896	100,635
R-squared	0.605	0.838	0.514	0.646
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	No	No
Sample period	Jan2–Mar31	Jan2–Mar31	Jan2–Mar31	Jan2–Mar31

This table reports the results of difference-in-differences regressions on daily volatility (columns (1) and (3)) and daily implied volatility (*ImpliedVol*) (columns (2) and (4)) during the first quarter of 2020. Specifications in columns (1) and (2) include firm fixed effects, whereas specifications in columns (3) and (4) include *Leverage* (the sum of long-term plus short-term debt divided by total assets), *Size* (the natural logarithm of total assets), *Book-to-Market* (the ratio of the book value of assets to the market value of assets (the book value of assets minus the book value of equity plus the market value of equity)), *Cash Holdings* (the ratio of cash to total assets), and *ROE* (the return on equity) instead of firm fixed effects. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. *ImpliedVol* is the daily implied volatility obtained from at-the-money options with an absolute value of delta equal to 0.50 and an expiry date of 30 days (An et al. 2014). The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. Day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust t-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A11: Difference-in-Differences regressions on daily volatility (*DailyVol*) and daily implied volatility (*ImpliedVol*) – two-way diversification (both geographic and by business segment)

	(1) *DailyVol*	(2) *ImpliedVol*	(3) *DailyVol*	(4) *ImpliedVol*
*COVID * Int & Bus Diversification Dummy*	0.0011	-0.0040	-0.0087***	-0.0400***
	(0.6307)	(-0.3183)	(-4.2445)	(-2.8564)
*FISCAL * Int & Bus Diversification Dummy*	0.0093***	0.0442***	0.0043	0.0275**
	(3.7459)	(3.3672)	(1.5558)	(2.1004)
Int & Bus Diversification Dummy			-0.0022***	-0.0252***
			(-3.2503)	(-3.2083)
Leverage			0.0145***	0.1706***
			(6.4393)	(6.2976)
Size			-0.0040***	-0.0712***
			(-12.1323)	(-18.4909)
Book-to-Market			0.0154***	0.3625***
			(8.8885)	(17.1673)
Cash Holdings			0.0135***	0.2047***
			(4.6111)	(6.4496)
ROE			-0.0033***	-0.0349***
			(-3.6700)	(-3.3938)
Observations	107,580	87,355	94,991	82,268
R-squared	0.603	0.860	0.510	0.652
Day FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	No	No
Sample period	Jan2–Mar31	Jan2–Mar31	Jan2–Mar31	Jan2–Mar31

This table reports the results of difference-in-differences regressions on daily volatility (columns (1) and (3)) and daily implied volatility (*ImpliedVol*) (columns (2) and (4)) during the first quarter of 2020. Specifications in columns (1) and (2) include firm fixed effects, whereas specifications in columns (3) and (4) include *Leverage* (the sum of long-term plus short-term debt divided by total assets), *Size* (the natural logarithm of total assets), *Book-to-Market* (the ratio of the book value of assets to the market value of assets (the book value of assets minus the book value of equity plus the market value of equity)), *Cash Holdings* (the ratio of cash to total assets), and *ROE* (the return on equity) instead of firm fixed effects. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. *ImpliedVol* is the daily implied volatility obtained from at-the-money options with an absolute value of delta equal to 0.50 and an expiry date of 30 days (An et al. 2014). The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Int & Bus Diversification Dummy* equals one if a firm diversifies both geographically and by business, and zero otherwise. Firms diversifying exclusively geographically or by business are excluded from this sample. Day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A12: Difference-in-Differences regressions on *DailyVol* – robustness tests considering exports to different world regions

	(1) No South America	(2) No South America	(3) No Africa	(4) No Africa	(5) No Middle East	(6) No Middle East	(7) No Oceania	(8) No Oceania	(9) All lockdowns
*COVID * Only International*	-0.0026**	-0.0024*	-0.0025**	-0.0024**	-0.0023**	-0.0021*	-0.0026**	-0.0025**	-0.0024**
	(-2.1257)	(-1.9260)	(-2.1207)	(-2.0782)	(-2.0025)	(-1.7970)	(-2.2211)	(-2.1791)	(-2.1160)
*FISCAL * Only International*	-0.0032*		-0.0037**		-0.0036**		-0.0041**		-0.0043**
	(-1.8147)		(-2.2542)		(-2.2201)		(-2.4405)		(-2.5681)
*South America lockdown * South America*									0.0047*
									(1.6892)
*Africa lockdown * Africa*									0.0067
									(1.5100)
*Oceania lockdown * Oceania*									0.0076**
									(2.3905)
*Middle East lockdown * Middle East*									-0.0037
									(-0.9952)
Observations	113,028	96,662	126,725	108,239	124,100	106,051	125,116	106,895	128,959
Firms	2,014	2,011	2,245	2,241	2,202	2,199	2,222	2,218	2,287
R-squared	0.598	0.582	0.603	0.587	0.602	0.586	0.602	0.586	0.604
Day FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table reports the results of difference-in-differences regressions on *DailyVol* during the first quarter of 2020. Regressions in Columns (1)–(2) are carried out on the full sample excluding firms exporting to South America. Regressions in Columns (3)–(4) are carried out on the full sample excluding firms exporting to Africa. Regressions in Columns (5)–(6) are carried out on the full sample excluding firms exporting to the Middle-East region. Regressions in Columns (7)–(8) are carried out on the full sample excluding firms exporting to Oceania. The regression reported in Columns (9) is carried out on the full sample. The dependent variable, *DailyVol*, is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only International* equals one if a firm diversifies geographically but not by business, and zero otherwise. *South America lockdown* equals one from Monday, March 16 until Tuesday, March 31, and zero before it. *Africa lockdown* equals one from Monday 23 March until Tuesday, March 31, and zero before it. *Oceania lockdown* equals one from Monday, March 23 until Tuesday, March 31, and zero before it. *Middle East lockdown* equals one from Thursday, March 5 until Tuesday, March 31, and zero before it. *South America* equals one if a firm exports to South American countries, and zero otherwise. *Africa* equals one if a firm exports to African countries, and zero otherwise. *Oceania* equals one if a firm exports to Oceanian countries, and zero otherwise. *Middle East* equals one if a firm exports to Middle Eastern countries, and zero otherwise. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.

Table A13: Regressions considering the impact of different sectors

	(1) *DailyVol*	(2) *DailyVol*	(3) *DailyVol*	(4) *DailyVol*	(5) *DailyVol*	(6) *DailyVol*	(7) *DailyVol*	(8) *DailyVol*
*COVID * Only Business*	0.0071***	0.0074***	0.0071***	0.0066***	0.0074***	0.0069***	0.0068***	0.0092***
	(3.6895)	(3.6386)	(3.0991)	(3.3450)	(3.5350)	(3.5518)	(3.3584)	(3.7943)
*FISCAL * Only Business*	0.0121***	0.0124***	0.0102***	0.0120***	0.0134***	0.0117***	0.0113***	0.0125***
	(4.0198)	(4.0312)	(3.1369)	(4.3812)	(4.0776)	(4.1515)	(4.0316)	(3.1828)
*COVID * Mining * Only Business*	-0.0079							
	(-1.1856)							
*FISCAL * Mining * Only Business*	0.0022							
	(0.2958)							
*COVID * Mining*	0.0257***							
	(3.5822)							
*FISCAL * Mining*	0.0010							
	(0.1174)							
*COVID * Construction * Only Business*		-0.0191***						
		(-2.6909)						
*FISCAL * Construction * Only Business*		-0.0195**						
		(-2.1161)						
*COVID * Construction*		0.0142**						
		(2.3553)						
*FISCAL * Construction*		0.0102						
		(1.5581)						
*COVID * Manufacturing * Only Business*			-0.0019					
			(-0.5780)					
*FISCAL * Manufacturing * Only Business*			-0.0002					
			(-0.0536)					
*COVID * Manufacturing*			-0.0021					
			(-1.3878)					
*FISCAL * Manufacturing*			-0.0061**					
			(-2.5088)					
*COVID * Transport * Only Business*				-0.0014				
				(-0.2972)				
*FISCAL * Transport * Only Business*				-0.0134				
				(-1.5187)				
*COVID * Transport*				0.0086**				
				(2.3163)				
*FISCAL * Transport*				0.0187***				
				(3.2909)				
*COVID * Communications * Only Business*					-0.0010			
					(-0.1455)			
*FISCAL * Communications * Only Business*					-0.0222**			
					(-2.5541)			
*COVID * Communications*					-0.0024			
					(-0.5374)			
*FISCAL * Communications*					0.0065			
					(1.3249)			
*COVID * Wholesale * Only Business*						0.0010		
						(0.1222)		
*FISCAL * Wholesale * Only Business*						0.0015		
						(0.1652)		
*COVID * Wholesale*						0.0050*		
						(1.7325)		
*FISCAL * Wholesale*						0.0080**		
						(2.4600)		
*COVID * Retail * Only Business*							-0.0015	
							(-0.3280)	
*FISCAL * Retail * Only Business*							-0.0059	
							(-0.9028)	
*COVID * Retail*							0.0076**	
							(2.4434)	
*FISCAL * Retail*							0.0221***	
							(3.1434)	
*COVID * Services * Only Business*								-0.0084**
								(-2.5979)
*FISCAL * Services * Only Business*								-0.0016
								(-0.2811)
*COVID * Services*								0.0024
								(1.6076)
*FISCAL * Services*								0.0023
								(0.8090)
Firms	2,287	2,287	2,287	2,287	2,287	2,287	2,287	2,287
Observations	128,959	128,959	128,959	128,959	128,959	128,959	128,959	128,959
R-squared	0.606	0.605	0.605	0.606	0.605	0.605	0.606	0.605

This table reports the results of regressions on *DailyVol* during the first quarter of 2020. *DailyVol* is a range-based measure of stock volatility, computed as the daily high price minus the daily low price divided by the midprice. The dummy variable *COVID* equals one for the period from February 24 to March 31, 2020, and zero from January 2 to February 21. *FISCAL* equals one from March 18 to March 31, 2020, and zero from January 2 to March 17. *Only Business* equals one if a firm diversifies by business but not geographically, and zero otherwise. *Mining* is equal to one for the SICs: 10-14, and zero otherwise. *Construction* is equal to one for the SICs 15-17, and zero otherwise. *Manufacturing* is equal to one for the SICs 20-39), and zero otherwise. *Transport* is equal to one for the SICs 40-47, and zero otherwise. *Communications* is equal to one for the SIC 48, and zero otherwise. Wholesale is equal to one for the SICs 50-51, and zero otherwise. *Retail* is equal to one for the SICs 52-59, and zero otherwise. *Services* is equal to one for the SICs 70-89, and zero otherwise. Firm and day fixed effects are included in all specifications. Firm and day fixed effects are included in all specifications. The constant is included, but not reported. Standard errors are clustered at the firm and day level. Robust *t*-statistics are reported in parentheses. ***, **, * denote significance at the 1%, 5%, 10% level respectively.