Do markets price CEOs health hazards?
Evidence from the COVID-19 pandemic*

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Abstract

We find evidence that markets anticipate the potential loss of firm value in the event of the CEO falling sick and eventually dying of COVID-19 in a sample of almost 3,000 listed firms from across 137 regions in 10 European countries. First, we use soccer games as "super-spreader" events. The instrumented number of infected cases per capita in the region where company headquarters are located predicts a significant drop in stock returns during March and April 2020 for firms managed by CEOs with a higher probability of dying from COVID-19. Second, we show that the stock price of these firms increases significantly the day in which positive news on the development of COVID-19 vaccines are released in the market.

JEL Codes: G01, G12, G14, M12

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1. Introduction

In this paper we investigate whether financial markets anticipate the impact of CEO illness on shareholders' value. We hypothesize that the initial spread of the COVID-19 virus during March 2020 in the region where the firm is headquartered was perceived by the market as a threat to the health and life of the company's CEO. We test if financial markets priced this health hazard in the cross-section of stock return from almost 3,000 publicly listed firms located across 137 regions in 10 European countries. Our evidence, based on two alternative identification strategies, supports our hypothesis.

As a general rule, companies do not have an obligation to report if the CEO falls ill.[1] On the one side, they risk a market overreaction that could trigger a massive sell off and a drop in the stock's price (Guarino, Stevenson, Marshall (2021)).[2] On the other, for contagious diseases such as COVID-19, there is a risk that information regarding an executive's illness may leak publicly. Providing an accurate description of the situation and the preparatory measures taken could quell market rumors and prevent an adverse market reaction (Burke (2020)). In such cases, companies may prefer to control the timing and quality of the information released to the market to maximize transparency through a voluntary public disclosure. Arguably, companies trade off these pros and cons making public disclosure of a CEO illness ultimately an endogenous choice. The final decision will depend on CEO and firm characteristics (not always observable) and the timing of the event. For instance, the nature and severity of the illness, the quality of the firm's governance, the existence (or absence) of a succession plan, whether the CEO and Chair are the same person, or the specificity of the CEO to the continuity of the business activity. Thus, any evidence from a market reaction to the public disclosure of CEO's positive COVID-19 testing is inconclusive. We confirm this analyzing the stock price reaction (relative to the market) of 25 companies the day in which they disclosed the CEO had tested positive for COVID-19. As expected, there is no clear pattern: some companies outperform the market, some underperform, while others perform like the market.

The COVID-19 pandemic provides a unique opportunity to overcome this identification problem and investigate whether markets price CEOs health hazards. First, it is a publicly recognized and measurable threat potentially affecting CEOs from all companies across sectors and countries

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[1] European market regulators, like the Securities Exchange Commission (SEC) in the US, do not require that firms disclose when the CEO is sick. Only when illness presents a material risk to the company's business or the CEO must be replaced, firms are required to report it. See Horwich (2018) for a discussion on this topic.

[2] In the words of Jane Stevenson, Korn Ferry's global leader for CEO succession and vice chairman of the firm's Board and CEO Services practice: "… disclosing a positive COVID-19 test could send investors and employees into a panic, potentially erasing millions of dollars in market value, without it ever escalating to the point where the CEO becomes sidelined from performing his or her duties."

simultaneously. Second, not all CEOs are expected to be equally vulnerable. From the beginning of the pandemic, the available data on COVID-19 cases and fatalities showed that the threat posed by the virus was much more severe for older, male individuals. Third, several pharmaceutical companies began the process to develop a vaccine within an unprecedented short period of time during which they made several public announcements about their progress.

We exploit these features to implement two independent empirical strategies. In the first strategy, we proxy the magnitude of the threat posed by COVID-19 to the health of the CEO by the number of reported cases per million inhabitants during March 2020 in the region where the company is headquartered. We then test whether stocks of companies more exposed to the virus in March 2020 (i.e., with headquarters in regions with higher per capital number of cases) run by older, male CEOs (treated firms) perform worse than those managed by younger, female CEOs (control firms) during March and April 2020.

We conjecture that a standard OLS regression of the cross section of stock returns on the lagged number of regional COVID-19 cases interacted with the CEO's age and gender would be inconclusive. Although the original outbreak of the pandemic in China at the end of 2019 could be considered exogenous, the distribution and propagation of cases across countries and regions in Europe is not. The cases in each country are highly concentrated in certain regions.[3] This is hardly random. There is evidence, for instance, that regions with international airports and hubs are more likely to be affected first and harder by the virus (Paraskevas and Dimitriou (2020)). In addition, the number of inhabitants and high population density enhance the virus spread (Rocklöv and Sjödin (2020)). At the same time, the most populous and densely inhabited areas in each country tend to be relatively wealthier. On the one side, they are likely to concentrate more economic and medical resources to counterattack the pandemic than other regions within the same country. On the other side, these regions are likely to perform more tests, hence overestimating the relative number of cases with respect to less densely populated areas. Companies headquarter location is not random either.[4] Headquarters in Europe, like in the rest of the world are highly concentrated in a few metropolitan areas and regions within each country (e.g., Strauss-Kahn and Vives (2009) and Heidenreich and Baur (2015)).

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[3] European Centre for Disease Prevention and Control (https://covid-statistics.jrc.ec.europa.eu/Home/Maps).

[4] Shilton and Stanley (1999), for instance, show that metropolitan areas with higher income per capita are associated with more headquarters. The positive effect of agglomeration in densely populated areas is a factor known to affect the location of firms' headquarters (Henderson and Ono (2008)).

Therefore, some variables, like income per capita or population density, are likely correlated both with the spread of the virus and headquarters location. A high concentration of firms from highly sensitive sectors (like tourism or hospitality) in regions more likely to affected by the virus would yield a spurious correlation between the regional number of COVID-19 cases and stock performance.

We tackle these issues by instrumenting the accumulated number of COVID-19 cases per million inhabitants in each region during March 2020 with the region's *population*, its *density*, and, alternatively, the number, attendants, and stadium capacity of the *soccer matches* played in the region during that month.

We believe that the exclusion restriction of our instruments is well founded. There is no reason to believe that population and density across regions within a country should have a *direct* effect on the cross section of stock returns due to the pandemic.[5] As per the soccer games, Gómez and Mironov (2021) show that these events worked as "super-spreaders" of COVID-19 cases across European regions in our sample. National leagues, and pan-European tournaments, like the UEFA Champions and the Europa League, were scheduled well before the original outbreaks of COVID-19 in China. Although there is evidence of the behavioral impact of victories and losses of soccer matches on stock returns at the national market level (e.g., Edmans, García, and Norli (2007)), our soccer-related instruments are totally unrelated to the game's output. As far as we know, there is neither theory nor evidence that links *directly* the cross-section of individual stock returns within a country with the number of attendants to a soccer match or the capacity of the venue where it is played.

We manually collect data from soccer games from all competitions (domestic and international) played in the 137 regions across Belgium, France, Italy, Germany, the Netherlands, Poland, Spain, Sweden, Switzerland, and the UK, between January 1 and until the end of March 2020 (most games in Europe were canceled after March 10). We only include games played in venues with a minimum capacity of 25,000 people.[6] In total, there are 148 qualifying games during this period. We also collect the confirmed cases of COVID-19 in these regions until the end of March, plus several economic and demographic variables: gross regional product (GRP), population,

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[5] Hong, Kubik, and Stein (2008) show that population density across US Census regions is correlated with the ratio of aggregate book value of all firms headquartered in the region, divided by the aggregate income of all households living in the region. This ratio, on time, predicts higher stock prices, hence *indirectly* linking low expected returns to low population density. Their results, however, come from a panel of annual data from 1970 through 2005. We believe it is far less likely that population density directly affects the cross-section of European stock returns specifically over March and April 2020 in reaction to the pandemic.

[6] Gómez and Mironov (2021) show that the predictive power of the instruments decreases substantially when stadiums with lower maximum capacity (particularly 15,000 spectators or lower) are included in the sample, consistent with the evidence on "super-spreaders" of the virus documented in other large events (e.g., Ahammer, Halla, and Lackner (2020), Dave et al (2020), Felbermayr, Hinz, and Chowdhry (2020), and Fischer (2021)).

and density. There are 2,927 publicly listed firms in these regions with available accounting data as of fiscal year-end 2019 and for which we can collect the age and gender of the CEO and the Board Chair. We estimate their cumulative daily raw and abnormal (Fama and French (1992), three-factor risk-adjusted) excess returns over March and April 2020.

Consistently with our hypothesis, we find that markets distinguish between relatively younger and older CEOs when pricing the threat of COVID-19 to the company's management. For CEOs between 50 and 60 years old (51% of our sample), a 1% increase in the instrumented number of cases per million inhabitants (on average, 10 new cases) during March implies an expected decrease of -0.26 basis points in abnormal returns over March and April. For CEOs between 60 and 70 years old (17% of our sample), the decrease is 66 basis points. The same shock implies an expected decline of 177.8 basis points for CEOs between 70 and 80 years old (3% of our sample).

We show a virtually full reversal in stock returns for the same firms in May 2020, after the first virus wave had receded in Europe and the threat subsided. Finally, these results vanish when we replace the company's CEO with the Board Chair. Overall, we interpret these results as evidence supporting that stock markets price the potential value-loss for shareholders from the unexpected replacement of the incumbent CEO during a health hazard.

A potential concern about the first empirical strategy is that older CEOs may be less prepared to overcome the challenges of the pandemic.[7] This could explain our results independently of the threat to the CEOs health and life.[8] To address this concern, in our second empirical strategy, we identify 6 dates in which either Pfizer, Moderna, or AstraZeneca released relevant positive news about the development of a vaccine against COVID-19. From March 1 through December 31, 2020, we let the market decide what is "relevant" and only consider news that triggered a statistically significant positive abnormal return (higher than 2.6 standard-deviations) in the stock of the corresponding pharma company the day of the announcement. Our conjecture is that, if markets price CEOs health hazards, such news should cause a positive abnormal return in companies managed by CEOs with higher risk of severe illness or even death if infected with COVID-19. Consistent with our conjecture, on average, firms with CEOs older than 60 (65) experience 23 (41) basis points abnormal return on the day of a major vaccine development

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[7] There is evidence that older CEOs are less open to change (Musteen, Barker, and Baeten (2006)). Older CEOs tend to have longer tenure in the firm. Berger, Ofek, and Yermack (1997) show that CEO tenure and managerial entrenchment are positively related. This may signal worse corporate governance.

[8] As evidence inconsistent with this hypothesis, we show that the instrumented number of cases per region fails to explain any difference is revenue growth during the first quarter of 2020 (relative to the first quarter of 2019) across firms managed by CEOs with higher versus lower probability of dying from COVID-19.

announcements. A one-percent increase in the probability to die (based on the CEOs age and gender) if infected of COVID corresponds to 3 basis points increase in abnormal return on the day of major vaccine development announcements.

Our main contribution lies on the literature that analyzes the effect of CEOs on firm value (e.g., Bertrand and Schoar (2003), Pérez-González (2006), Bennedsen, Nielsen, Pérez-González, and Wolfenzon (2007), Nguyen and Nielsen's (2014), Bloom and Van Reenen (2007), and Bloom et al. (2013)). Unlike in most of these papers that use a dichotomous and infrequent exogenous shock (the CEO's death), we identify the value of CEOs through a continuous variable: the instrumented spread of regional COVID-19 cases. In that sense, our contribution is closer to Bennedsen, Pérez-González, and Wolfenzon (2020) who use days of CEO hospitalization among a sample of non-listed Danish firms. Like in their paper, we show that CEOs are unique to shareholders: an increase in the number of COVID-19 cases in the region has no distinctive effect on older, non-CEO, board members, including the Chair. Our tests also isolate a "pure CEO" effect since there is, to the best of our knowledge, no parallel restructuring in the company top management during the pandemic (as opposed to the changes after the CEO's death). Likewise, our identification strategy does not confound demand and supply drivers of CEO value associated to CEO fixed effects (Fee, Hadlock, and Pierce (2013)).[9]

Unlike Bennedsen, Pérez-González, and Wolfenzon (2020), the COVID-19 pandemic allows us to analyze the value of CEOs in a set of *publicly listed* firms across 10 European countries in reaction to a common shock. These firms are considerably larger than the set of private Danish firms. Theory (e.g., Gabaix and Landier (2008)) predicts and the empirical evidence confirms (e.g., Edmans, Gabaix, and Jenter (2017)) that the compensation (and, presumably, value) of CEOs is greater for larger companies. More importantly, rather than analyzing the *ex-post* effect of the CEOs absence on the firm's operating performance, our test document that financial markets discount *ex-ante* the value loss caused by the CEOs potential illness or death due to the pandemic's spread in the region where the firm headquarters are located. Consistent with markets pricing this hazard, when the threat recedes in May 2020 or news on the development of a vaccinee against COVID-19 is released, stock returns from companies managed by older CEOs experience positive abnormal return. We interpret this as joint evidence of the unique value of CEOs and financial markets efficiency.

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[9] CEO fixed effects are simultaneously observed by the board of directors and other market participants. Thus, CEOs may be hired in the first place because of their known attributes. This makes it very challenging to distinguish empirically whether the impact of CEOs on firm performance and stock returns is driven by what the firms knows (demand side) or the CEO's contribution (supply side). We show that the number of regional cases of COVID-19 does not affect changes in firm's sales due to the pandemic, regardless of the CEO's age.

Secondly, we also contribute to a literature that links sports to stock returns. Ashton, Gerrad and Hadson (2003) show that the return on the FTSE100 index is strong and symmetrically correlated with the performance of the England soccer team. On the other side, Boyle and Walter (2002) conclude that there is no evidence in favor of any effect of rugby on New Zealand's stock market. Edmans, García and Norli (2007) use a cross-section of 39 countries to show that losses in soccer matches have an economically and statistically significant negative effect on the losing country's stock market index. They extend this evidence to other sports like cricket, rugby, ice hockey, and basketball. As far as we know, the number of soccer matches, their attendance, or the venue capacity have never been used as instruments to predict the cross-section of stock returns. We are also the first to show formally the link between these events and the propagation of the virus in Europe.

Finally, we contribute to the literature that analyzes the impact of COVID-19 on markets and firm policies. This impact has been shown not to be uniform across sectors, firm characteristics (like leverage, cash holdings, or social and environmental ranking scores), or the firm's access to credit and liquidity.[10] In this paper we use the spread of COVID-19 to investigate a different question. Namely, whether markets discount the threat of the virus to the health of the CEO and its impact on shareholder value.

The rest of the paper is organized as follows. Section 2 analyzes the stock performance of companies that disclosed the CEO was infected with COVID-19. Section 3 describes the data and methodology used in our first empirical strategy based on the instrumented number of cases of COVID-19 per million inhabitants. We discuss some robustness tests and alternative explanations of our findings in Section 4. Section 5 presents the second empirical strategy based on the release of news on the progress in the development of a vaccine against COVID-19. We conclude in Section 6. Appendix A.1 details the definition and sources of all variables used in the empirical analysis. Appendix A.2 includes the vaccine news and dates used in our second identification strategy. Additional evidence and robustness tests are presented in Appendix B.

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[10] Ramelli and Wagner (2020) show that high company leverage and low cash holdings are associated with lower stock return as the virus spread to Europe and the United States. Fahlenbrach, Rageth and Stulz (2020) document that US firms with less financial flexibility experienced worse stock returns at the outset of the epidemic and benefited more from after the stimulus announced by the FED. Acharya and Steffen (2020) provide evidence that US firms with access to liquidity perform better during the first quarter of 2020. Alfaro, Chari, Greenland, and Schott (2020) show that unexpected changes in the US aggregate estimates of COVID-19 predict stock returns and that less profitable and more debt-laden firms are more exposed. Hassan, Hollander, van Lent, and Tahoun (2020) show through textual analysis that firms in the US and across 80 countries that are more exposed to the risks of COVID-19 perform worse. Albuquerque, Koskinen, Yang, and Zhang (2020) document that US stocks with higher environmental and social rankings are more resilient during the first quarter of 2020.

2. COVID-19 cases disclosed and stock performance

As a first test, we analyze the stock market reaction the day in which a firm makes public that the CEO has tested positive for COVID-19. As explained in the introduction, this strategy is plagued with endogeneity biases and the conclusions are unreliable. Our objective is to document this.

We perform a word search in Factiva from March 2020 through March 2021 out of which we identify 607 news potentially related to cases of CEOs infected with COVID-19. After reading all the news, we identify 25 announcements by listed firms. They are reported in Table 1, sorted by CEO age, from older (top) to younger (bottom). All observations except one correspond to male CEOs. In the last three columns, we report the stock return the day of the announcement, the corresponding market return the same day, and the difference between both. For the two cases corresponding to the companies with the oldest CEO in this sample (78 years old), the stock underperforms by 2.86% and 4.65%, respectively. However, the next two observations show a remarkable stock outperformance relative to the index of 10.11% and 3.94%, for CEOs, respectively, 69 and 64 years old. This inconsistent pattern is repeated through the table, also among the younger CEOs at the bottom.

According to these results, we should conclude that the risk posed by COVID-19 to the health and life of CEOs was not consistently priced by financial markets. Our next objective is to present an identification strategy that may overcome the identification issues discussed in the introduction and see whether our conclusion changes.

[Insert Table 1 about here]

3. First empirical strategy: instrumented number of COVID-19 cases per million inhabitants

Our objective is to study whether the spread of COVID-19 cases across regions in Europe affected differently the cross-section of stock returns of the firms headquartered in Europe depending on the CEO or Board Chair age and gender. Our hypothesis is that markets discounted the likelihood that firm's top management falls sick due to COVID-19 thus reflecting the value of the CEO for firm shareholders. We first present the data, then our empirical strategy, and finally the results.

3.1 Data

We collect data from 2,927 publicly listed firms located across 137 regions in Belgium, France, Italy, Germany, the Netherlands, Poland, Spain, Sweden, Switzerland, and the UK.[11] For each firm, we retrieve from Compustat-Capital IQ the following variables: *Size* (proxied by the company's sales in USD million), *Debt/Assets*, *TobinQ*, *Operating income*, and *Cash/Assets.*[12]

We then collect the age and gender of the company's CEO and the Board Chair from three sources. From Boardex and Orbis, we retrieve the age and gender of 1,308 and 598 CEOs and Chairs, respectively. The remaining 1,021 observations are collected manually from the company's website and online press articles. We borrow from the Spanish Ministry of Health the case fatality rate across age groups and gender defined as the number of confirmed deaths due to COVID-19 by the number of confirmed cases in Spain and published in in the top Spanish newspaper on April 12, 2020.[13] For robustness tests, we also use the statistics reported by Oxford (see Figure 1) sorted only by age for Italy and Spain.[14] We map each company's CEO age and gender into the corresponding probability to create the step-linear variable *Prob. Death (CEO)*. Each variable's definition and the corresponding source are explained in Appendix A.1.

Panel A in Table 2 shows that the average firm in our sample has revenues of USD 4.3 billion, 24% leverage, Tobin's Q of almost 2, and 14% of cash relative to total assets. The average (and median) CEO (Chair) is 55 (63) years old and only 6% are women. Based on the Spanish case fatality rates sorted by age and gender available at the time of our tests, the average CEO (Chair) had a probability of 2% (5%) to die conditional on testing positive for COVID-19.

Panels B and C in Table 2 show the distribution of age of the CEO and Chair, respectively, across countries. On average, across all observations, only 20% of the CEOs are older than 60. In contrast, 57% of Chairs are older than 60. This threshold is important since, according to Figure 1, the fatality rate of people infected with COVID-19 increases exponentially for patients who are older than 60. Across countries, the distribution of CEO age is relatively homogenous. Poland has a remarkably younger population of CEOs in our sample (although it accounts only for 36 of the almost 3,000 observations). On the other end, France, Spain, and Italy have, in that order, the higher concentration of CEOs with age above 60 years. Since these patters may signal

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[11] So far, we are unable to obtain regional data of COVID-19 cases from Northern Ireland, Scotland, or Wales. Hence, only English regions are considered for the moment.

[12] We only include firms with available accounting data from fiscal-year-end 2019.

[13] *El País*, "El coronavirus mata más a los hombres que a las mujeres," April 12, 2020.

[14] It is important to recall that these statistics were disclosed during March and April 2020, hence known by the market at the time of our cross-sectional tests. We are unaware of similar statistics for other countries in our sample reported at that time.

differences and management style and, therefore, stock performance, we will introduce country fixed effects and, additionally, industry fixed effects at the two-digit SIC level (70 industries).

For each firm and day in March and April 2020, we estimate raw and abnormal returns. Raw returns are calculated as the log difference of adjusted daily closing stock prices from Compustat. To obtain abnormal returns, we estimate alphas and betas from the Fama and French (1992) three-factor model for European stock markets using daily closing stock prices from 2019. We then estimate daily abnormal returns in March and April 2020 as the difference between the actual return and the stock return predicted by the three-factor model. All data are in USD. We subtract the daily return on the one-month Treasury bill to obtain abnormal excess returns. Daily returns, both raw and (excess) abnormal, are accumulated from March 1 through April 30, 2020. Appendix A.1 describes in detail all the variables and steps involved in the estimation of stock returns. Panel A in Table 2 shows that the average company in our sample has negative 13% cumulative return over the two months and negative 6% excess abnormal return over the same period. Relative to the second quarter of 2019, sales decreased on average 14% in the second quarter of 2020. Operating margin (defined as operating profit over sales) decreased on average by 6% during the same period.

We collect the accumulated number of diagnosed cases of COVID-19 per firm and region from the beginning of available records until March 31. We call this variable *Cases*. There are, on average, 6,744 accumulated cases of COVID-19, equivalent to 1,033 cases per million inhabitants in the region where the firm is headquartered.

To instrument the number of cases per region, we collect data from soccer games from all competitions (domestic and international) played in the 137 regions between January 1 and until the end of March 2020 (most games in Europe were canceled after March 10). We only include games played in venues with a minimum capacity of 25,000 people. In total, there are 148 qualifying games during the sample period. From each game, we collect date, playing teams, attendance (when available), venue capacity, and the region and country where it is located.

We accumulate the number of games (*# Games*), their *Attendance*, and the venue *Capacity* across the 137 regions where firms are located from March 1 through 30. On average, across all firms, there were 3.14 accumulated games, attended by (accumulated) 107,289 people in venues with an (accumulated) maximum capacity 146,056 spectators. The variable *I_Games* takes a value of 1 if there was a soccer match in the region where the firm is located from March

1 through 30, zero otherwise. Table 2 shows that, on average, 74% of the firms are in regions with soccer games during that period.

Finally, we collect the *Population*, *Density,* and Gross Regional Product per capita (*GRP*) of each region where firms are located. Panel D in Table 2 presents the pairwise correlations among the main variables in our analysis. Regional population and the soccer variables show the highest correlation (about 0.77). Intuitively, it makes sense that larger and more densely populated cities host more games. Table B.1 in Appendix B shows the statistics per region and firm.

[Insert Table 2 about here]

3.2 Empirical strategy

As we argue in the Introduction, a simple OLS regression of the cross section of stock returns on the lagged number of regional COVID-19 cases would be inconclusive. We tackle this by instrumenting first the accumulated number of COVID-19 cases per million inhabitants in each region during March 2020 with the region's *Population*, its *Density*, and, alternatively, one the three variables related to the soccer matches played in the region during that month: *I_Games*, *Attendance*, and *Capacity.* Wealthier regions are likely to be more densely populated and have more stadiums and soccer teams. Thus, we control for the region's *GRP.* Several firm variables have been shown to affect stock returns in relation to the virus outbreak. Therefore, we control for each firm's *Size*, *TobinQ*, *Debt/Assets*, and *Cash/Asset.* Since countries and sectors differ in their regional concentration and their exposure and reaction to the pandemic, we include country and industry fixed effects.[15]

The instrumented cases are then used to predict the cross-section of accumulated daily stock returns over March and April. We include the same controls and fixed effects than in the first-stage regressions. Fatality rates of infected cases increased non-linearly with age. Figure 1 shows available statistics from two countries in our sample, Italy and Spain, together with China and South Korea. If our hypothesis is correct, markets should discount more heavily the stock value of firms led by older, male CEOs. To test this hypothesis, we interact Log*(Cases/Population)* in each region with *Prob. Death (CEO)*, and instrument this interaction using the same instruments and controls previously discussed. We also instrument the number of cases. We then introduce both instrumented variables and the *Prob. Death (CEO)* in the regression on the cross-section of stock returns, including all the controls and fixed effects. Our hypothesis predicts that the coefficient on the interaction should be negative.

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[15] In unreported tests, we also introduce dummies for headquarter location in country capital cities. Results are not affected.

[Insert Figure 1 about here]

3.3 Evidence from the cross-section of stock returns

In this section, we study how the instrumented number of cases of COVID-19 across regions in Europe during March 2020 affected the cross-section of stock returns over March and April.

If our hypothesis is correct, we should expect stock markets to discount the incidence of COVID-19 in the region where the firm's top management is located when the probability of the CEO's death is higher after controlling for firm characteristics, country, and sector fixed effects. Ideally, we would like to run the following regression for each firm *f* in region *r*:

$$\begin{aligned} R_{r,f} = \alpha + \beta Prob.\ of\ contagion\left(CEO_f\right) \times Cond.\ \ prob.\ of\ \ death(CEO_f) \\ + \gamma_1 Log(GRP_r) + \ \gamma_2 \frac{Debt}{Assets_f} + \gamma_3 TobinQ_f + \gamma_4 \frac{Cash}{Assets_f} \\ + \gamma_5 Log\left(Size_f\right) + FE_c + FE_i + \tau_{r,f} \end{aligned} \quad (1)$$

where $R_{r,f}$ represents the stock return from company f in region *r*, $Prob.\ of\ contagion\left(CEO_f\right)$ is the probability of getting infected with COVID-19, and $Cond.\ \ prob.\ of\ \ death\left(CEO_f\right)$ is the probability of dying from COVID-19 conditional on being infected with the virus. However, we do not have direct estimates of $Prob.\ of\ contagion\left(CEO_f\right)$ or $Cond.\ \ prob.\ of\ \ death(CEO_f)$.

To test our hypothesis and based on the available data, we assume that the CEO's probability of contagion is an increasing function of the number of cases per population in the region where the company is headquartered. Additionally, we assume that the CEO's conditional probability of death is an increasing function of the probability of dying from COVID-19 conditional on age and gender.

Figure 1 shows that the probability of death due to COVID-19 is highly nonlinear with respect to the patient's age. This pattern is very similar across the four countries for which we have been able to obtain statistics by age in the period of our sample. From the beginning of the pandemic, the fatality rates for males were also known to be significantly higher than those for females.

Thus, to proxy $Prob.\ of\ \ death(CEO_f)$, we use data on fatality rates across age groups and gender published by the Spanish Ministry of Health (see Pastor-Barriuso et al (2020)).[16]

Each observation is a firm *f* located in region *r*. In the first stage, we instrument the number of COVID-19 cases per million in the region where the firm is located with the region's Population, Density and, alternatively, one of the three soccer variables, namely: *I_Games*, *Attendance*, and *Capacity*. We run the following regression:

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\begin{aligned}
Z_{r,f} = \theta_0 + \theta_1 Y_r + \theta_2 Log(Population_r) + \theta_3 Log(Density_r) \\
+ \theta_4 Log(GRP_r) + \theta_5 Prob.Death\,(CEO_f) + \theta_6 \frac{Debt}{Assets_f} \\
+ \theta_7 TobinQ_f + \theta_8 \frac{Cash}{Assets_f} + \theta_9 Log(Size_f) + FE_c + FE_i + \epsilon_{r,f}.
\end{aligned} \tag{2}
$$

where $Z_{r,f} = Log\left(\frac{1+Cases}{Population_{r,f}}\right)$ in specifications (1)-(3) and $Z_{r,f} = Log\left(\frac{1+Cases}{Population_{r,f}}\right) \times Prob.Death\,(CEO_f)$ in specifications (4)-(6). Y_r is, alternatively, in each specification, I_Games_r, $Log(1 + Attendance_r)$, and$Log(1 + Capacity_r)$. FE_c and FE_i stand for country and industry fixed effects, respectively. The rest of variables are defined in Appendix A.1. Their summary statistics are reported in Table 2. Standard errors are clustered at the region level.

[Insert Table 3 about here]

Table 3 presents the coefficients estimated from regression (1). In column (1) the instruments are the dummy variable *I_Games*, (Log) *Population*, and (Log) *Density*. In this case, the coefficient θ_1 means that, within the same country and industry, the number of cases per million people in regions where there was at least one soccer match during March is, on average, 40 percentage points higher than in regions where there were no games. This coefficient is significant at the 1% level.

When we look at (log) *Attendance* or (log) *Capacity* in specifications (2) and (3), the coefficient θ_1 should be interpreted as the elasticity of the number of COVID-19 cases per million people with respect to the number of attendants to the soccer games in each region and the venue capacity, respectively. Thus, given the sample statistics in Table 2, for the average region in our

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[16] The case fatality rates are reported in Table A1 of the online Appendix. Importantly, all of these rates were publicly known during our sample period. We were not able to find statistics disaggregated by gender for other EU countries. The results are qualitatively similar when we use the fatality rates aggregated across gender for Spain or Italy in Figure 1.

sample, a 1% increase in the accumulated number of attendants to soccer games (about 1,072 spectators on average) increases the cases of COVID-19 per million by 0.3 (=1%×0.030×1,033) or, equivalently, 1.71 (=0.3×5.699) new cases in the region in March 2020. This result is significant at the 5% level. Finally, in specification (3), a 1% increase in the venue capacity (about 1,460 spectators on average) is associated to an increment of 0.37 (=1%×0.036×1,033) new cases of COVID-19 per million or about 2.11 (=0.37×5.699) new cases in the average region of our sample during March 2020. This coefficient is significant at the 1% level.

Log(*Population*) is non-significant in any specification, which is not surprising given its high correlation with the three soccer-related variables. Log(*Density*) is strongly significant as we expected. Coefficient θ_3 means that a 1% increase in regional population density is associated with 10 basis points increment in the number of cases of COVID-19. The size and significance of this coefficient is very stable across the three specifications.

As expected, Log(*GRP*) is highly significant and an important determinant in the change of the number of cases. A 1% increase in gross regional product is associated with about 83 basis points increase of COVID-19 cases. It is important to notice that, in spite of the high significance, both statistical and economic, of Log(*Density*) and Log(*GRP*), the three instrument variables associated to soccer games are significant and economically meaningful predictors of new cases of COVID-19. We interpret all this evidence as strong support of their relevance. Finally, also expectedly, the coefficients on the firm variables (size, leverage, Tobin's Q, and cash holdings) are all no-significant.

In specifications (4)-(6), the coefficients on the three soccer instruments are positive and statistically significant at the 5% level in specifications (5) and (6). The coefficient is marginally significant in specification (4) when the soccer instrument is *I_Games*.

In the second stage regression, we replace the predicted variables from (2) into equation (1). We then test the following (instrumented) regression:

$$\begin{aligned} R_{r,f} = \alpha_0 &+ \beta_1 Log\left(\frac{1+\widehat{Cases}}{Population_{r,f}}\right) \\ &+ \widehat{\beta_2 Log\left(\frac{1+Cases}{Population_{r,f}}\right)\times Prob.of\ death\ (CEO_f)} \\ &+ \gamma_1 Log(GRP_r) + \gamma_2 Prob.of\ death\ (CEO_f) + \gamma_3 \frac{Debt}{Assets_f} \\ &+ \gamma_4 TobinQ_f + \gamma_5 \frac{Cash}{Assets_f} + \gamma_6 Log(Size_f) + FE_c + FE_i + \epsilon_{r,f} \end{aligned} \tag{3}$$

Our object of interest is the coefficient β_2 In the (instrumented) interaction term. We report the regression coefficients in Table 4.

[Insert Table 4 about here]

The estimated coefficient β_2 in specifications (2)-(4) is negative and statistically significant at the 5% level (10% when the instrument is *I_Games*.[17] Taking the derivative of equation (3) with respect to Log((1+*Cases)/Population*) and replacing the estimated coefficients from specification (3) in Table 4 yields:

$$\frac{\partial R_{r,f}}{\partial Log\left(\frac{1+Cases}{Population_{r,f}}\right)} = -0.059 - 13.121 \times Prob.\ of\ \ death\left(CEO_f\right)$$

Thus, on average, an increase of 1% in the number of cases of COVID-19 per capita in the region where the firm is headquartered (on average, 10 new cases) decreases abnormal stock returns by 13.12 basis points per additional percentage point of probability of death for the company's CEO. Considering the conditional probabilities from Spain by gender and given that 94% of CEOs in our sample are males, when the CEO is younger than 50 (28% of our sample), the probability is below 1%. The impact would be negative albeit very marginal. Between 50-60 years old (51% of our sample), the conditional probability of death for males is 1.5%. Thus, a 1% increase in the number of cases per million inhabitants during March implies an expected decrease of -0.26 basis points (=-0.059-13.121×1.5%) in abnormal returns over March and April. The probability of dying conditional on being infected rises to 4.6% for males between 60–70 years old (17% of our sample). Thus, a 1% increase in the number of cases per million during March implies an expected decrease of 66 basis points (=-0.059-13.121×4.6%) in abnormal returns over March and April. Likewise, a 1% increase in cases per million inhabitants for males between 70-80 years old (3% of our sample) implies an expected decrease of at least 177.8 (=-0.059-13.121×13.1%) basis points in abnormal returns.

Therefore, Table 4 suggests that markets distinguished between relatively younger and older CEOs when discounting the threat of COVID-19 to company management during the first wave in Europe. The conclusions are analogous when we use the estimated coefficients from specifications (3) or (5).

On the other hand, in specification (1), we report the coefficients estimated if we fail to instrument the cases per capita and its interaction with the probability of CEO death. The

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[17] Results are similar when we consider raw returns in Table A2 in the Online Appendix.

coefficient on the interaction term becomes negligible and statistically insignificant. Therefore, our instruments unveil a pattern that otherwise would not have been observed due to potential endogeneity issues.

4. Robustness tests and alternative explanations

In this section, we report some robustness tests and the evidence from potentially alternative explanations of our findings.

4.1 Reversal effect in May 2020

As shown in Figure 2, by the end of May 2020 the (countrywide) number of new cases per million people (on a rolling 7-day average basis) had decreased below 20 in all countries of our sample except the UK and Sweden. Arguably, markets should have discounted at that point that the probability of the CEO dying of falling seriously sick from COIVD-19 had decreased considerably. If that is correct, we predict an upward swing in prices during May 2020 among the same stocks that experienced a decline over March and April. Namely, shares from firms managed by relatively older CEOs. To test this conjecture, we run regression (3) replacing the abnormal return from March and April with that of May 2020. Results are reported in Table 5.

Supporting our hypothesis, stocks from companies headquartered in regions who suffered a higher number of cases of COVID-19 in March bounce back in May. Like in Table 4, the OLS tests in specification (1) show no correlation between the (uninstrumented) cases of COVID-19 and stock returns. After instrumenting the number of cases per million inhabitant, specifications (2)-(4) show an effect symmetric to that reported in Table 5. The three coefficients are positive and significant at the 10% level. The magnitudes are very similar to those reported in Table 5. Hence, stocks from firms managed by older CEOs experienced during May 2020 a return increase associated to the number of regional COVID-19 cases during March that almost neutralized the drop in returns during March and April. We interpret this as evidence of our instrumented variables capturing the threat of COVID-19 to the CEOs health and life (and its relaxation) and prices by the market.

[Insert Figure 2 about here]

[Insert Table 5 about here]

4.2 The impact of COVID-19 on the Board Chair

Are CEOs particularly valuable for shareholders or should we expect a similar market reaction for the Board Chair? Let us remember that, as shown in Panels B and C from Table 1, Board Chairs are significantly older than CEOs. The average Board Chair is 62 years old versus the CEO's average age of 55. Thus, a priori, we should expect a higher stock price impact of a potential contagion with COVID-19 from Chairs, assuming both are equally valuable to shareholders.

To test this, we replace the age and gender of the CEO with the age and gender of the company's Chair and rerun regression (3). Results are reported in Table 6. Overall, the coefficients on the interaction term are similar in magnitude across specifications but non-significant. That is, there is no significant difference in stock returns from regional cases of COVID-16 per capita between firms with relatively younger or older executives.[18] We interpret this as evidence of the singular value of CEOs for shareholders.

[Insert Table 6 about here]

4.3 Alternative explanations

The distribution of CEOs and Board Chairs of different age across firms is not random.[19] If older CEOs are less able to navigate the pandemic or if, for whatever reason, they happen to be more prevalent in sectors more affected by the pandemic, this could explain our empirical findings independently of the threat to the CEO's health. If that is true, we expect that the instrumented regional number of COVID-19 cases affect operating performance differently across firms run by older relative to younger CEOs. In Table 7, the dependent variable in equation (3) becomes the change in revenue in the second quarter of 2020 relative to the second quarter of 2019. In The instrumented number of COVID-19 cases per million people in the region where the firm is headquartered has no predicted power on the change in firm operating performance, regardless of the CEO age. We interpret this evidence as inconsistent with the alternative explanations previously mentioned.

[Insert Table 7 about here]

5. Second empirical strategy: sock price reactions to news on the development of a vaccine against COVID-19.

In this section, we introduce an alternative test based on the reaction of stock prices to announcements of progress in the development of a vaccine against COVID-19. If our hypothesis

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[18] Table B.3 in Appendix B shows that results are analogous when we use raw stock returns. Unreported results are also qualitative similar when we replace CEO's age with the average age other top firm executives who are not board members.

[19] Table B.4 in Appendix B shows that firms run by CEOs older than the median sample age are larger and have lower *Tobins Q* and liquidity than firms run by younger CEOs. They tend to be in more populated regions with higher number of COVID-19 cases per million people.

is right and markets price the risk of the CEO falling sick or eventually dying from COVID-19, we expect that a relevant vaccine announcement should cause a positive abnormal return for companies managed by CEOs with higher risk of death if infected with the virus. Specifically, we look at three major vaccine producers: Pfizer, Moderna, and AstraZeneca. To identify relevant announcements, we first look at daily stock price changes of the three pharma companies from March 1 through December 31, 2020. We then calculate daily abnormal returns using a 5-year monthly beta and S&P500 as a market reference.[20] We select days with an abnormal positive return greater than 2.58 standard deviation. Among these days, we select those in which the corresponding pharma company released some news related to the development of a vaccine. In total, we identify 6 dates that meet these requirements: July 13, July 22, and November 9 for Pfizer, March 16, and November 30 for Moderna, and July 15 for AstraZeneca.[21] Then, we estimate the following regression for our sample of companies:

$$\begin{aligned} R_{f,t} = \alpha + \beta CEORisk_f + \gamma_1 \frac{Debt}{Assets_f} + \gamma_2 TobinQ_f + \gamma_3 \frac{Cash}{Assets_f} \\ + \gamma_4 Log\left(Size_f\right) + FE_i + \epsilon_{f,t} \end{aligned} \tag{4}$$

where $R_{f,t}$ is the abnormal return of stock from firm f on the day of event, $CEORisk_f$ is, a dummy variable that takes a value of 1 if the CEO is older than 60 years (alternatively, 65), zero otherwise, or the probability of the CEO dying from COVID-19 if infected with the virus data proxied by the fatality rates reported in Table A1 of the Appendix.[22] The rest of controls are the same as in equation (1). We include industry fixed effects, FE_i. Results are reported in Table 8.

[Insert Table 8 about here]

Firms with CEOs older than 60 (alternatively, 65) experience 23 (alternatively, 41) basis points abnormal return on the day of a major vaccine development announcements. Both coefficients are significant at the 1% level. A one-percent increase in the probability to die given contagion of COVID-19 corresponds to 3 basis point increase in abnormal return on the day of the announcement (significant at the 5% level). We have also estimated a bootstrap model using as a sample actual realization of stock returns in 2020. The coefficients of interest keep about the same level of statistical significance.

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[20] Results are analogous if we replace S&P500 with FTSE100 for AstraZeneca.

[21] Appendix A.2 includes excepts from the announcements.

[22] The results are qualitatively similar when we use the fatality rates aggregated across gender for Spain or Italy in Figure 1.

We repeat the regression in (4) including the variable $ChairRisk_f$ defined analogously to the variable $CEORisk_f$ but for the company's Chair together with the CEO. Results are reported in Table 9.[23]

[Insert Table 9 about here]

All risk variables related to the Chair are statistically insignificant from zero, and the coefficients for risk of CEO are about the same as ones in Table 8. Based on results reported in Table 9 we can conclude that only the risk of CEO falling ill with COVID-19 is priced by financial markets.

Finally, we analyze the accumulated abnormal returns around major vaccine developments dates. We estimate equation (4) within a two-day window around the announcement date (date 0). In Figure 3, we plot the coefficient β for $CEORisk_f$ when the dummy takes a value of 1 if the CEO is older than 60, zero otherwise. Abnormal accumulated returns for companies with CEOs older than 60 years are statistically insignificant from zero for windows (-2 days,-2 days) and (-2 days,-1 day). They are positive and statistically significant for windows (-2 days, 0 days), (-2 days, 1 day) and (-2 days,2 days).[24] Notably, we can see that the effect is persistent and does not disappear after the day of announcement.

To summarize the results of this section, we have shown that companies with older CEOs experienced positive abnormal returns on the dates when a major COVID vaccine development is announced. We also can see that this effect is not temporary and stayed at the same level at least 2 business days after the announcements.

[Insert Figure 3 about here]

6. Conclusion

In this paper, we study whether markets discount CEO value for shareholders. We use the spread of COVID-19 across regions from 10 European countries and almost 3,000 firms to test whether stock markets price the threat to shareholder value derived from the likelihood of CEOs catching the virus, falling sick and, eventually, dying. To overcome the endogeneity in firm location and the speed of the virus spread, we instrument the number of cases of COVID-19 per million people in the region where each firm is headquartered with the number of the region's inhabitants, its population density, and, alternatively, three variables related to the soccer games played in the region during March 2020. Namely, a dummy variable that takes a value of

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[23] Table B.5 in the Appendix shows that results are analogous when we use raw returns.

[24] Accumulated abnormal return for window (-*x* days, *x* days) is defined as the sum of abnormal returns for days -*x*, -*x*+1 … *x*-1, and *x*.

one if some game took place in the region, the accumulated attendance of games played, and the accumulated capacity of game venues.

We control for the regional gross product (GRP), firm characteristics (i.e., size, leverage, cash holdings and Tobin's Q), sector, and country fixed effects. Stock abnormal returns over March and April 2020 decrease significantly with the number of infected inhabitants in the region *only* for firms managed by male CEOs older than 60 years. This is consistent with the documented higher likelihood of older males falling sick and dying after being infected with the virus.

Consistent with a decrease in the threat to CEO health and life, stock returns from firms run by older CEOs experience an almost symmetric rebound in May 2020, after the first virus wave receded in Europe. Results are not robust when we replace CEO's age with the average age of the Board Chair. We interpret this as evidence of the singular value of CEOs for the firm perceived by the market. Finally, the instrumented regional number of COVID-19 cases fail to explain any change in operating performance across firms managed by older versus younger CEOs. This evidence as inconsistent with alternative explanations of our findings based on differences in corporate governance or the ability to adapt to the challenges raised by the pandemic among firms managed by older versus younger CEOs.

As additional evidence, we show that the price of stocks from companies managed by CEOs older than 60 years' experience a positive abnormal return the day in which a positive new development on the vaccine against COVID-19 is disclosed by any of the three major pharma companies developing it.

Overall, our results present novel evidence of the value of CEOs for shareholders in times of crisis and how this value is priced by stock markets.

References

Acharya, V. and Sascha Steffen, 2020. The risk of being a fallen angel and the corporate dash for cash in the midst of COVID, forthcoming in COVID Economics: A Real Time Journal

Ahammer, A., Halla, M., and Lackner, M. (2020). Mass Gatherings Contributed to Early COVID-19 Spread: Evidence from US Sports. COVID Economics, 30:44–62.

Albuquerque, Rui A. and Koskinen, Yrjo J and Yang, Shuai and Zhang, Chendi, 2020. Resiliency of Environmental and Social Stocks: An Analysis of the Exogenous COVID-19 Market Crash, Review of Corporate Finance Studies 9, 593–621.

Alfaro, L., Chari, A., Greenland, A., and Schott, P. K., 2020. Aggregate and Firm-Level Stock Returns During Pandemics, in Real Time, NBER Working Paper No. 26950.

Ashton, John, Bill Gerrard, and Robert Hudson, 2003. Economic impact of national sporting success: Evidence from the London Stock Exchange, Applied Economic Letters 10, 783–785.

Bennedsen, Morten, Kasper M. Nielsen, Francisco Pérez-González, and Daniel Wolfenzon. 2007. Inside the Family Firm: The Role of Families in Succession Decisions and Performance, Quarterly Journal of Economics, May, Vol. 122, No. 2: 647-691.

Bennedsen, Morten, Francisco Pérez-González, and Daniel Wolfenzon, 2020. Do CEOs Matter? Evidence from Hospitalization Events, forthcoming in the Journal of Finance.

Berger, P.G., Ofek, E. and Yermack, D.L., 1997. Managerial Entrenchment and Capital Structure Decisions. The Journal of Finance, 52: 1411-1438.

Bertrand, Marianne, and Antoinette Schoar, 2003. Managing with Style: The Effect of Managers on Firm Policies, Quarterly Journal of Economics, 118 (4), pp. 1169-1208.

Bloom, Nicholas and John Van Reenen. 2007. Measuring and Explaining Management Practices Across Firms and Countries, Quarterly Journal of Economics, Vol. 122 No. 4, 1351-1408.

Bloom, Nicholas, Benn Eifert, Aprajit Mahajan, David McKenzie, John Roberts, Does Management Matter? Evidence from India 2013, Quarterly Journal of Economics 128 (1), 1–51.

Boyle, Glenn, and Brett Walter, 2002. Reflected glory and failure: International sporting success and the stock market, Applied Financial Economics 13, 225–235.

Burke, K. (2020), Managing Coronavirus. COVID-19 Illness in the C-Suite: Disclosure and Other Considerations for Public Companies, Covington & Burling LLP.

Dave, Dhaval M., McNichols, and Joseph J. Sabia, 2020, The Contagion Externality of a Superspreading Event: The Sturgis Motorcycle Rally and COVID-19, Southern Economic Journal 87, 769-807.

Edmans, A., D. García, and Ø. Norli, 2007, Sports Sentiment and Stock Returns. The Journal of Finance 62, 1967-1998.

Edmans, Alex, Xavier Gabaix, and Dirk Jenter, 2017. Executive Compensation: A Survey of Theory and Evidence. The Handbook of the Economics of Corporate Governance, Volume 1, 383-539.

Fahlenbrach, R., Rageth, K., and Stulz, R., 2020. How Valuable is Financial Flexibility when Revenue Stops? Evidence from the Covid-19 Crisis, NBER Working Paper No. 27106.

Fama, Eugene F & French, Kenneth R, 1992. The Cross-Section of Expected Stock Returns, Journal of Finance 47(2), 427-465.

Fee, C. Edward, Charles J. Hadlock, and Joshua R. Pierce, 2013, Managers with and without style: Evidence using exogenous variation, Review of Financial Studies 26, 567–601.

Felbermayr, Gabriel, Julian Hinz, and Sonali Chowdhry, 2020, Après-ski: The Spread of Coronavirus from Ischgl through Germany, Working Paper.

Fischer, Kai, 2021, Thinning out Spectators: Did Football Matches Contribute to the Second COVID-19 Wave in Germany? Working Paper.

Gabaix, Xavier, and Augustin Landier, 2008. Why has CEO Pay Increased So Much?, The Quarterly Journal of Economics 123, 49-100.

Gómez, J.P. and M. Mironov, 2021, Using Soccer Games as an Instrument to Forecast the Spread of COVID-19 in Europe, Finance Research Letters, forthcoming

Guarino, A., J. Stevenson, and R. Marshall, 2021, “When the CEO gets sick,” Korn Ferry Institute.

Heidenreich M., Baur N., 2015. Locations of Corporate Headquarters in Europe: Between Inertia and Co-evolution. In: Lundan S. (eds) Transnational Corporations and Transnational Governance. Palgrave Macmillan, London

Hassan, T.A., Hollander, S., van Lent, L, and Tahoun, A., 2020. Firm-level Exposure to Epidemic Diseases: Covid-19, Sars, and H1N1, NBER Working Paper No. 26971.

Henderson, J.V., and Yukako Ono, 2008, Where do manufacturing firms locate their headquarters? Journal of Urban Economics 68, 431-450.

Hong, H., Jeffrey D. Kubik, Jeremy C. Stein, 2008. The only game in town: Stock-price consequences of local bias, Journal of Financial Economics 90 (1), 20-37.

Horwich, A., 2018, The Securities Law Disclosure Rules of the Road Regarding Executive Illness, Securities Regulation Law Journal, forthcoming.

Musteen, M., Barker, V. L., & Baeten, V. L., 2006. CEO attributes associated with attitude toward change: The direct and moderating effects of CEO tenure. Journal of Business Research, 59, 604–612.

Nguyen, B.D. and Nielsen, K.M., 2014. What death can tell: are executives paid for their contributions to firm value?. *Management Science*, 60(12), 2994-3010.

Onder G, Rezza G, Brusaferro S., 2020, Case-Fatality Rate and Characteristics of Patients Dying in Relation to COVID-19 in Italy. JAMA. doi:10.1001/jama.2020.4683.

Paraskevas Nikolaou, and Loukas Dimitriou, 2020. Identification of critical airports for controlling global infectious disease outbreaks: Stress-tests focusing in Europe, Journal of Air Transport Management 85.

Pastor-Barriuso, R. et al. 2020. Infection fatality risk for SARS-CoV-2 in community dwelling population of Spain: nationwide seroepidemiological study, BMJ 2020;371:m4509 doi: https://doi.org/10.1136/bmj.m4509

Pérez-González, Francisco. 2006. Inherited Control and Firm Performance, American Economic Review, Vol. 96, No. 5, 1559-1588.

Ramelli, Stefano and Wagner, Alexander F., 2020. Feverish Stock Price Reactions to COVID-19, Review of Corporate Finance Studies 9, 622-655.

Rocklöv, Joacim, and Henrik Sjödin, 2020. High population densities catalyze the spread of COVID-19, Journal of Travel Medicine 27.

Shilton, L., Stanley, C., 1999. Spatial patterns of headquarters. Journal of Real Estate Research 17, 341–364.

Strauss-Kahn V., Xavier Vives, 2009. Why and where do headquarters move? Regional Science and Urban Economics 39 (2), 168-186.

Appendix A.1
Variables definition and source

Main variables	
Cases	Accumulated number of COVID-19 diagnosed cases per region from the following sources:

Country	Agency/Website	Country	Agency/Website
Belgium	Epistat	Poland	Serwis Rzeczypospolitej Polskiej
France	Santé Publique France	Spain	Instituto de Salud Carlos III
Italy	Dipartimento della Protezione Civile	Sweden	Folkhalsomyndigheten
Germany	Robert Koch Institute	Switzerland	FOPH
The Netherlands	RIVM	UK	GOV.UK

Cases/Population	Accumulated number of COVID-19 diagnosed cases per million inhabitant per region.
# Games	Accumulated number of soccer matches per region. Collected from the website https://www.thesportsman.com/football
I_Games	A dummy variable that takes a value of 1 if there was a soccer match in the region where the firm is located, zero otherwise.
Attendance	Accumulated number of attendants to all soccer matches in each. Various websites, including www.footlive.com, www.azscore.com, www.soccerway.com, www.fbref.com, and www.sofascore.com.
Capacity	Accumulated maximum capacity in all venues with a minimum capacity of 25,000 spectators that hosted soccer matches per region. Retrieved from the website: https://en.wikipedia.org/wiki/List_of_European_stadiums_by_capacity.

Demographic variables	
Population	Thousands of inhabitants in the region in 2018
Density	Inhabitants per square-Km in the region in 2018
GRP	Gross Regional Product: USD per capita in 2018

Country	Agency/Website	Country	Agency/Website
Belgium	NBB.Stat	Poland	Statistics Poland
France	INED	Spain	INE
Italy	ISTAT	Sweden	SCB
Germany	DESTATIS	Switzerland	FSO
The Netherlands	CBS	UK	ONS

Firm variables	
Size	Firm's sales (SALE) in USD Millions from Compustat , as of FYE 2019
Debt/Assets	Book value of debt (DLTT+DLC) over book assets (AT) from Compustat, as of FYE 2019.
TobinQ	Book value of assets (AT) minus book value of equity (CEQ) plus the market value of equity (CSHO×PRCC) all divided by book value of assets (AT) from Compustat, as of FYE 2019.
Cash/Assets	Cash holdings (CHE) over book assets (AT) from Compustat, as of FYE 2019.
Revenue growth (2Q20 vs 2Q19)	Quarterly change (second quarter of 2020 minus second quarter of 2019) of firm sales (SALESQ), from Compustat
Margin growth (2Q20 vs 2Q19)	Quarterly change (second quarter of 2020 minus second quarter of 2019) of operating profit margin. Operating profit margin is operating income before depreciation (OIBDPQ) over sales (SALEQ), from Compustat.
Raw return ®	For every day *t*, we define raw return as: r_t=Log ((PRCCD$_t$/AJEXDI$_t$)×TRFD$_t$)-Log ((PRCCD$_{t-1}$/AJEXDI$_{t-1}$)×TRFD$_{t-1}$), all variables from Compustat. We then accumulate daily returns from March 1 through April 30, 2020.
Abnormal return ®	For every stock, we regress daily raw returns (in excess of the one-month Treasury Bill) on the three-factor model of Fama and French (1992) during 2019. All data from Compustat. Adjusted stock prices are converted into USD using the exchange rates from the IMF. Daily data for the European three factors (in USD) and the one-month US Treasury Bill return are downloaded from Kenneth French website. Abnormal (excess) daily returns are calculated as the difference between the actual raw returns and the predicted returns from the three-factor model. We then accumulate daily returns from March 1 through April 30, 2020.
Age (CEO), Age(Chair)	Age in years of the company's CEO (Chair). In Boardex, we identify the CEO (Chair) based on the data item "Individual Role." In Orbis, we identify the CEO (Chair) based on the data item "Job Title English." We then pinpoint the following titles: "Chief Executive (Officer)", "CEO", "Chief Officer", "Highest Executive", "General Director" for the CEO; "President", "Chairman", "Chairwoman" for the Board Chair. The remaining observations are retrieved manually from the company's website and online press articles.
Male(CEO), Male(Chair)	Takes a value of 1 if the CEO (Chair) is a male, zero otherwise. From the same sources as the variable *Age*.

Prob. Death (CEO)

Given the age and gender, we assign a probability of death from COVID-19 to the company's CEO (Chair) based on the Case Fatality Rates for Spain collected by the Spanish Ministry of Health during the first wave and reported in El Pais (Figure 1) on April 12, 2020 (https://elpais.com/ciencia/2020-04-11/el-coronavirus-mata-mas-a-los-hombres-que-a-las-mujeres-como-casi-todo-lo-demas.html) For the epidemiologic study of these data see Pastor-Barriuso et al (2020).

Age	*Prob. Death (Male)*	*Prob. Death (Female)*	*Age*	*Prob. Death (Male)*	*Prob. Death (Female)*
30-39 years	0.4%	0.1%	70-79 years	13.1%	7.3%
40-49 years	0.6%	0.2%	80-89 years	24.8%%	16.6%
50-59 years	1.5%	0.6%	90+ years	30.6%%	20.7%
60-69 years	4.6%	2.1%			

Appendix A.2
Dates of major vaccine news

Pfizer

July 13. Pfizer and BioNTech Granted FDA Fast Track Designation for Two Investigational mRNA-based Vaccine Candidates Against SARS-CoV-2 https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biontech-granted-fda-fast-track-designation-two

July 22. Pfizer and BioNTech Announce an Agreement with U.S. Government for up to 600 Million Doses of mRNA-based Vaccine Candidate Against SARS-CoV-2 https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biontech-announce-agreement-us-government-600

November 9. Pfizer, BioNTech say Covid vaccine is more than 90% effective — 'great day for science and humanity' https://www.cnbc.com/2020/11/09/covid-vaccine-pfizer-drug-is-more-than-90percent-effective-in-preventing-infection.html

Moderna

March 16. First human trial for coronavirus vaccine begins Monday in the US https://www.cnbc.com/2020/03/16/first-human-trial-for-coronavirus-vaccine-begins-monday-in-the-us.html

November 30. Moderna Requests Emergency FDA Authorization for COVID-19 Vaccine https://time.com/5916268/moderna-fda-covid-19-vaccine/

AstraZeneca

July 15 Covid Vaccine Front-Runner Is Months Ahead of Her Competition https://www.bloomberg.com/news/features/2020-07-15/oxford-s-covid-19-vaccine-is-the-coronavirus-front-runner

Table 1

Announcement of CEOS infected with COVID-19

From March 1, 2020 through March 30, 2021 we perform a word search in Factiva for CEOs who have has tested positive or died of COVID-19. The table reports the company name and country, together with the CEO's surname and first name, age (years), and gender (M for male and F for female). It also shows the country index return, and the company's stock return the day of the announcement. Relative performance is the difference between the stock and the corresponding market index return on the day of the announcement. The indices are S&P500 for the USA, FTSE 100 for the UK, KLCI for Malaysia, Nikkei 225 for Japan, DAX 30 for Germany, ASE for Greece, CAC 40 for France, and TSX for Canada. The symbol * next to the CEO first name denotes that the CEO died of COVID-19. Observations are ordered by CEO age, from older (top) to younger (bottom). M (F) denotes Male (Female).

		CEO							
Company	Country	Surname	First Name	Age	Gender	Date of Annoucement	Stock Return	Index Return	Relative Performance
Performance Shipping	Greece	Palios	Simeon	78	M	24/03/2020	5.26%	8.12%	-2.86%
Diana Shipping	Greece	Palios	Simeon	78	M	24/03/2020	4.73%	9.38%	-4.65%
Spirit of Texas Bank	USA	Bass	Dean	69	M	09/04/2020	10.88%	0.77%	10.11%
Domtar Corporation	Canada	Williams	John	65	M	29/01/2021	2.01%	-1.93%	3.94%
Texas Roadhouse	USA	Taylor	Kent*	65	M	23/03/2021	-1.90%	-1.12%	-0.78%
PVH Corp	USA	Chirico	Emmanuel	63	M	01/04/2020	-13.31%	-4.41%	-8.90%
Morgan Stanley	USA	Gorman	James	62	M	09/04/2020	4.34%	1.45%	2.89%
Japan Post Insurance	Japan	Senda	Tetsuya	61	M	04/12/2020	2.54%	-0.22%	2.76%
Athenex, Inc	USA	Lau	Johnson	59	M	08/01/2021	-3.64%	1.03%	-4.67%
Norma Grop	Germany	Schneider	Michael	58	M	24/03/2020	9.11%	9.65%	-0.54%
Murphy Oil Corporation	USA	Jenkins	Roger	58	M	27/03/2020	-10.07%	-3.37%	-6.70%
Wide Open West	USA	Elder	Teresa	58	F	29/03/2020	2.49%	3.35%	-0.86%
Booking Holdings Inc.	USA	Fogel	Glenn	58	M	01/04/2020	-5.48%	-4.41%	-1.07%
K+S	Germany	Lohr	Burkhard	58	M	12/05/2020	-5.80%	-1.16%	-4.64%
Altria Group	US	Willard	Howard	57	M	20/03/2020	-7.61%	-4.34%	-3.27%
ADT	USA	DeVries	Jim	57	M	09/04/2020	13.73%	1.45%	12.28%
Sime Darby	Malaysia	Davidson	Fjeffri Salim	56	M	19/03/2020	2.98%	-2.86%	5.84%
MS Garden Sports	USA	Dolan	Jim	55	M	29/03/2020	-4.72%	3.35%	-8.07%
Strategic education Inc.	USA	McDonnell	Karl	54	M	11/01/2021	2.76%	-1.25%	4.01%

British Telecom	UK	Jansen	Philip	54	M	12/03/2020	-12.49%	-10.37%	-2.12%
Hewlett Packard Enterprise	USA	Neri	Antonio	53	M	18/06/2020	0.62%	0.06%	0.56%
CapStar Financial Holdings Inc	USA	Schools	Tim	52	M	17/06/2020	-4.15%	0.15%	-4.30%
Nexity	France	Ruggieri	J.-Philippe*	51	M	24/04/2020	-0.50%	-1.30%	0.80%
Tesla	USA	Musk	Elon	49	M	13/11/2020	-0.79%	1.02%	-1.81%
Kimco Realty Corporation	USA	Conor	Flynn	39	M	07/04/2020	5.67%	-0.16%	5.83%

Table 2

Summary Statistics

Each observation is a firm. For each firm, we retrieve from Compustat-Capital IQ the following variables: *Size* (proxied by the company's Revenue in USD million), *Debt/Assets*, *Tobin's Q*, and *Cash/Assets* as of FYE 2019. *Abnormal returns* (in decimals) are calculated netting the expected returns predicted by the Fama and French (1992) three-factor model from the actual returns. *Revenue* (*Margin*) *growth* is the quarterly change (second quarter of 2020 minus second quarter of 2019) of firm sales (operating profit margin). *Raw returns* (in decimals) are calculated as the log difference of adjusted daily closing stock prices from Compustat. We report the accumulated daily excess (over the one-month T-bill) abnormal return and raw returns over March and April 2020. *Age* is in years, and *Male* is a dummy that takes a value of 1 if the CEO (Chair) is a male, zero if female. *Prob. Death is* the probability of the death after being infected of COVID-19 depending on age and gender. *Cases* are accumulated in each region through March 30. *Cases/Population* is the number of cases per million inhabitants. *#Games*, *Attendance* and *Capacity* are accumulated in each region from March 1 through 30. I_*Games* is a dummy variable that takes a value of 1 if there was a soccer match in the region where the firm is located from March 1 through 30, zero otherwise. The rest of variables are defined in Table1. Log (*x*) denotes the natural logarithm of *x*. Appendix A.1 includes the definition and source of each variable. Panel B reports the correlation matrix of the main variables. Panel C (D) reports the distribution of CEO (Chair) age across countries. Panel D reports ten correlation matrix.

Panel A. Summary Statistics

	Mean (1)	Median (2)	St. Dev. (3)	# Regions (4)	# Obs. (5)
Size (USD Million)	4,302	224	17,503	137	2,927
Log(*Size*)	5.35	5.42	2.76	137	2,927
Debt/Assets	0.24	0.22	0.21	137	2,927
Tobin's Q	1.97	1.24	2.21	137	2,927
Cash/Assets	0.14	0.08	0.18	137	2,927
Revenue growth (2Q20 vs 2Q19)	-0.14	-0.10	0.49	132	1,767
Margin growth (2Q20 vs 2Q19)	-0.06	-0.01	2.15	132	1,767
Abnormal return	-0.06	-0.07	0.28	137	2,927
Raw return	-0.13	-0.12	0.26	137	2,927
Age (CEO)	54.56	55.00	7.85	137	2,927
Male (CEO)	0.94		0.25	137	2,927
Prob. Death (CEO)	0.02	0.02	0.03	137	2,927
Age (Chair)	62.28	63.00	8.84	137	2,927
Male (Chair)	0.94		0.24	137	2,927
Prob. Death (Chair)	0.05	0.05	0.05	137	2,927
Cases	6,744	2,793	8,918	137	2,927
Cases/Population (per Million*)*	1,033	800	1,012	137	2,927
Log((1+*Cases*)*/Population*)	-7.22	-7.13	0.84	137	2,927
# Games	3.14	2.00	3.58	137	2,927

I_Games	0.74	1.00	0.44	137	2,927
Attendance	107,289	40,164	159,503	137	2,927
Capacity	146,056	95,858	174,257	137	2,927
Log(1+*Attendance*)	8.08	10.60	5.16	137	2,927
Log(1+*Capacity*)	8.74	11.47	5.26	137	2,927
Population (Thousand)	5,699	4,356	4,654	137	2,927
Density	1372	422	1976	137	2,927
GRP per capita	51,244	51,981	15,922	137	2,927
Log(*Population*)	15.07	15.29	1.14	137	2,927
Log(*Density*)	6.31	6.05	1.36	137	2,927
Log(*GRP*)	10.79	10.86	0.33	137	2,927

Panel B. CEO Age Distribution by country

	Age<=40	40<Age<=50	50<Age<=60	60<Age<=70	Age>70	# Obs.
Belgium	0%	24%	56%	19%	1%	91
England	3%	24%	53%	16%	2%	858
France	5%	22%	40%	23%	9%	455
Germany	3%	24%	55%	17%	1%	448
Italy	1%	20%	54%	20%	5%	210
Netherlands	0%	21%	56%	19%	4%	75
Poland	17%	31%	39%	8%	6%	36
Spain	1%	19%	51%	25%	3%	67
Sweden	6%	35%	47%	11%	1%	489
Switzerland	2%	22%	59%	16%	2%	198
Average	4%	24%	51%	17%	3%	
St. Dev.	5%	5%	7%	5%	3%	
# Obs.	111	735	1,490	497	94	2,927

Panel C. Chair Age Distribution by country

	Age<=40	40<Age<=50	50<Age<=60	60<Age<=70	Age>70	# Obs.
Belgium	0%	5%	27%	53%	14%	91
England	0%	5%	24%	51%	20%	858
France	3%	14%	35%	31%	17%	455
Germany	0%	11%	37%	34%	17%	448
Italy	0%	12%	34%	27%	27%	210
Netherlands	0%	8%	24%	45%	23%	75
Poland	11%	33%	25%	19%	11%	36
Spain	0%	6%	25%	37%	31%	67
Sweden	1%	10%	35%	43%	10%	489
Switzerland	1%	3%	34%	51%	11%	198
Average	2%	11%	30%	39%	18%	
St. Dev.	3%	9%	5%	11%	7%	
# Obs.	27	265	911	1,210	514	2,927

Panel D. Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log(*Population*)(1)	1.00						
Log(*Density*)(2)	0.34	1.00					
Log(*GRP*)(3)	0.21	0.33	1.00				
Log(1+*Cases/Population*)(4)	0.33	0.24	0.45	1.00			
Log(1+*Attendance*)(5)	0.77	0.43	0.19	0.24	1.00		
Log(1+*Capacity*)(6)	0.78	0.38	0.16	0.33	0.95	1.00	
I_Games (7)	0.75	0.32	0.12	0.32	0.93	0.99	1.00

Table 3
First-stage regression of COVID-19 cases per capita and its interaction with the CEO's probability of death against instruments

This table reports the coefficients from the following regression:

$$Z_{r,f} = \theta_0+\theta_1 Y_r + \theta_2 Log(Population_r) + \theta_3 Log(Density_r) + \theta_4 Log(GRP_r)+\theta_5 Prob.Death\left(CEO_f\right) + \theta_6 \frac{Debt}{Assets_f} + \theta_7 TobinQ_f + \theta_8 \frac{Cash}{Assets_f} + \theta_9 Log\left(Size_f\right)+FE_c + FE_i + \epsilon_{r,f}.$$

$Z_{r,f} = Log\left(\frac{1+Cases}{Population_{r,f}}\right)$ in specifications (1)-(3), and $Z_{r,f} = Log\left(\frac{1+Cases}{Population_{r,f}}\right) \times Prob.Death\ (CEO_f)$ in specifications (4)-(6). $\frac{1+Cases}{Population_{r,f}}$ is the accumulated number of COVID-19 cases per million people in region *r* where firm *f* is located since statistics are available until March 31, 2020. $Prob.Death\ (CEO_{r,f})$ is the probability (percent) of death from COVID-19 of the CEO of company *f* based on the Case Fatality Rates for Spain in March 2020 by age and gender collected by the Spanish Ministry of Health. Y_r is, alternatively, I_Games_r, a dummy variable that takes a value of one if there was a soccer match in region *r* where firm *f* is located from March 1 through March 30, zero otherwise; $Log(1+Attendance_r)$, the natural logarithm of 1 plus the accumulated number of match attendants to those games; $Log(1+Capacity_r)$, the natural logarithm of 1 plus the accumulated venue capacity where the games were played. FE_c and FE_i stand for country and industry fixed effects, respectively. Appendix A.1 includes the definition and source of each variable. The F-test is a test on the joint-significance of the three instruments. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

	Log((1+*Cases*)/*Population*))			Log((1+*Cases*)/*Population*)) × *Prob. Death* (*CEO*)		
	(1)	(2)	(3)	(4)	(5)	(6)
I_Games	0.4031			-0.0030		
	(0.1262)***			(0.0016)*		
Log(1+*Attendance*)		0.0298			-0.0004	
		(0.0145)**			(0.0001)**	
Log(1+*Capacity*)			0.0361			-0.0003
			(0.0115)***			(0.0001)**
Log(*Population*)	0.0533	0.0545	0.0352	-0.0002	0.0003	0.0000
	(0.0548)	(0.0659)	(0.0602)	(0.0006)	(0.0007)	(0.0007)
Log(*Density*)	0.1018	0.1059	0.0994	0.0008	0.0009	0.0008
	(0.0509)**	(0.053)**	(0.0524)*	(0.0005)	(0.0005)*	(0.0005)
Log(*GRP*)	0.8499	0.8265	0.8289	-0.0033	-0.0033	-0.0032
	(0.1842)***	(0.1903)***	(0.1855)***	(0.0023)	(0.0023)	(0.0023)
Prob. Death (*CEO*)	0.1544	0.1699	0.1531	0.1466	0.1461	0.1466
	(0.2178)	(0.2127)	(0.2166)	(0.1311)	(0.1311)	(0.1311)
Debt/Assets	-0.0130	-0.0039	-0.0130	-0.0043	-0.0043	-0.0043
	(0.033)	(0.0344)	(0.033)	(0.0034)	(0.0034)	(0.0034)
TobinQ	0.0016	0.0019	0.0018	-0.0005	-0.0005	-0.0005
	(0.0028)	(0.0029)	(0.0028)	(0.0003)	(0.0003)	(0.0003)
Cash/Assets	0.0131	0.0223	0.0172	0.0021	0.0020	0.0021
	(0.0467)	(0.0456)	(0.0464)	(0.0023)	(0.0023)	(0.0023)
Log(*Size*)	0.0049	0.0058	0.0052	0.0002	0.0002	0.0002
	(0.0032)	(0.0031)*	(0.0032)	(0.0002)	(0.0002)	(0.0002)
Country FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
F-test	20.775	14.926	21.649	9.046	6.437	9.296
R-sq	0.807	0.801	0.807	0.953	0.953	0.953
Number of firms	2,927	2,927	2,927	2,927	2,927	2,927
Number of regions	137	137	137	137	137	137

Table 4

Cross-section of Abnormal Stock Returns over March and April 2020 Including Probability of Death of the CEO

This table reports the coefficients from the following regression:

$$R_{r,f} = \alpha + \beta_1 Log\left(\frac{1+\widehat{Cases}}{Population_{r,f}}\right) + \widehat{\beta_2 Log\left(\frac{1+Cases}{Population_{r,f}}\right) \times Prob.of\ death\left(CEO_f\right)} + \gamma_1 Log(GRP_r)$$
$$+ \gamma_2 Prob.of\ death\left(CEO_f\right) + \gamma_3 \frac{Debt}{Assets_f} + \gamma_4 TobinQ_f + \gamma_5 \frac{Cash}{Assets_f} + \gamma_6 Log\left(Size_f\right) + FE_c$$
$$+ FE_i + \epsilon_{r,f}$$

$\mathrm{R}_{\mathrm{r,f}}$ is the daily abnormal (excess) return in decimals on stock from firm *f* headquartered in region *r* accumulated over March and April 2020. $\mathrm{Log}\left(\frac{1+\widehat{\mathrm{Cases}}}{\mathrm{Population}_{\mathrm{r,f}}}\right)$ is the natural logarithm of 1 plus the accumulated number of COVID-19 cases per million in region *r* from March 1 through 30, 2020 instrumented in Table 4 by Log(*Population*), Log(*Density*), and, alternatively, *I_Games*, Log(1+*Attendance*), and Log(1+*Capacity*) in specifications (1)-(3), respectively. Analogously, $\widehat{Log\left(\frac{1+Cases}{Population_{r,f}}\right) \times Prob.of\ death\left(CEO_f\right)}$ is the instrumented interaction term in specifications (4)-(6) in Table 4. $Prob.Death\ (CEO_{r,f})$ is the probability (in decimals) of death from COVID-19 of the CEO of company *f* based on the Case Fatality Rates for Spain in March 2020 by age and gender collected by the Spanish Ministry of Health. $\mathrm{FE_c}$ and $\mathrm{FE_i}$ stand for country and industry fixed effects, respectively. To facilitate the interpretation of the coefficients $\mathrm{Log}\left(\frac{1+\widehat{\mathrm{Cases}}}{\mathrm{Population}_{\mathrm{r,f}}}\right)$ and $Prob.Death\ (CEO_{r,f})$ are demeaned. The rest of variables are defined in Appendix A.1. Specification (1) uses $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}_{\mathrm{r,f}}}\right)$ and $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}_{\mathrm{r,f}}}\right) \times Prob.of\ death\left(CEO_f\right)$ without instrumenting in a standard OLS regression. Standard errors are clustered at the region level. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

		Soccer Instrument		
	OLS (1)	*I_Games* (2)	Log (1+*Attendance*) (3)	Log (1+*Capacity*) (4)
Log((1+*Cases*)/*Population*)	-0.014	-0.061	-0.059	-0.061
	(0.012)	(0.057)	(0.044)	(0.055)
Log((1+*Cases*)/*Population*) ×*Prob. of Death (CEO)*	0.356	-19.251	-13.121	-18.095
	(0.287)	(9.838)*	(6.137)**	(9.078)**
Log(*GRP*)	0.053	0.059	0.074	0.063
	(0.027)*	(0.077)	(0.063)	(0.073)
Prob. of Death (CEO)	-0.257	2.629	1.726	2.459
	(0.21)	(2.713)	(1.794)	(2.511)
Debt/Assets	-0.011	-0.099	-0.071	-0.094
	(0.026)	(0.085)	(0.064)	(0.081)
TobinQ	0.005	-0.005	-0.002	-0.004
	(0.004)	(0.01)	(0.007)	(0.009)
Cash/Assets	0.121	0.165	0.151	0.162
	(0.038)***	(0.062)***	(0.051)***	(0.06)***
Log(*Size*)	-0.008	-0.003	-0.004	-0.003
	(0.003)***	(0.005)	(0.004)	(0.005)
Country FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
R-sq	0,155	-	-	-
Number of firms	2,927	2,927	2,927	2,927
Number of regions	137	137	137	137

Table 5
Cross-section of Abnormal Stock Returns
Including Probability of Death of the CEO in May 2020

This table reports the coefficients from the following regression:

$$R_{r,f} = \alpha + \beta_1 Log\left(\widehat{\frac{1+Cases}{Population_{r,f}}}\right) + \beta_2 \widehat{Log\left(\frac{1+Cases}{Population_{r,f}}\right)\times Prob.of\ death\ \left(CEO_f\right)} + \gamma_1 Log(GRP_r)$$
$$+ \gamma_2 Prob.of\ death\ \left(CEO_f\right) + \gamma_3 \frac{Debt}{Assets_f} + \gamma_4 TobinQ_f + \gamma_5 \frac{Cash}{Assets_f} + \gamma_6 Log\left(Size_f\right) + FE_c$$
$$+ FE_i + \epsilon_{r,f}$$

$\mathrm{R}_{\mathrm{r,f}}$ is the daily abnormal (excess) return in decimals on stock from firm *f* headquartered in region *r* accumulated May 2020. $\mathrm{Log}\left(\widehat{\frac{1+\mathrm{Cases}}{\mathrm{Population}_{\mathrm{r,f}}}}\right)$ is the natural logarithm of 1 plus the accumulated number of COVID-19 cases per million in region *r* from March 1 through 30, 2020 instrumented in Table 5 by Log(*Population*), Log(*Density*), and, alternatively, *I_Games*, Log(1+*Attendance*), and Log(1+*Capacity*) in specifications (1)-(3), respectively. Analogously, $\widehat{Log\left(\frac{1+Cases}{Population_{r,f}}\right)\times Prob.of\ death\ \left(CEO_f\right)}$ is the instrumented interaction term in specifications (4)-(6) in Table 4. $Prob.Death\ \left(CEO_{r,f}\right)$ is the probability (in decimals) of death from COVID-19 of the CEO of company *f* based on the Case Fatality Rates for Spain in March 2020 by age and gender collected by the Spanish Ministry of Health. $\mathrm{FE_c}$ and $\mathrm{FE_i}$ stand for country and industry fixed effects, respectively. The rest of variables are defined in Appendix A.1. Specification (1) uses $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}_{\mathrm{r,f}}}\right)$ and $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}_{\mathrm{r,f}}}\right)\times Prob.of\ death\ \left(CEO_f\right)$ without instrumenting in a standard OLS regression. Standard errors are clustered at the region level. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

		Soccer Instrument		
	OLS (1)	*I_Games* (2)	Log (1+*Attendance*) (3)	Log (1+*Capacity*) (4)
Log((1+*Cases*)/*Population*)	0.010	0.067	0.066	0.068
	(0.014)	(0.06)	(0.048)	(0.057)
Log((1+*Cases*)/*Population*) ×*Prob. of Death (CEO)*	-0.450	18.838	12.847	17.474
	(0.301)	(10.33)*	(6.959)*	(9.633)*
Log(*GRP*)	-0.039	-0.060	-0.076	-0.065
	(0.031)	(0.078)	(0.067)	(0.074)
Prob. of Death (CEO)	0.346	-2.489	-1.608	-2.288
	(0.227)	(2.714)	(1.851)	(2.501)
Debt/Assets	-0.021	0.065	0.038	0.059
	(0.034)	(0.084)	(0.064)	(0.08)
TobinQ	-0.003	0.006	0.003	0.005
	(0.004)	(0.009)	(0.007)	(0.008)
Cash/Assets	-0.168	-0.212	-0.199	-0.209
	(0.051)***	(0.069)***	(0.06)***	(0.067)***
Log(*Size*)	-0.001	-0.005	-0.004	-0.005
	(0.004)	(0.005)	(0.004)	(0.005)
Country FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
R-sq	0.111	-	-	-
Number of firms	2,920	2,920	2,920	2,920
Number of regions	137	137	137	137

Table 6

Cross-section of Abnormal Stock Returns

Including Probability of Death of the Board Chair over March and April 2020

This table reports the coefficients from the following regression:

$$
\begin{aligned}
R_{r,f} = \alpha &+ \beta_1 Log\left(\frac{1+\widehat{Cases}}{Population_{r,f}}\right) + \beta_2 \widehat{Log\left(\frac{1+Cases}{Population_{r,f}}\right) \times Prob.of\ death\ \left(Chair_f\right)} + \gamma_1 Log(GRP_r) \\
&+ \gamma_2 Prob.of\ death\ \left(Chair_f\right) + \gamma_3 \frac{Debt}{Assets_f} + \gamma_4 TobinQ_f + \gamma_5 \frac{Cash}{Assets_f} + \gamma_6 Log\left(Size_f\right) + FE_c \\
&+ FE_i + \epsilon_{r,f}
\end{aligned}
$$

$\mathrm{R}_{\mathrm{r,f}}$ is the daily abnormal (excess) return in decimals on stock from firm *f* headquartered in region *r* accumulated over March and April 2020. $\mathrm{Log}\left(\frac{\widehat{1+\mathrm{Cases}}}{\mathrm{Population}_{\mathrm{r,f}}}\right)$ is the natural logarithm of 1 plus the accumulated number of COVID-19 cases per million in region *r* from March 1 through 30, 2020 instrumented in Table 4 by Log(*Population*), Log(*Density*), and, alternatively, *I_Games*, Log(1+*Attendance*), and Log(1+*Capacity*) in specifications (1)-(3), respectively. Analogously, $\widehat{Log\left(\frac{1+Cases}{Population_{r,f}}\right) \times Prob.of\ death\ \left(Chair_f\right)}$ is the instrumented interaction term in specifications (4)-(6) in Table 4. $Prob.Death\ (Chair_{r,f})$ is the probability (in decimals) of death from COVID-19 of the Board Chair of company *f* based on the Case Fatality Rates for Spain in March 2020 by age and gender collected by the Spanish Ministry of Health. $\mathrm{FE_c}$ and $\mathrm{FE_i}$ stand for country and industry fixed effects, respectively. To facilitate the interpretation of the coefficients $\mathrm{Log}\left(\frac{\widehat{1+\mathrm{Cases}}}{\mathrm{Population}_{\mathrm{r,f}}}\right)$ and $Prob.Death\ (CEO_{r,f})$ are demeaned. The rest of variables are defined in Appendix A.1. Specification (1) uses $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}_{\mathrm{r,f}}}\right)$ and $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}_{\mathrm{r,f}}}\right) \times Prob.of\ death\ \left(Chair_f\right)$ without instrumenting in a standard OLS regression. Standard errors are clustered at the region level. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

		Soccer Instrument		
	OLS (1)	*I_Games* (2)	Log (1+*Attendance*) (3)	Log (1+*Capacity*) (4)
Log((1+*Cases*)/*Population*)	-0.015	0.047	-0.001	0.066
	(0.011)	(0.126)	(0.073)	(0.158)
Log((1+*Cases*)/*Population*)	0.155	-17.551	-10.602	-20.124
×*Prob. of Death (Chair)*	(0.083)*	(16.633)	(6.654)	(21.333)
Log(*GRP*)	0.029	-0.058	0.008	-0.084
	(0.024)	(0.183)	(0.108)	(0.222)
Prob. of Death (Chair)	-0.262	1.102	0.566	1.301
	(0.081)***	(2.949)	(1.57)	(3.486)
Debt/Assets	-0.065	-0.157	-0.121	-0.171
	(0.025)***	(0.13)	(0.069)*	(0.154)
TobinQ	0.015	0.007	0.011	0.006
	(0.003)***	(0.011)	(0.006)*	(0.013)
Cash/Assets	0.104	0.224	0.178	0.241
	(0.039)***	(0.188)	(0.099)*	(0.223)
Log(*Size*)	-0.007	-0.006	-0.006	-0.006
	(0.003)**	(0.006)	(0.004)	(0.007)
Country FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
R-sq	0.212	-	-	-
Number of firms	2,927	2,927	2,927	2,927
Number of regions	137	137	137	137

Table 7

Cross-section of Revenue Growth

This table reports the coefficients from the following regression:

$$
\begin{aligned}
Revenue\ Growth_{r,f} &= \alpha + \beta_1 Log\left(\frac{1+\widehat{Cases}}{Population_{r,f}}\right) + \beta_2 \widehat{Log\left(\frac{1+Cases}{Population_{r,f}}\right)\times Prob.of\ death\ (CEO_f)} + \gamma_1 Log(GRP_r) \\
&\quad + \gamma_2 Prob.of\ death\ (CEO_f) + \gamma_3 \frac{Debt}{Assets_f} + \gamma_4 TobinQ_f + \gamma_5 \frac{Cash}{Assets_f} + \gamma_6 Log(Size_f) + FE_c \\
&\quad + FE_i + \epsilon_{r,f}
\end{aligned}
$$

$\text{Revenue Growth}_{\text{r,f}}$ is the quarterly growth of revenues from firm *f* headquartered in region *r* from the second quarter of 2020 with respect to the second quarter of 2019. $\text{Log}\left(\frac{1+\widehat{\text{Cases}}}{\text{Population}_{\text{r,f}}}\right)$ is the natural logarithm of 1 plus the accumulated number of COVID-19 cases per million in region *r* from March 1 through 30, 2020 instrumented in Table 4 by Log(*Population*), Log(*Density*), and, alternatively, *I_Games*, Log(1+*Attendance*), and Log(1+*Capacity*) in specifications (1)-(3), respectively. Analogously, $\text{Log}\left(\frac{1+\widehat{\text{Cases}}}{\text{Population}_{\text{r,f}}}\right) \times Prob.of\ \widehat{death}\ (CEO_f)$ is the instrumented interaction term in specifications (4)-(6) in Table 4. $Prob.Death\ (CEO_{r,f})$ is the probability (in decimals) of death from COVID-19 of the CEO of company *f* based on the Case Fatality Rates for Spain in March 2020 by age and gender collected by the Spanish Ministry of Health. FE_c and FE_i stand for country and industry fixed effects, respectively. To facilitate the interpretation of the coefficients $\text{Log}\left(\frac{1+\widehat{\text{Cases}}}{\text{Population}_{\text{r,f}}}\right)$ and $Prob.Death\ (CEO_{r,f})$ are demeaned. The rest of variables are defined in Appendix A.1. Specification (1) uses $\text{Log}\left(\frac{1+\text{Cases}}{\text{Population}_{\text{r,f}}}\right)$ and $\text{Log}\left(\frac{1+\text{Cases}}{\text{Population}_{\text{r,f}}}\right) \times Prob.of\ death\ (CEO_f)$ without instrumenting in a standard OLS regression. Standard errors are clustered at the region level. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

		Soccer Instrument		
			Log	Log
	OLS	*I_Games*	(1+*Attendance*)	(1+*Capacity*)
	(1)	(2)	(3)	(4)
Log((1+*Cases*)/*Population*)	-0.026	-0.009	-0.009	-0.010
	(0.016)	(0.047)	(0.049)	(0.047)
Log((1+*Cases*)/*Population*)	-0.894	3.176	2.755	3.441
×*Prob. of Death (CEO)*	(0.36)**	(6.041)	(4.903)	(5.844)
Log(*GRP*)	0.065	0.050	0.049	0.052
	(0.038)*	(0.074)	(0.079)	(0.075)
Prob. of Death (CEO)	-0.474	-1.241	-1.162	-1.292
	(0.337)	(1.321)	(1.099)	(1.294)
Debt/Assets	-0.065	-0.054	-0.055	-0.053
	(0.049)	(0.054)	(0.054)	(0.054)
TobinQ	0.031	0.033	0.032	0.033
	(0.005)***	(0.005)***	(0.005)***	(0.005)***
Cash/Assets	-0.204	-0.215	-0.214	-0.216
	(0.11)*	(0.105)**	(0.106)**	(0.105)**
Log(*Size*)	-0.021	-0.022	-0.022	-0.022
	(0.006)***	(0.006)***	(0.006)***	(0.006)***
Country FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
R-sq	0,118	-	-	-
Number of firms	2,387	2,387	2,387	2,387
Number of regions	137	137	137	137

Table 8
Cross-section of Abnormal Stock Returns On Major Vaccine News

This table reports the coefficients from the following regression:

$$R_{f,t} = \alpha + \beta CEORisk_f + \gamma_1 \frac{Debt}{Assets_f} + \gamma_2 TobinQ_f + \gamma_3 \frac{Cash}{Assets_f} + \gamma_4 Log(Size_f) + FE_i + \epsilon_{f,t}$$

where $R_{f,t}$ is the abnormal return of stock from firm f on the day of event, $CEORisk_f$ is, a dummy variable that takes a value of 1 if the CEO is older than 60 years (alternatively, 65), zero otherwise, or the probability of the CEO dying from COVID-19 if infected with the virus data proxied by the fatality rates reported in Table A1 of the Appendix. The rest of controls are the same as in equation (1). We include industry fixed effects, FE_i. Standard errors are reported in parenthesis. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

	(1)	(2)	(3)
CEO Age≥60	0.0023		
	(0.0008)***		
CEO Age≥65		0.0041	
		(0.0012)***	
Prob. of Death (CEO)			0.0283
			(0.0142)**
Debt/Assets	0.0033	0.0032	0.0032
	(0.0025)	(0.0025)	(0.0025)
TobinQ	-0.0004	-0.0003	-0.0004
	(0.0002)*	(0.0002)*	(0.0002)*
Cash/Assets	-0.0068	-0.0069	-0.0069
	(0.0033)**	(0.0033)**	(0.0033)**
Log(*Size*)	0.0010	0.0010	0.0010
	(0.0002)***	(0.0002)***	(0.0002)***
Industry FE	Y	Y	Y
R-sq	0.007	0.007	0.007
Number of observations	17,408	17,408	17,408
Number of firms	2,923	2,923	2,923
	Bootstrap Analysis 1,000 Attempts of 6 Random Dates		
Probability (t_boostrap>t_value)	0.000	0.000	0.028
Probability(t_boostrap>0)	0.408	0.503	0.452
Probability(t_boostrap<0)	0.592	0.497	0.548

Table 9
Cross-section of Abnormal Stock Returns On Major Vaccine News Including Board Chairs

This table reports the coefficients from the following regression:

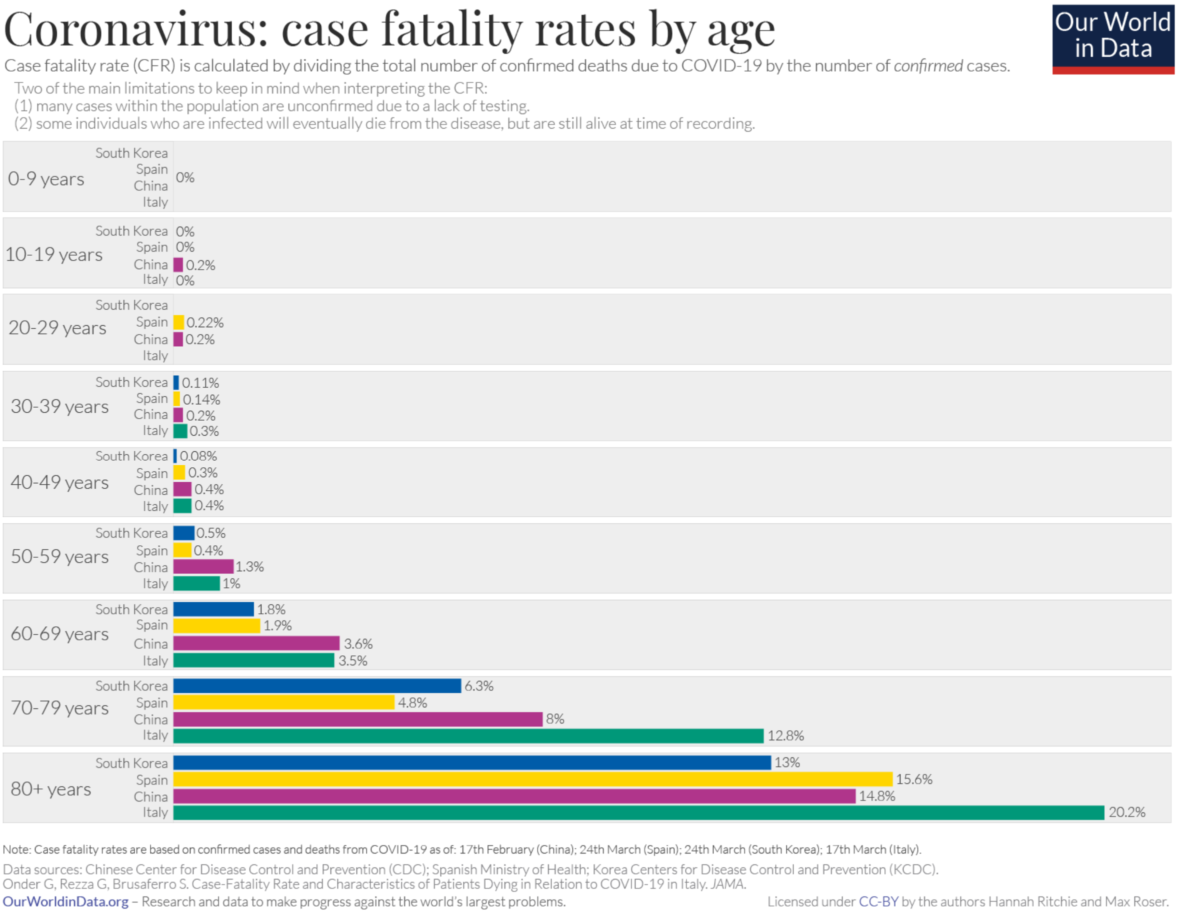
$$R_{f,t} = \alpha + \beta CEORisk_f + \delta ChairRisk_f + \gamma_1 \frac{Debt}{Assets_f} + \gamma_2 TobinQ_f + \gamma_3 \frac{Cash}{Assets_f} + \gamma_4 Log(Size_f) + FE_i + \epsilon_{f,t}$$

where $R_{f,t}$ is the abnormal return of stock from firm f on the day of event, $CEORisk_f$ is, a dummy variable that takes a value of 1 if the CEO is older than 60 years (alternatively, 65), zero otherwise, or the probability of the CEO dying from COVID-19 if infected with the virus data proxied by the fatality rates reported in Table A1 of the Appendix. $ChairRisk_f$ is defined analogously to , $CEORisk_f$ but for the company's Chair. The rest of controls are the same as in equation (1). We include industry fixed effects, FE_i. Standard errors are reported in parenthesis. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

	(1)	(2)	(3)
CEO Age≥60	0.0021		
	(0.0009)**		
Chair Age≥60	0.0009		
	(0.0008)		
CEO Age≥65		0.0035	
		(0.0013)***	
Chair Age≥65		0.0014	
		(0.0008)*	
Prob. of Death (CEO)			0.0255
			(0.0149)*
Prob. of Death (Chair)			0.0051
			(0.0077)
Debt/Assets	0.0034	0.0033	0.0033
	(0.0025)	(0.0025)	(0.0025)
TobinQ	-0.0004	-0.0003	-0.0004
	(0.0002)*	(0.0002)*	(0.0002)*
Cash/Assets	-0.0069	-0.0069	-0.0069
	(0.0033)**	(0.0033)**	(0.0033)**
Log(*Size*)	0.0010	0.0010	0.0010
	(0.0002)***	(0.0002)***	(0.0002)***
Industry FE	Y	Y	Y
R-sq	0.007	0.008	0.007
Number of observations	17,408	17,408	17,408
Number of firms	2,923	2,923	2,923

Figure 1
COVID-19 Fatality Rates By Age

The figure shows Case Fatality Rates (CSF) of COVID-19 in four countires where data is available. CSF per age group is defined as the total number of confirmed deaths due to COVID-19 divided by the number of confirmed cases. The graph is retrieved from https://ourworldindata.org/mortality-risk-covid#case-fatality-rate-of-covid-19-by-age. Data is collected by Our World in Data by Oxford Martin School at the University of Oxford. The figures come from the Chinese Center for Disease Control and Prevention (CDC) as of 17th February; Spanish Ministry of Health as of 24th March; Korea Centers for Disease Control and Prevention (KCDC) as of 24th March; and the Italian National Institute of Health, as presented in Onder et al. (2020).



Coronavirus: case fatality rates by age

Case fatality rate (CFR) is calculated by dividing the total number of confirmed deaths due to COVID-19 by the number of *confirmed* cases.

Two of the main limitations to keep in mind when interpreting the CFR:
(1) many cases within the population are unconfirmed due to a lack of testing.
(2) some individuals who are infected will eventually die from the disease, but are still alive at time of recording.

Note: Case fatality rates are based on confirmed cases and deaths from COVID-19 as of: 17th February (China); 24th March (Spain); 24th March (South Korea); 17th March (Italy).

Data sources: Chinese Center for Disease Control and Prevention (CDC); Spanish Ministry of Health; Korea Centers for Disease Control and Prevention (KCDC).
Onder G, Rezza G, Brusaferro S. Case-Fatality Rate and Characteristics of Patients Dying in Relation to COVID-19 in Italy. *JAMA.*
OurWorldinData.org – Research and data to make progress against the world's largest problems. Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.

Figure 2

Daily New Confirmed COVID-19 Cases per Million People

This graph represents the 7-day rolling average daily new confirmed cases of COVID-19 per million people in the 10 countries of our sample, from March 1 through May 31, 2020. The graph is retrieved from https://ourworldindata.org/coronavirus . Data is collected by Our World in Data by Oxford Martin School at the University of Oxford. Figures are provided by the John Hopkins University.

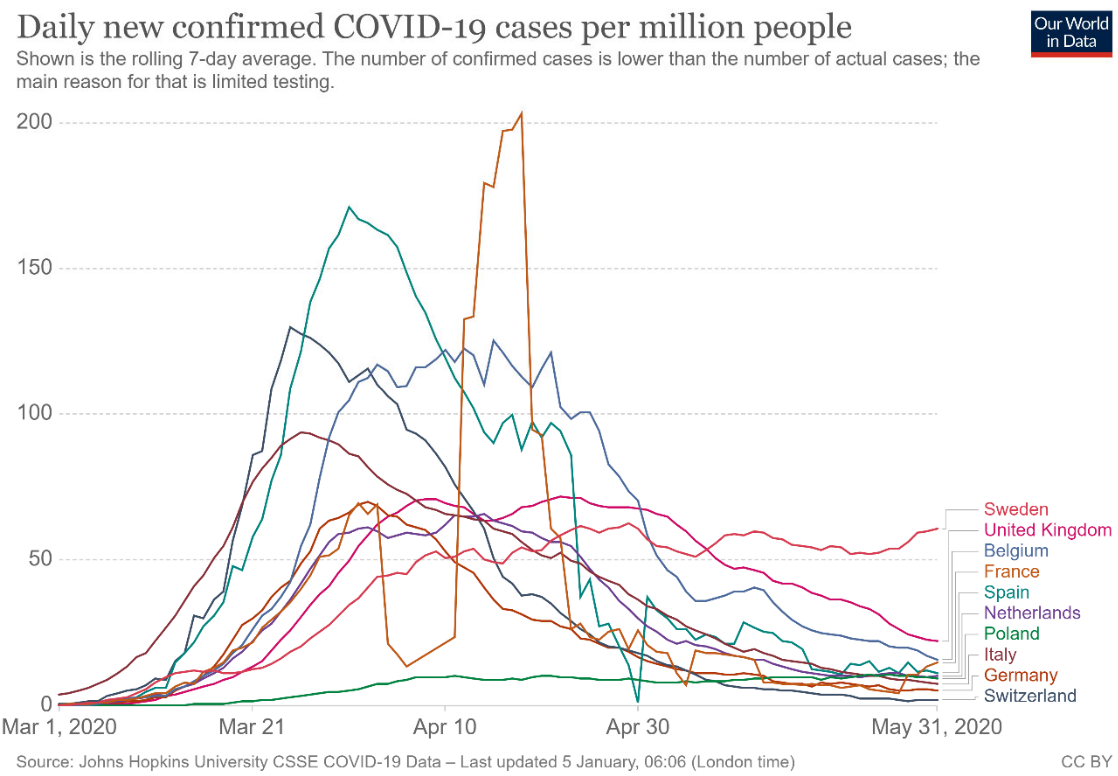
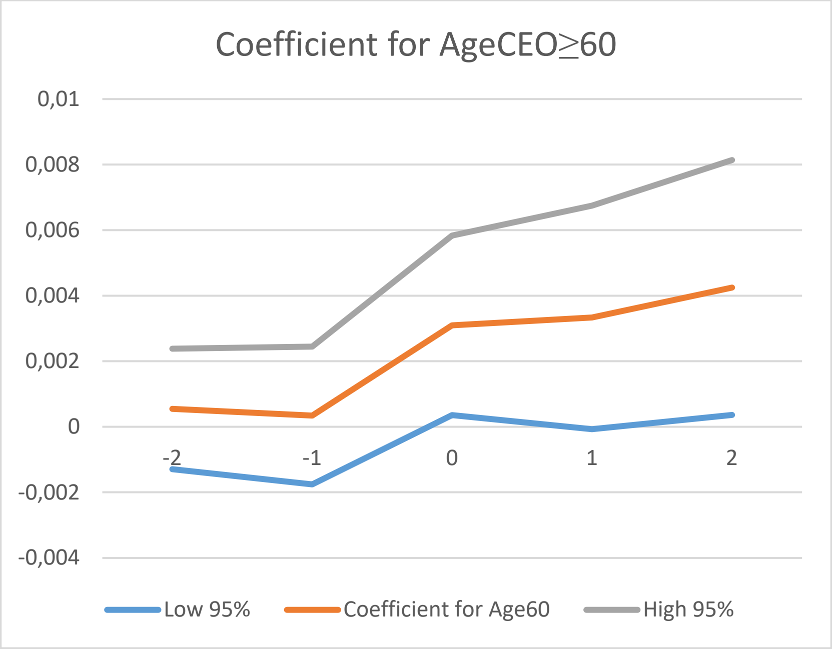


Figure 3

Coefficient of Regression of Abnormal Stock Returns on the Dummy Variable Age CEO≥60 on a 2-Day Window around the Announcement Day

This graph represents the estimation of coefficient β of equation (4) within a two-day window around the announcement date (date 0). *CEORisk* is a dummy which equates to one if CEO is older than 60, zero otherwise. Abnormal accumulated returns are taken for the following windows (-2 days, -2 days), (-2 days, -1 day), (-2 days, 0 days), (-2 days, 1 day), (-2 days, + 2 days).



Appendix B

Table B.1

Statistics per Region and Firm

Each firm in one observation. *Cases* is the accumulated number of diagnosed cases of COVID-19 in the region where the firm is located until March 31. *# Games*, *Attendance*, and *Capacity* are the accumulated number of soccer matches played in the region where the firm is located, their attendance, and the venue capacity, respectively, from March 1 through 30. *Size* is the firm revenue in 2019 in USD million. *Population* is thousands of inhabitants per region; *Density* is number of inhabitants per square-Km, both as of 2018. The table reports the average value of each variable across firms in the region. Appendix A.1 describes all variables and their source.

Country Region	Cases	Population	Density	# Games	Attendance	Capacity	Size	# Firms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Belgium Brussels	1,872	1,199	7,381	-	-	-	3,954	31
Belgium Flanders	9,710	6,553	481	3	34,179	89,925	2,203	46
Belgium Wallonia	5,146	3,624	214	2	26,007	60,000	121	14
England Bedfordshire	224	669	542	-	-	-	2,234	7
England Berkshire	239	911	722	-	-	-	4,682	23
England Bristol	103	463	4,224	-	-	-	2,628	9
England Buckinghamshire	253	809	432	1	7,880	30,500	1,034	19
England Cambridgeshire	165	853	252	-	-	-	1,236	26
England Cheshire	185	1,059	452	-	-	-	330	26
England Cumbria	380	499	74	-	-	-	498	3
England Derbyshire	379	1,053	401	2	57,969	67,194	843	9
England Devon	207	1,194	178	-	-	-	59	3
England Dorset	105	772	274	-	-	-	456	3
England Durham	202	867	324	-	-	-	223	6
England East Riding of Yorkshire	49	600	242	1	16,178	25,400	2,020	2
England East Sussex	117	845	472	1	30,124	30,750	315	5
England Essex	473	1,833	499	-	-	-	326	13
England Gloucestershire	222	916	291	-	-	-	949	7
England Greater London	7,121	8,899	5,671	10	461,871	495,752	3,623	400
England Greater Manchester	901	2,813	2,204	3	95,591	129,496	689	25
England Hampshire	721	1,844	489	1	30,096	32,505	716	18
England Hertfordshire	396	1,184	721	-	-	-	4,981	22

England Kent	461	1,846	494	-	-	-	258	14
England Lancashire	351	1,498	487	1	13,099	31,367	534	6
England Leicestershire	259	1,053	489	2	59,306	64,624	1,239	12
England Merseyside	462	1,423	2,200	4	147,964	187,290	70	4
England Norfolk	148	904	168	-	-	-	428	4
England North Yorkshire	241	1,159	134	1	18,884	34,988	1,010	13
England Northamptonshire	170	748	316	-	-	-	1,997	5
England Nottinghamshire	318	1,154	535	1	27,307	30,603	1,578	5
England Oxfordshire	198	688	264	-	-	-	240	24
England Somerset	135	965	232	-	-	-	165	10
England South Yorkshire	685	1,403	904	3	77,522	112,326	470	13
England Staffordshire	318	1,131	417	1	23,126	30,089	170	7
England Surrey	387	1,190	716	-	-	-	1,991	28
England Tyne and Wear	468	1,136	2,105	2	82,091	101,045	1,220	11
England Warwickshire	161	571	289	-	-	-	57	3
England West Midlands	1,541	2,916	3,235	5	107,569	146,251	809	21
England West Sussex	146	859	431	-	-	-	222	9
England West Yorkshire	430	2,320	1,143	2	50,733	64,596	1,148	29
England Wiltshire	112	720	207	-	-	-	717	10
England Worcestershire	170	592	340	-	-	-	648	4
France Auvergne-Rhône-Alpes	4,374	7,917	113	4	165,801	202,372	1,729	60
France Bourgogne-Franche-Comté	2,202	2,818	59	-	-	-	265	7
France Brittany	673	3,307	121	1	24,818	29,778	188	10
France Centre-Val de Loire	789	2,578	66	-	-	-	377	3
France Grand Est	7,983	5,555	97	1	14,797	26,661	190	14
France Hauts-de-France	2,626	6,007	189	2	40,164	88,409	687	8
France Normandy	902	3,336	111	1	5,948	25,181	747	2
France Nouvelle-Aquitaine	1,281	5,936	70	1	15,799	42,115	656	17
France Occitanie	1,630	5,808	80	1	13,301	33,150	135	20
France Pays de la Loire	884	3,738	116	1	20,704	37,473	633	11

France Provence-Alpes-Côte d'Azur	2,492	5,022	160	2	70,749	103,178	297	22
France Île-de-France	14,269	12,117	1,009	2	47,542	95,858	7,054	281
Germany Badendeath Württemberg	12,334	10,880	304	3	107,605	116,320	5,844	56
Germany Bavaria	14,810	12,844	182	3	131,048	155,660	6,461	108
Germany Berlin	2,575	3,520	3,946	1	58,028	74,649	627	39
Germany Brandenburg	798	2,485	84	-	-	-	80	5
Germany Bremen	294	671	1,598	-	-	-	831	5
Germany Hamburg	2,191	1,787	2,367	2	70,863	86,546	1,675	31
Germany Hesse	3,283	6,176	292	2	51,500	103,000	3,061	57
Germany Lower Saxony	4,063	7,927	167	3	52,395	109,000	21,143	21
Germany North Rhinedeath Westphalia	13,225	17,865	524	13	405,198	592,700	7,057	90
Germany Rhinelanddeath Palatinate	2,726	4,053	204	3	61,341	117,780	6,413	13
Germany Saarland	782	996	388	-	-	-	508	2
Germany Saxony	1,882	4,085	221	3	114,385	117,182	306	3
Germany Saxonydeath Anhalt	680	2,245	110	1	17,095	27,250	55	3
Germany Schleswigdeath Holstein	1,120	2,859	181	-	-	-	782	10
Germany Thuringia	784	2,171	134	-	-	-	538	5
Italy Campania	2,092	5,802	424	3	30,424	129,086	275	4
Italy Emilia-Romagana	14,074	4,459	199	2	-	55,812	2,104	31
Italy Friuli-Venezia Giulia	1,593	1,215	153	3	2,345	75,396	27,610	4
Italy Lazio	3,095	5,879	341	2	45,000	141,268	9,127	27
Italy Liguaria	3,416	1,551	286	2	-	73,198	748	4
Italy Lombardia	43,208	10,061	422	4	24,000	159,197	1,444	96
Italy Marche	3,825	1,525	162	-	-	-	788	3
Italy Piedemont	9,301	4,356	172	2	-	83,014	2,228	16
Italy Sardinia	722	1,640	68	-	-	-	87	2
Italy Toscana	4,608	3,730	162	1	-	47,300	968	6
Italy Umbria	1,078	882	104	-	-	-	265	3
Italy Veneto	9,155	4,906	267	2	6,511	78,090	1,702	14
Netherlands Gelderland	1,475	2,084	420	2	28,420	50,000	874	4

Netherlands North Brabant	3,412	2,563	523	1	35,000	35,000	4,923	10
Netherlands North Holland	1,845	2,878	1,082	1	52,707	54,990	9,575	37
Netherlands Overijssel	698	1,162	350	2	27,000	60,410	843	2
Netherlands South Holland	1,949	3,706	1,317	2	95,000	102,354	28,029	15
Netherlands Utrecht	1,046	1,354	981	-	-	-	4,216	7
Poland Greater Poland	149	3,398	114	1	8,634	45,830	950	3
Poland Lesser Poland	192	3,287	217	2	35,174	67,000	255	4
Poland Lower Silesia	274	2,887	145	1	6,149	42,771	108	4
Poland Masovia	544	5,204	146	2	48,076	62,206	1,814	20
Poland Pomerania	54	2,220	121	1	13,055	41,984	1,904	3
Poland Silesia	264	4,646	377	-	-	-	881	2
Spain Andalucía	6,392	8,450	96	3	105,167	136,265	1,115	3
Spain Cataluña	19,991	7,571	236	2	107,395	139,287	5,089	7
Spain Galicia	4,432	2,781	94	1	25,965	34,600	10,655	3
Spain Madrid	29,840	6,499	809	2	138,779	148,986	7,446	42
Spain País Vasco	6,838	2,193	303	1	36,350	53,289	7,044	10
Spain Valencia	5,922	5,129	221	4	63,826	146,955	9,457	2
Sweden Blekinge	22	160	54	-	-	-	46	2
Sweden Dalarna	123	287	10	-	-	-	1,891	6
Sweden Gävleborg	100	287	16	-	-	-	867	2
Sweden Halland	101	329	60	-	-	-	560	4
Sweden Jämtland	82	130	3	-	-	-	778	2
Sweden Jönköping	142	361	34	-	-	-	2,165	9
Sweden Kalmar	36	245	22	-	-	-	1,186	3
Sweden Kronoberg	39	200	24	-	-	-	3,973	5
Sweden Skåne	290	1,362	123	-	-	-	2,378	80
Sweden Stockholm	2,122	2,344	360	3	26,451	124,000	7,966	263
Sweden Södermanland	281	295	48	-	-	-	130	2
Sweden Uppsala	198	376	46	-	-	-	2,160	25
Sweden Värmland	51	281	16	-	-	-	2,454	2

Sweden Västerbotten	63	270	5	-	-	-	564	3
Sweden Västernorrland	55	245	11	-	-	-	4,976	3
Sweden Västmanland	83	274	53	-	-	-	2,504	4
Sweden Västra Götaland	426	1,710	71	-	-	-	7,680	63
Sweden Örebro	118	302	35	-	-	-	293	3
Sweden Östergötland	429	462	44	-	-	-	442	8
Switzerland Aargau	364	678	388	-	-	-	583	5
Switzerland Basel-Landschaft	502	290	502	-	-	-	902	9
Switzerland Basel-Stadt	573	200	5,072	-	-	-	12,213	12
Switzerland Bern	767	1,035	158	-	-	-	2,450	12
Switzerland Fribourg	333	319	141	-	-	-	357	4
Switzerland Geneva	2,779	499	1,442	-	-	-	2,958	13
Switzerland Graubünden; Grisons	374	198	26	-	-	-	1,353	2
Switzerland Luzern	267	410	233	-	-	-	1,436	10
Switzerland Nidwalden	60	43	138	-	-	-	9,746	2
Switzerland Schaffhausen	35	82	246	-	-	-	1,687	4
Switzerland Solothurn	142	273	308	-	-	-	679	3
Switzerland St, Gallen	287	508	222	-	-	-	4,219	11
Switzerland Thurgau	130	276	229	-	-	-	1,321	5
Switzerland Ticino	1,408	353	110	-	-	-	464	2
Switzerland Uri	325	36	33	-	-	-	937	2
Switzerland Valais	921	344	53	-	-	-	226	2
Switzerland Vaud	2,533	799	188	-	-	-	7,560	14
Switzerland Zug	237	127	416	-	-	-	990	22
Switzerland Zürich	2,793	1,521	701	-	-	-	5,752	64

Table B.2
Cross-section of Raw Stock Returns over March and April 2020
Including Probability of Death of the CEO

This table reports the coefficients from the following regression:

$$r_{r,f} = \alpha + \beta_1 Log\left(\frac{1+\widehat{Cases}}{Population_{r,f}}\right) + \beta_2 Log\left(\frac{1+Cases}{Population_{r,f}}\right)\times \widehat{Prob.of\ death}\left(CEO_f\right) + \gamma_1 Log(GRP_r)$$
$$+\gamma_2 Prob.of\ Death\left(CEO_f\right) + \gamma_3 \frac{Debt}{Assets_f} + \gamma_4 TobinQ_f + \gamma_5 \frac{Cash}{Assets_f} + \gamma_6 Log\left(Size_f\right) + FE_c + FE_i + \epsilon_{r,f}$$

$r_{\mathrm{r,f}}$ is the daily raw return in decimals on stock from firm *f* headquartered in region *r* accumulated over March and April 2020. $\mathrm{Log}\left(\frac{\widehat{1+\mathrm{Cases}}}{\mathrm{Population}_{\mathrm{r,f}}}\right)$ is the natural logarithm of 1 plus the accumulated number of COVID-19 cases per million in region *r* from March 1 through 30, 2020 instrumented in Table B.4 by Log(*Population*), Log(*Density*), and, alternatively, *I_Games*, Log(1+*Attendance*), and Log(1+*Capacity*) in specifications (1)-(3), respectively. Analogously, $\mathrm{Log}\left(\frac{\widehat{1+\mathrm{Cases}}}{\mathrm{Population}_{\mathrm{r,f}}}\right) \times Prob.of\ \widehat{death}\left(CEO_f\right)$ is the instrumented interaction term in specifications (4)-(6) in Table B.4. $Prob.Death\ (CEO_{r,f})$ is the probability (in decimals) of death from COVID-19 of the CEO of company *f* based on the Case Fatality Rates for Spain in March 2020 by age and gender collected by the Spanish Ministry of Health. $\mathrm{FE_c}$ and $\mathrm{FE_i}$ stand for country and industry fixed effects, respectively. The rest of variables are defined in Appendix A.1. Specification (1) uses $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}_{\mathrm{r,f}}}\right)$ and $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}_{\mathrm{r,f}}}\right) \times Prob.of\ death\left(CEO_f\right)$ without instrumenting in a standard OLS regression. Standard errors are clustered at the region level. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

		Soccer Instrument		
	OLS (1)	*I_Games* (2)	Log (1+*Attendance*) (3)	Log (1+*Capacity*) (4)
Log((1+*Cases*)/*Population*)	-0.015	-0.067	-0.073	-0.068
	(0.011)	(0.048)	(0.043)*	(0.048)
Log((1+*Cases*)/*Population*)	0.369	-16.625	-13.341	-16.386
×*Prob. of Death (CEO)*	(0.214)*	(7.645)**	(5.567)**	(7.361)**
Log(*GRP*)	0.031	0.051	0.069	0.054
	(0.025)	(0.067)	(0.062)	(0.067)
Prob. of Death (CEO)	-0.244	2.257	1.774	2.222
	(0.162)	(2.307)	(1.823)	(2.234)
Debt/Assets	-0.063	-0.139	-0.124	-0.138
	(0.025)**	(0.07)**	(0.059)**	(0.069)**
TobinQ	0.015	0.008	0.009	0.008
	(0.003)***	(0.007)	(0.006)	(0.007)
Cash/Assets	0.102	0.140	0.133	0.139
	(0.039)***	(0.055)**	(0.05)***	(0.054)**
Log(*Size*)	-0.008	-0.004	-0.004	-0.004
	(0.003)**	(0.004)	(0.004)	(0.004)
Country FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
R-sq	0.210	-	-	-
Number of firms	2,927	2,927	2,927	2,927
Number of regions	137	137	137	137

Table B.3

Cross-section of Raw Stock Returns over March and April 2020

Including Probability of Death of the Board Chair

This table reports the coefficients from the following regression:

$$r_{r,f} = \alpha + \beta_1 Log\left(\frac{1+\widehat{Cases}}{Population}_{r,f}\right) + \beta_2 Log\left(\frac{1+Cases}{Population}_{r,f}\right)\widehat{\times Prob.of\ death}\left(Chair_f\right) + \gamma_1 Log(GRP_r)$$

$$+ \gamma_2 Prob.of\ Death\left(Chair_f\right) + \gamma_3 \frac{Debt}{Assets_f} + \gamma_4 TobinQ_f + \gamma_5 \frac{Cash}{Assets_f} + \gamma_6 Log\left(Size_f\right) + FE_c + FE_i + \epsilon_{r,f}$$

$r_{\mathrm{r,f}}$ is the daily raw return in decimals on stock from firm *f* headquartered in region *r* accumulated over March and April 2020. $\mathrm{Log}\left(\frac{1+\widehat{\mathrm{Cases}}}{\mathrm{Population}}_{\mathrm{r,f}}\right)$ is the natural logarithm of 1 plus the accumulated number of COVID-19 cases per million in region *r* from March 1 through 30, 2020 instrumented in Table B.4 by Log(*Population*), Log(*Density*), and, alternatively, *I_Games*, Log(1+*Attendance*), and Log(1+*Capacity*) in specifications (1)-(3), respectively. Analogously, $\mathrm{Log}\left(\frac{1+\widehat{\mathrm{Cases}}}{\mathrm{Population}}_{\mathrm{r,f}}\right) \times Prob.of\ \widehat{death}\left(Chair_f\right)$ is the instrumented interaction term in specifications (4)-(6) in Table B.4. $Prob.Death\ (Chair_{r,f})$ is the probability (in decimals) of death from COVID-19 of the Chair of company *f* based on the Case Fatality Rates for Spain in March 2020 by age and gender collected by the Spanish Ministry of Health. $\mathrm{FE_c}$ and $\mathrm{FE_i}$ stand for country and industry fixed effects, respectively. The rest of variables are defined in Appendix A.1. Specification (1) uses $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}}_{\mathrm{r,f}}\right)$ and $\mathrm{Log}\left(\frac{1+\mathrm{Cases}}{\mathrm{Population}}_{\mathrm{r,f}}\right) \times Prob.of\ death\left(Chair_f\right)$ without instrumenting in a standard OLS regression. Standard errors are clustered at the region level. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

		Soccer Instrument		
	OLS (1)	*I_Games* (2)	Log (1+*Attendance*) (3)	Log (1+*Capacity*) (4)
Log((1+*Cases*)/*Population*)	-0.015	0.047	-0.001	0.066
	(0.011)	(0.126)	(0.073)	(0.158)
Log((1+*Cases*)/*Population*)	0.155	-17.551	-10.602	-20.124
×Prob. of Death (Chair)	(0.083)*	(16.633)	(6.654)	(21.333)
Log(*GRP*)	0.029	-0.058	0.008	-0.084
	(0.024)	(0.183)	(0.108)	(0.222)
Prob. of Death (Chair)	-0.262	1.102	0.566	1.301
	(0.081)***	(2.949)	(1.57)	(3.486)
Debt/Assets	-0.065	-0.157	-0.121	-0.171
	(0.025)***	(0.13)	(0.069)*	(0.154)
TobinQ	0.015	0.007	0.011	0.006
	(0.003)***	(0.011)	(0.006)*	(0.013)
Cash/Assets	0.104	0.224	0.178	0.241
	(0.039)***	(0.188)	(0.099)*	(0.223)
Log(*Size*)	-0.007	-0.006	-0.006	-0.006
	(0.003)**	(0.006)	(0.004)	(0.007)
Country FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
R-sq	0.212	-	-	-
Number of firms	2,927	2,927	2,927	2,927
Number of regions	137	137	137	137

Table B.4

Summary Statistics for the Sample of Companies

Subsamples by CEO age

Each observation is a firm. For each firm, we retrieve from Compustat-Capital IQ the following variables: *Size* (proxied by the company's Revenue in USD million), *Debt/Assets*, *Tobin's Q*, and *Cash/Assets* as of FYE 2019. *Abnormal returns* (in decimals) are calculated netting the expected returns predicted by the Fama and French (1992) three-factor model from the actual returns. *Raw returns* (in decimals) are calculated as the log difference of adjusted daily closing stock prices from Compustat. We report the accumulated daily excess (over the one-month T-bill) abnormal return and raw returns over March and April 2020. *Cases* are accumulated in each region through March 30. *Cases/Population* is the number of cases per million inhabitants. *#Games*, *Attendance* and *Capacity* are accumulated in each region from March 1 through 30. I_*Games* is a dummy variable that takes a value of 1 if there was a soccer match in the region where the firm is located from March 1 through 30, zero otherwise. The rest of variables are defined in Table 1. Log (*x*) denotes the natural logarithm of *x*. Appendix A.1 includes the definition and source of each variable. CEO age<Median (alternatively, CEO age>=Median) includes only firms whose CEO is less than (alternatively, equal or above) the sample median age. When the CEO and the board Chair are different individuals, we take the average of both ages.

	Age of CEO<Median			Age of CEO>=Median				
	Mean (1)	St. Dev. (2)	#Obs. (3)	Mean (4)	St. Dev. (5)	#Obs. (6)	Difference in means (7)	T-stat of the difference (8)
Size (USD Million)	3,476	16,591	1,441	5,102	18,314	1,486	1626	2.64
Log(*Size*)	5.155	2.671	1,441	5.548	2.835	1,486	0.393	2.67
Debt/Assets	0.243	0.215	1,441	0.241	0.208	1,486	-0.002	-0.24
Tobin's Q	2.088	2.366	1,441	1.855	2.032	1,486	-0.233	-3.15
Cash/Assets	0.144	0.185	1,441	0.132	0.169	1,486	-0.012	-1.84
Revenue growth (2Q20 vs 2Q19)	-0.132	0.510	856	-0.149	0.476	911	-0.017	-0.77
Margin growth (2Q20 vs 2Q19)	-0.151	2.308	856	0.030	1.986	911	0.181	1.77
Abnormal return	-0.056	0.281	1,441	-0.057	0.270	1,486	-0.001	-0.15
Raw return	-0.114	0.267	1,441	-0.140	0.247	1,486	-0.025	-2.30
Age (CEO)	48.4	4.8	1,441	60.5	5.2	1,486	12.1	28.22
Male (CEO)	0.915		1,441	0.956		1,486	0.04	4.35
Prob. Death (CEO)	0.009	0.005	1,441	0.033	0.033	1,486	0.024	11.36

Age (Chair)	60.8	9.5	1,441	63.7	7.9	1,486	3.0	5.02
Male (Chair)	0.937		1,441	0.943		1,486	0.01	0.73
Prob. Death (Chair)	0.043	0.046	1,441	0.053	0.048	1,486	0.009	3.75
Cases	6,072	8,464	1,441	7,397	9,293	1,486	1,325	3.27
Cases/Population (per Million*)*	967	949	1,441	1,097	1,066	1,486	0	2.78
Log((1+*Cases)/Population*)	-7.28	0.83	1,441	-7.17	0.84	1,486	0.112	2.48
# Games	3.2	3.6	1,441	3.1	3.6	1,486	0	-0.19
I_Games	0.73	0.45	1,441	0.75	0.43	1,486	0	0.90
Attendance	107,782	162,042	1,441	106,810	157,054	1,486	-971.97	-0.13
Capacity	146,553	175,715	1,441	145,574	172,889	1,486	-978.30	-0.14
Log(1+*Attendance*)	8.005	5.195	1,441	8.161	5.124	1,486	0.156	0.58
Log(1+*Capacity*)	8.616	5.343	1,441	8.861	5.180	1,486	0.244	0.81
Population (Thousand)	5,367	4,561	1,441	6,021	4,722	1,486	653.49	2.52
Density	1,415	2,020	1,441	1,329	1,931	1,486	-86	-0.94
GRP per capita	51,639	15,904	1,441	50,862	15,935	1,486	-777	-0.76
Log(*Population*)	14.989	1.157	1,441	15.149	1.113	1,486	0.160	2.81
Log(*Density*)	6.300	1.409	1,441	6.316	1.315	1,486	0.016	0.25
Log(*GRP*)	10.802	0.325	1,441	10.786	0.326	1,486	-0.016	-0.77

Table B.5

Cross-section of Raw Stock Returns On Major Vaccine News Including Board Chairs

This table reports the coefficients from the following regression:

$$r_{f,t} = \alpha + \beta CEORisk_f + \delta ChairRisk_f + \gamma_1 \frac{Debt}{Assets_f} + \gamma_2 TobinQ_f + \gamma_3 \frac{Cash}{Assets_f} + \gamma_4 Log(Size_f) + FE_i + \epsilon_{f,t}$$

where $r_{f,t}$ is the raw return of stock from firm f on the day of event, $CEORisk_f$ is, a dummy variable that takes a value of 1 if the CEO is older than 60 years (alternatively, 65), zero otherwise, or the probability of the CEO dying from COVID-19 if infected with the virus data proxied by the fatality rates reported in Table A1 of the Appendix. $ChairRisk_f$ is defined analogously to , $CEORisk_f$ but for the company's Chair. The rest of controls are the same as in equation (1). We include industry fixed effects, FE_i. Standard errors are reported in parenthesis. ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

	(1)	(2)	(3)
CEO Age≥60	0.0023		
	(0.0008)***		
Chair Age≥60	-0.0001		
	(0.0008)		
CEO Age≥65		0.0037	
		(0.0012)***	
Chair Age≥65		0.0004	
		(0.0007)	
Prob. of Death (CEO)			0.0270
			(0.0143)*
Prob. of Death (Chair)			-0.0014
			(0.0073)
Debt/Assets	0.0030	0.0029	0.0029
	(0.0023)	(0.0023)	(0.0023)
TobinQ	-0.0002	-0.0001	-0.0002
	(0.0002)	(0.0002)	(0.0002)
Cash/Assets	-0.0051	-0.0051	-0.0051
	(0.0031)	(0.0031)	(0.0031)
Log(*Size*)	0.0013	0.0013	0.0013
	(0.0002)***	(0.0002)***	(0.0002)***
Industry FE	Y	Y	Y
R-sq	0,007	0,007	0,007
Number of observations	17,749	17,749	17,749
Number of firms	2,841	2,841	2,841