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Did the COVID-19 Shock Impair the Stock Performance of Companies with Older CEOs?

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by

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Abstract

Since its lethality increases exponentially with age, the early 2020 COVID-19 shock unexpectedly raised the risk of corporate disruption at companies led by older CEOs. While normally unprepared successions might be beneficial by replacing entrenched CEOs, this systemic shock projected a possible crowding of older CEOs' successions, with disruption costs dominating changeover benefits. Within this natural experiment, we find that stock returns and volatility worsened at S&P 500 listed companies with older CEOs when the COVID-19 lethal risk emerged. Our results resist various robustness checks. This advises companies to adopt contingency strategies of top managers' replacement against possibly recurring pandemics.

JEL Codes: C23; G12; G32; M12.

Keywords: COVID-19; Stock Performance; CEO's Age; S&P 500.

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1. Introduction

Although various pundits had prognosticated that pandemics were increasingly likely to occur because of the heightened risk of zoonotic spillover from other animal species to humans (Allen et al., 2017; EFSA & ECDPC, 2018; Afelt et al., 2018), the Coronavirus pandemic broken out in early 2020 caught the large public by surprise. As such, the great tragedy of COVID-19 offers scientists a natural experiment where the intrinsic problem of endogeneity in agents' choices against expected occurrences may be ruled out. It is then interesting to explore whether and how the specific features of this pandemic provoked market reactions. This is especially the case for financial markets, which – as usual after major negative shocks – suffered huge losses after the news about COVID-19 became public. Indeed, in the two months of February and March 2020 the S&P 500 index lost almost one third of its value.

Our research question exploits this natural experiment considering an age-related specific characteristic of COVID-19, which could cause asymmetric effects across companies. Namely, as it was soon documented, the lethality of this Coronavirus increases exponentially with age. Hence, the COVID-19 shock unexpectedly raised the risk that companies led by older CEOs might be upset by sudden departure of their top executives. On one hand, the literature on unprepared CEOs' successions reaches mixed results under business as usual, with the cost of managerial disruption being often outweighed or even overshadowed by the benefit of replacing entrenched top executives (Salas, 2010). On the other hand, the systemic and asymmetric nature of the COVID-19 shock projected a possible crowding of older CEOs' successions, where the disruption cost might well dominate the potential changeover benefit. Against a given pool of candidates for the replacement, the fact that many successions would be enacted at the same time raised, in fact, the risk of mismatch between a company and the chosen successor (Bandiera et al., 2020).

Within this natural experiment, we study whether stock returns and volatility worsened at S&P 500 listed companies led by older CEOs after the COVID-19 lethal risk became common knowledge. Using company fixed effects, we find that, indeed, returns (volatility) plummeted (boomed) as a function of CEOs' age. Our results prove resilient to various robustness checks such as including CEO's seniority – a possible alternative to age – or a dummy for California – enjoying both younger CEOs and relatively more companies specializing in the Information Technology, which generally benefited from the pandemic. In contrast, we show that S&P 500 listed companies' stock performance was unrelated to CEO's age during the 2008 systemic financial crisis.

Against the possible recurrence of pandemic shocks, our findings suggest that companies ought to strengthen their contingency plans, including operational strategies to swiftly replace top managers.

Indeed, our findings are not only statistically robust but reach a sizable economic impact as evidenced by the huge fitted difference in returns attributable to the COVID-19 effect, where the company led by the youngest CEO outperformed by 10 percentage points the company run by the eldest CEO.

In the rest of the paper, Section 2 encapsulates the relevant existing literature on how markets value CEOs' unexpected successions. Section 3 describes the data we employ, presents our empirical methodology, and expands on our main results. Section 4 reports the various checks we performed to ascertain the robustness of our results. Finally, Section 5 recaps the main findings, underlines the chief implications of our results, and outlines some unanswered research questions possibly suggested for future research.

2. Literature review on CEO age and sudden death.

A CEO is the most important figure in a company and his/her personal characteristics such as age, gender, quality, and experience certainly represent an element of evaluation for investors. Jacobsen (2014) suggests that the market attaches value to CEO-specific information and that observable and unobservable manager characteristics can have a meaningful impact on a firm's outcome.

In this section, we will focus on two aspects of a CEO: age and the possibility that s/he could die unexpectedly and try to understand how these two factors can affect company returns. These two aspects would seem to be only slightly correlated with each other since as age increases, the chances of death increase too. However, during the pandemic in which the increase in infections and deaths almost entirely affected adults, the two elements have become intricately linked.

There is now a large and consolidated literature on the role played by the age of the CEO on corporate performance. One of the first works on the subject is that of Baysinger & Hoskisson (1990) which highlights how the experience of a CEO is postulated to have a positive influence on performance. Gibbons & Murphy (1992) showed in their study that older executives are found to be prone to be more conservative as they approach retirement, focusing on projects that produce earlier financial results. More recently, however, new works seem to be moving in the opposite direction. The studies of Bertrand & Mullainathan (2003); Davidson et al. (2007) show that the age of the CEO is inversely correlated with company performance. Using a sample of S&P 500 firms, Peni (2014) suggests that demographic and experience-related characteristics may be associated with the market valuation and financial performance of the firm. Serfling (2014) documents a negative relation between CEO age and stock return volatility. The older CEOs seem to reduce firm risk through less risky investment policies. Li et al. (2017) underline that younger CEOs are more likely to enter new lines of business and leave existing ones. Younger CEOs undertake bolder expansions and divestments which lead to

significant increases and decreases in firm size, respectively. Younger CEOs also prefer to grow through acquisitions rather than de novo investments.

Stock markets are inevitably affected by exogenous shocks deriving from events that often determine their daily returns. Exogenous and completely unforeseen events such as the unexpected death of the CEO can certainly affect the daily returns of companies, at least in the short term. The stock price reaction to the sudden death of an executive was negatively correlated with the company's past performance. Those who had been a CEO of the company for a longer period of a time had a statistically significant negative correlation compared with a CEO who had spent a shorter time in the company. Regarding this aspect, there are works with conflicting results. One of the first studies on the death of managers is that of Johnson et al. (1985) who document positive abnormal returns for the death of the founder CEOs and negative abnormal returns for other top executives. More recently, among the most cited works, we find that of Salas (2010) in which the author documented how the stock price reacts to unexpected senior executive deaths. His findings suggest that if a highly effective manager dies unexpectedly, the stock price reaction should be negative. If, however, death removes an entrenched manager when the board would or could not, the stock price reaction should be positive. The departure of top managers other than the CEO can also influence the markets. For example, Nguyen & Maisner Nielsen (2010) investigate contributions of independent directors to shareholder value by examining stock price reactions to sudden deaths in the US from 1994 to 2007. They find that after the death of a director, stock prices drop by 0.85% on average. More recently, Betzer et al. (2020) find that the stock market attributes a significantly higher contribution to shareholder value to deceased executives with more general managerial skills as reflected by a larger decline in stock prices when an executive's sudden death is announced. Compared to this, Jenter et al. (2016) found that most sudden deaths, and especially sudden deaths of young and short-tenured CEOs, cause large value losses. Instead, other CEO deaths – non-sudden deaths, and sudden deaths of old and long-tenured CEOs – are on average associated with large value gains.

Over the years, there have been some famous episodes that have shown how the death of a CEO has had a negative effect on corporate valuations by markets. Among the most recent cases is the passing away of Steve Jobs, who was not only the CEO of Apple but also one of its co-founders (for a review of the causes of death of the various CEOs, see Larcker & Tayan, 2012). However, there are also examples of positive returns to the departure of the CEO as demonstrated by what happened for example to the CEO of Cott Corporation who died in 1998, or more recently, with the death of Lee Kun-hee of Samsung who died after a long illness. In both cases, equity returns were not affected and, on the contrary, they recorded a significant rise. This demonstrates that the daily return can

depend on several factors specific to each company. However, what seems certified is that an unexpected death, especially initially, has a negative effect on the markets.

In addition to a CEO's passing away, some studies have analyzed the effects of the illness and possible days of hospitalization of a CEO on the stock markets. In this regard, Bennedsen et al. (2020), using a sample of 8,798 Danish firms from 1995 to 2007, found that those with hospitalized CEOs underperformed when their chief executives were sick.

In a period with strong insecurity, the likelihood that several positions were vacant in the same period also raised. The replacement process can be long, and costly. Different studies investigated the various process that board of director use to improve financial performance during and after CEO succession (Smith et al. 1999; Cucculelli and Micucci, 2008; Lambertides, 2009; Greene and Smith, 2021). Balinger and Marcel (2010) suggest that several firms are unable to smoothly transition from an outgoing to a new CEO, and therefore prefer to choose an "interim CEO" who temporarily leads the firm until the board finds a permanent solution (He and Zhu, 2020). However, the value effect of delay varies and not all firms benefit from long delays (Rivolta, 2018). An interim succession is traditionally viewed as a significant corporate governance failure and therefore it is not rewarded by higher returns in the markets.

To our knowledge, there are no works that have investigated the relationship between the COVID-19 pandemic or death of the CEO and equity results. Most of the studies published so far have concerned other aspects such as corporate characteristics and equity markets (Ding et al., 2021; Fahlenbrach et al., 2020; Ramelli & Wagner, 2020), business ownership (e.g., family members or not; Amore et al., 2021) or, more generally, the financial characteristics of individual companies and industrial characteristics (Carletti et al., 2020).

Based on the papers referred above, we believe that with the advent of the COVID-19 pandemic at the beginning of 2020, the probability that a manager could get sick or even die has grown enormously. The number of infections in the US, especially in the first phase, in which government restrictions and containment measures were among the mildest in the world, has increased this probability and this state of uncertainty also due to the possibility that there could be an unexpected replacement of several CEOs may have had an effect on equity markets.

3. Data, Methodology, and Results

3.1 Data

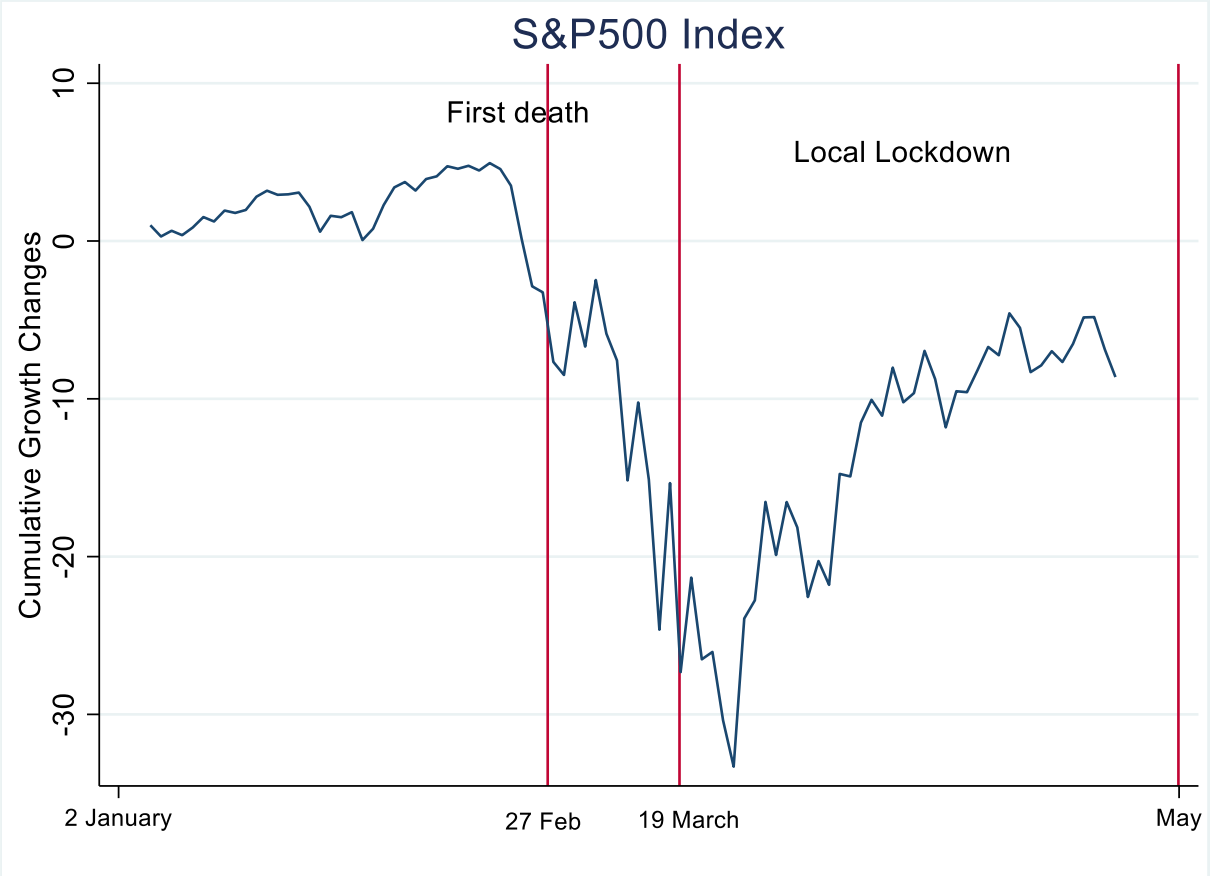
Since the first confirmed cases were announced in China at the end of 2019, to have a number of pre-COVID-19 observations we collected data on confirmed cases and deaths from May 2019 until the end of April 2020 using the online database "ourworldindata.org". In detail we identified the date of the first death for coronavirus in US (27th February) and first day of "Stay at Home Order" in California (19th March), followed by others local lockdown in the different States[2].

The data on stock market returns for the S&P 500, on the other hand, were taken from the "investing.com" web site where all the main world indices are available daily. The Age and gender of CEOs, on the other hand, were collected manually on the websites of the various companies or from the site marketscreener.com. The Internet "*Archive Wayback Machine*" on Company websites was used in the robustness analysis to observe what happened in the previous 2008-09 crisis.

As can be seen in Figure 1, the S&P 500 index lost over 30 percentage points in a single month between mid-February 2020 and mid-March 2020 with a slow recovery until the end of May which was still below the previous period, the month of February. The situation worsened in conjunction with the first death on American soil and even more so with the first lockdowns in the states of New California, Nevada, Illinois, New Jersey. Louisiana and New York.

[2] For more details on local lockdown in US see https://www.timeanddate.com/holidays/us/lockdown-day-1

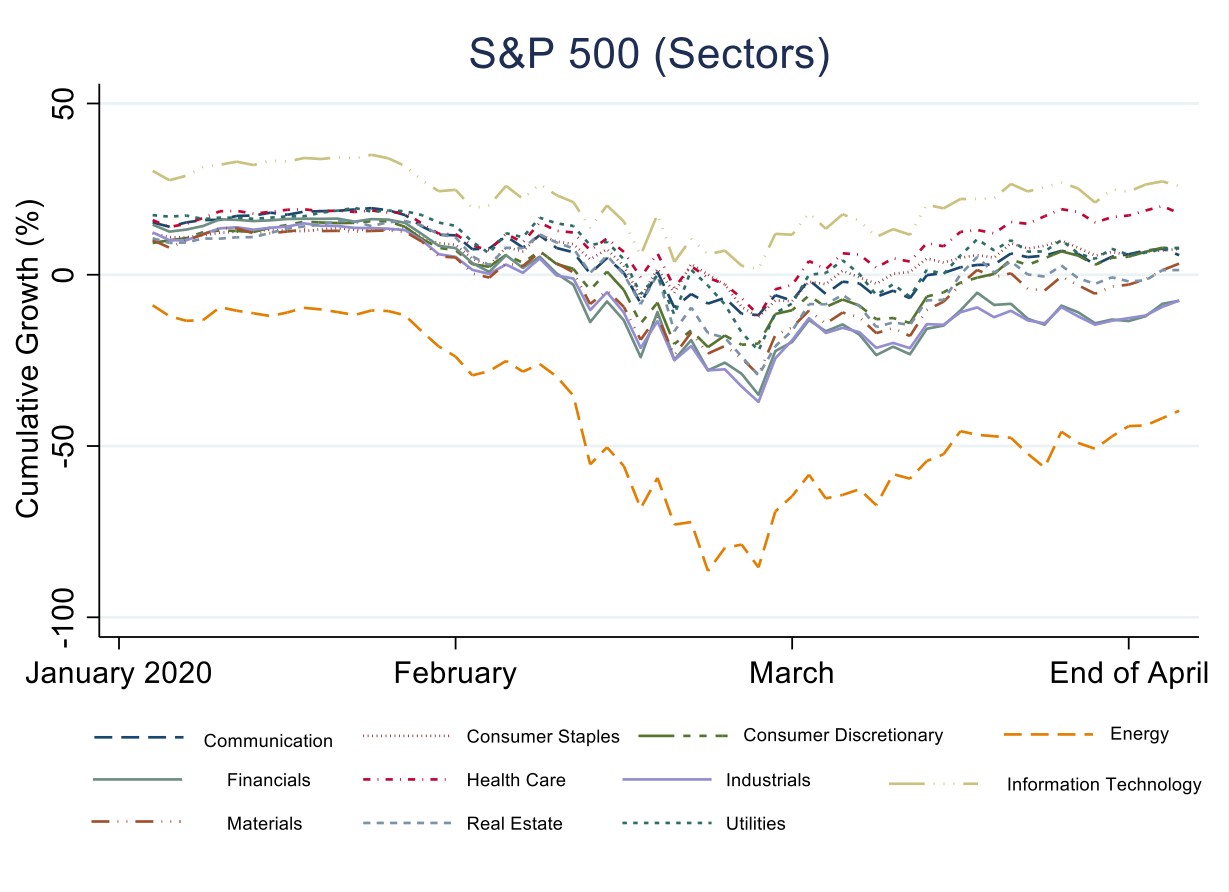
Figure 1 The S&P 500 index



Source author's own

Among the sectors most affected, as can be seen from the sectoral indices of the S&P 500, were the Energy (-95%) and Financial sectors (-45%), while the most resilient sectors were High Tech and Healthcare (Figure 2).

Figure 2 the S&P 500 stock prices by sector



Source author's own

Table 1 shows descriptive statistics by sector for Age, Seniority, Gender, and California for the 477 companies considered in this analysis (to avoid endogeneity, we removed 28 companies who changed CEO in 2020). The average Age of CEOs is 58.3, ranging between 36 and 89 years old. A substantial heterogeneity can be observed among sectors, with Communication Services and Technology with average age of CEOs below 57 and Financial Services with average age of CEOs above 60 years old. The average seniority (in years) is 7.4, with a minimum of 1 and a maximum of 57. Among sectors, the average seniority ranges between 5 in Consumer Defensive and 9 in Financial Services. The female representation is 0.05 (5%) in average, with a maximum of 0.12 (12%) in the Utilities sector and a minimum of zero in Communication Services. Finally, 14% of the companies are in California, this percentages reach 45 in the sector of Technology, while it is zero for Basic Materials and Energy.

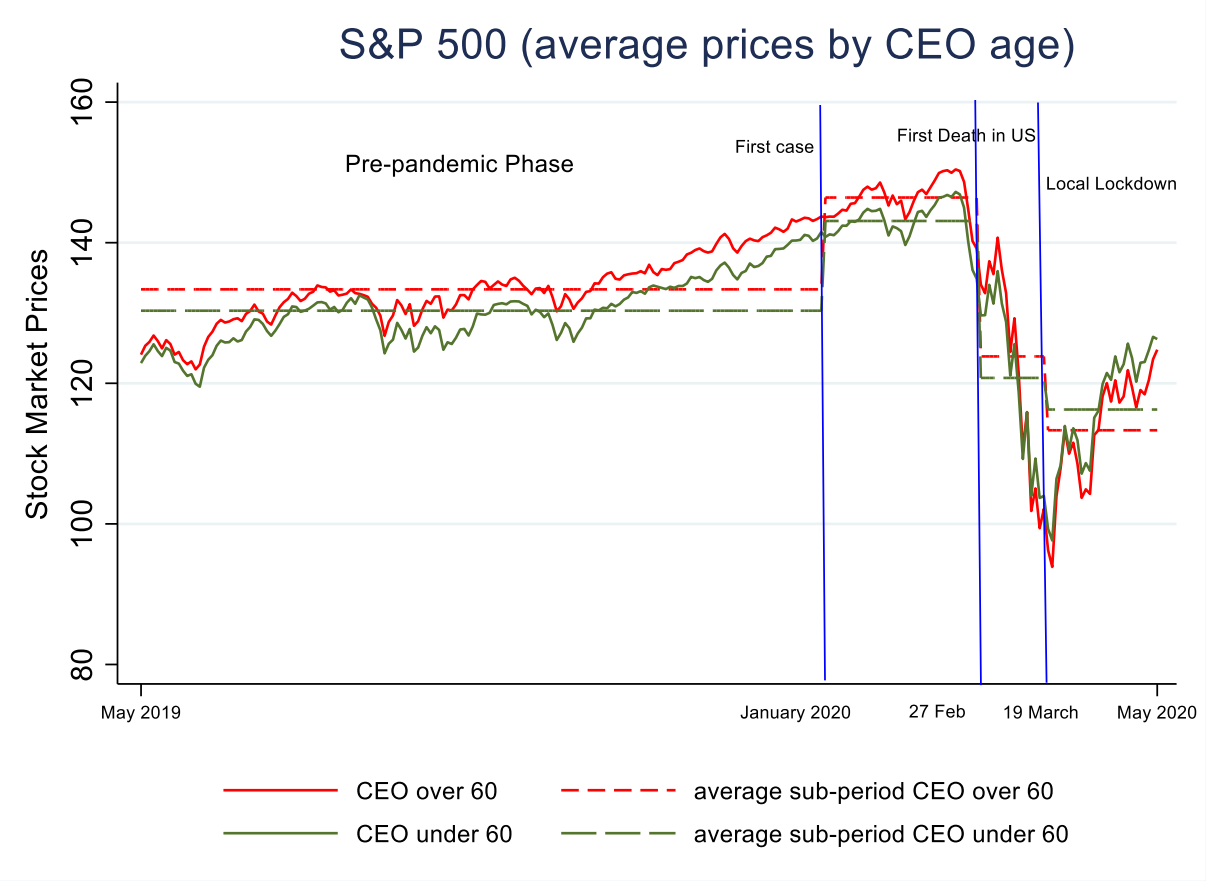
Table 1 Descriptive statistics

Sector	Age	Seniority	Gender (Female =1)	California
Basic Materials	59.450	6.200	0.050	0.000
	(6.329)	*(4.389)*	*(0.218)*	*(0.000)*
Communication Services	56.348	9.000	0.000	0.304
	(8.218)	*(7.553)*	*(0.000)*	*(0.460)*
Consumer Cyclical	57.934	7.623	0.066	0.066
	(7.982)	*(8.963)*	*(0.248)*	*(0.248)*
Consumer Defensive	58.405	4.973	0.027	0.054
	(5.759)	*(5.773)*	*(0.162)*	*(0.226)*
Energy	57.769	6.769	0.077	0.000
	(6.566)	*(5.584)*	*(0.266)*	*(0.000)*
Financial Services	60.879	9.015	0.061	0.061
	(6.707)	*(8.828)*	*(0.239)*	*(0.239)*
Healthcare	58.474	7.579	0.018	0.158
	(6.594)	*(7.462)*	*(0.131)*	*(0.365)*
Industrials	57.866	5.836	0.060	0.045
	(5.428)	*(6.599)*	*(0.237)*	*(0.207)*
Real Estate	59.200	8.433	0.033	0.267
	(8.608)	*(7.224)*	*(0.18)*	*(0.442)*
Technology	56.538	8.108	0.108	0.446
	(5.923)	*(7.299)*	*(0.31)*	*(0.497)*
Utilities	58.440	6.120	0.120	0.040
	(4.355)	*(3.445)*	*(0.325)*	*(0.196)*
		All		
Mean	58.327	7.352	0.059	0.140
Standard Deviation	6.760	7.377	0.235	0.347
Min	36	1	0	0
Max	89	57	1	1

477 S&P500 listed companies. Mean and *(Standard Deviation);*

A first approximation on the relationship between age of CEO and stock market performance can be seen in Figure 3 in which the average stock market prices are shown for CEO under and over 60 years old. It can be noted that the average daily prices of CEO over 60 dominate the average daily prices of CEO under 60 until March, while a clear switch can be observed after the first death and the first lockdown in USA.

Figure 3 Stock market prices for CEO under and over 60 years old



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3.2 Empirical strategy

To estimate the causal relationship between the age of CEO and the financial performance of the company before and after COVID-19 we use the daily stock market returns and we set up a Differences-in Differences (DiD) study design. We leverage the fact that, among companies belonging to SP500, the age of the CEO varies greatly (see Table 1). Following the seminal approach of Card (1992), we use a DiD with continuous treatment, using the age of the CEO as the intensity treatment variable. The basic approach of DiD is to compare the difference in outcomes after and before the intervention between two groups (treated and the untreated). The use of DiD allows to avoid the endogeneity problems typical of comparisons between heterogeneous groups, for an overview see Mayer (1995). In the case of DiD with continuous treatment, the treatment is modelled as a continuous variable, and every treated unit is identified by the intensity of the treatment, i.e., the age of the CEO.

The estimated model is as follows:

$$y_{it} = \theta_i + \lambda_t + \beta_0(COVID19_t \times Age_{it}) + \varepsilon_{it} \quad (1)$$

Where:

- y_{it} is the outcome of interest in company i at day t, where $t = (6\ May\ 2019 \longrightarrow 28\ April\ 2020)$.We test the effect of age on two performance indicators:
  - daily returns estimated as $r_{it} = \log p_t - \log p_{t-1}$ where p is the daily stock price;
  - rolling volatility estimated by the five days moving standard deviation $v_{it} = \text{StDev}(\log p_{t-2}, \dots, \log p_{t+2})$
- θ_i is the company fixed effect;
- λ_t is the daily fixed effect;
- $COVID19_t$ is a dummy taking value 1 for days after COVID-19 pandemic and 0 otherwise (we test three main days: the day after the first COVID-19 case in USA, the day after the first COVID-19 death in USA, and the day after the first lockdown in USA);
- Age_{it} is the age of CEO in logarithm;
- β_0 represents the parameter of interest capturing the effect of the Age_{it} on the company performance after the COVID-19;
- ε_{it} is the error term.

The specification in (1) defines the generalized DiD with continuous treatment (Bertrand et al., 2004; Hansen, 2007). To strengthen the plausibility of the exogeneity assumption, since unobservable company-level variables and daily trends may bias the coefficient β_0, our model accounts for company and daily fixed effects.

Equation (1) assumes a linear relationship between CEO age and outcomes. To test whether this is a good approximation, we also estimate the flexible equation:

$$y_{it} = \theta_i + \lambda_t + \beta_0(COVID19_t \times Old_{it}) + \varepsilon_{it} \quad (2)$$

Where Old_{it} is a dummy for CEO age higher than a certain threshold, we test three thresholds: over 60 years old, over 70 years old and over 80 years old. It is worth mentioning that equation (2) defines the generalized DiD with the treatment identified by a dummy (Bertrand et al. 2004; Hansen, 2007).

It is worth mentioning that a typical concern arising when the DiD is adopted is the presence of pre-policy trends which may drive the main results (Angrist and Pishke 2009). The possibility to interpret the estimated parameters (β_0) as causal effects relies on the assumption of the presence of equal trends of stock market returns, had the COVID-19 pandemic not taken place. To this regard, a graphical

inspection of the trends in Figure 3 clearly shows that pre-COVID-19 trends are parallel, and the post-COVID-19 drop in stock market prices is higher for companies leaded by CEO over 60 years old. This supports the credibility of the common trend hypothesis in our setting.

3.3 Results

In this section we show results of our analysis using estimates by regression in (1) and in (2). Table 2 shows that the effect of age on daily return is negative while the effect on volatility is positive in all the three models: i.e., from the day after the first COVID-19 case in USA, from the day after the first COVID-19 death in USA, and from the day after the first lockdown in USA. As both the dependent and independent variable are log-transformed, the coefficients connected to age can be referred to as elastic in econometrics. For this model they show that a one percent increase in the age of CEO would yield 0.0037% decreases in daily returns from the day after the first COVID-19 case in USA (Model 1), the same increase would yield 0.0057% decreases in daily returns from the day after the first COVID-19 death in USA (Model 2), and 0.0064% decreases in daily returns from the day after the first lockdown in USA (Model 3).

To have an approximation of the magnitude of the effect of age on returns, using the fitted values from equation (1), we simulate the cumulative (fitted) log returns for the company with the oldest CEO (Berkshire Hathaway which has CEO 89 years old in 2020), and the cumulative (fitted) log returns for the company with the youngest CEO (Facebook which has CEO 36 years old in 2020). From the day after the first COVID-19 death in USA to the 28th of April 2020 (using Model 2), the company with the oldest CEO has a (fitted) cumulative return of -0.23476 (-23%) while the company with the youngest CEO has a (fitted) cumulative return of -0.13348 (-13%).

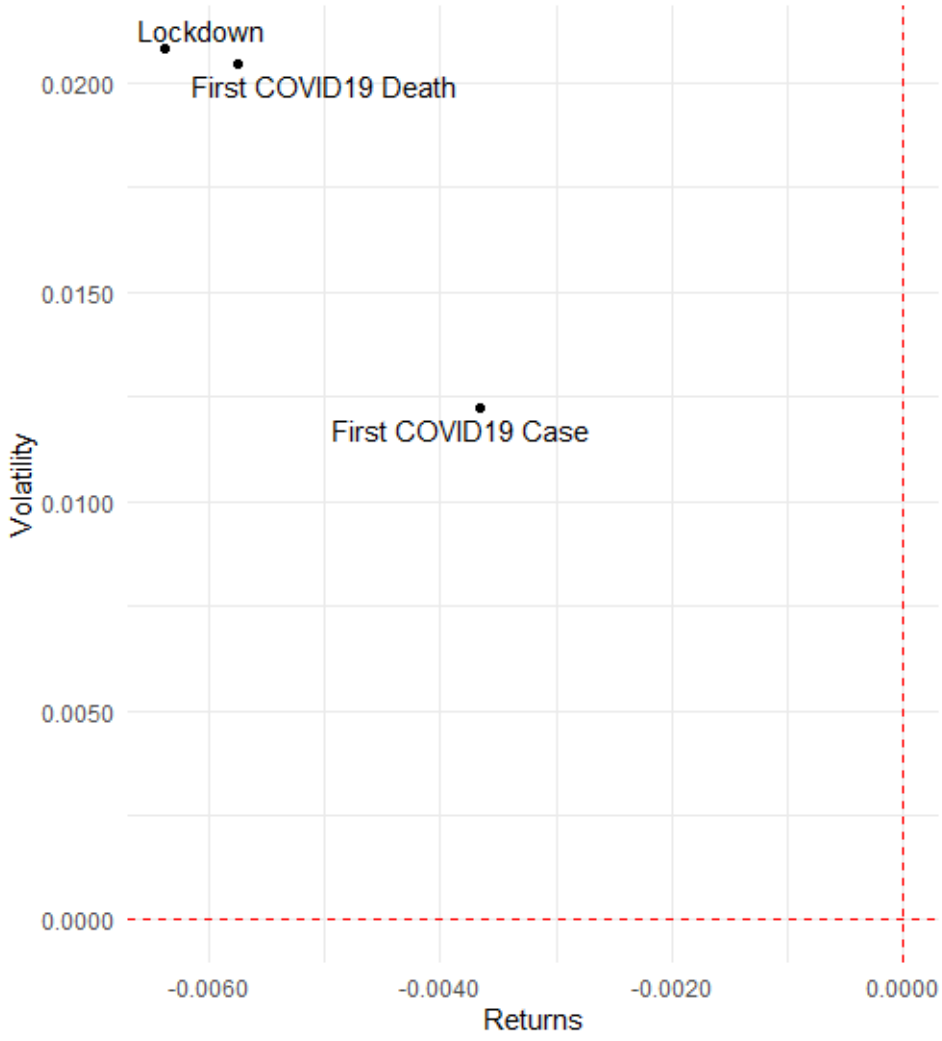
Table 2 Regression results modelling Age as continuous predictor (in log) as in equation (1)

	Daily returns			Rolling volatility		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
$COVID19_t \times Age_{it}$	-0.00366 ***			0.01223 ***		
	(0.00134)			*(0.00067)*		
$COVID19_t \times Age_{it}$		-0.00575 ***			0.02047 ***	
		(0.00161)			*(0.00082)*	
$COVID19_t \times Age_{it}$			-0.00638 ***			0.02081 ***
			(0.00166)			*(0.00084)*
Company fixed effect	yes	yes	yes	yes	yes	yes
Daily fixed effect	yes	yes	yes	yes	yes	yes
N. Obs.	117349	117349	117349	115441	115441	115441

Model 1 = from the day after the first COVID-19 case in USA; Model 2 = from the day after the first COVID-19 death in USA; Model 3 = from the day after the first lockdown in USA. *** p < 0.01; ** p < 0.05; * p < 0.1.

As shown in Figure 4, both for returns and volatility the magnitude of the coefficients increases with the increase of the day from which the COVID-19 pandemic is identified: coefficients from the day after the first lockdown in USA (Model 3) have higher magnitude than coefficients from the day after the first COVID-19 death in USA (Model 2), which in turn have higher magnitude than coefficients from the day after the first COVID-19 case in USA (Model 1).

Figure 4 Coefficient's plot of regression (1) modelling CEO age as continuous predictor



Source author's own

The baseline regression (1) specifies a linear relationship between CEO age and financial performances of companies after COVID-19. Is this a good approximation? Table 3 shows regression results using equation (2) in which the coefficient of interest is associated to a dummy for CEO age higher than a certain threshold. Testing three different thresholds with 10 years' time interval (a

dummy for CEO over 60, CEO over 70, and CEO over 80 respectively) the effect of age on the returns appears quite linear. Indeed, the coefficient (losses in returns) associated to CEO over 80 has higher magnitude than the coefficient associated to CEO over 70, which in turn has higher magnitude than the coefficient associated to CEO over 60. Conversely, the effect of age on volatility appears less linear, since the dummy for CEO over 70 have a negative coefficient while the dummies for CEO over 60 and CEO over 80 are have a positive effect on rolling volatility.

Overall, results in Table 2 and Table 3 show that the effect of age on the financial performances of companies after COVID-19 is negative and significant. Negative coefficients are associated to returns in all the model specifications: both with different post-COVID-19 definitions and with different age specifications (continues variable and dummies). Positive coefficients are associates to rolling volatility in all but one model specifications. Specifically, specifying age as a continuous variable the effect is positive in all the specifications, while using dummies the effect of age is positive in two out of the three specifications, highlighting a non-linear relationship between age and volatility after COVID-19.

Table 3 Regression results modelling age with dummy as in equation (2)

	Daily returns			Rolling volatility		
	Over 60	Over 70	Over 80	Over 60	Over 70	Over 80
$COVID19_t \times Old_{it}$	-0.00082 **			0.00509 ***		
	-0.00002			*(0.00020)*		
$COVID19_t \times Old_{it}$		-0.00149 *			-0.00149 *	
		(0.00089)			*(0.00089)*	
$COVID19_t \times Old_{it}$			-0.00397 *			0.00776 ***
			(0.00204)			*(0.00103)*
Company fixed effect	yes	yes	yes	yes	yes	yes
Daily fixed effect	yes	yes	yes	yes	yes	yes
N. Obs.	117349	117349	117349	115441	115441	115441

From the day after the first COVID-19 death in USA. *** p < 0.01; ** p < 0.05; * p < 0.1.

4. Robustness Checks

As robustness checks we propose different placebo tests, and explore whether stock returns and volatility worsened at London Stock Exchange listed companies. The first placebo test involves the seniority of the CEO, the second placebo test is on the gender of the CEO, the third is on a Dummy for companies based in California, the last involves testing the effect of age in the 2008 Financial Shock. Finally, we show that the negative effect of the age on the financial performances of companies can also be observed (partly) in the London Stock Exchange listed companies.

4.1 Age vs Seniority of CEOs

Table 4 shows the results of the first placebo test in which the Seniority (number of years from the appointment) of CEO ($Seniority_{it}$) replaces the age of the CEO in equation (1). Results shows that the effect of seniority on financial performances is not significant for returns while it is positive and significant for volatility. Nevertheless, results in columns 3 and 5 (Model 5) shows that the negative effect of age on financial performance is persistent to the inclusion of Seniority into the regressions.

Table 4 Regression results of Age vs Seniority of CEOs

	Daily returns		Rolling volatility	
	Model 4	Model 5	Model 4	Model 5
$COVID19_t \times Seniority_{it}$	-0.00009	-0.00688	0.00070 ***	-0.00175
	(0.0002)	*(0.00595)*	*(0.00010)*	*(0.00301)*
$COVID19_t \times Age_{it}$		-0.00970 ***		0.02164 ***
		(0.00306)		*(0.00155)*
$COVID19_t \times Seniority_{it} \times Age_{it}$		0.00176		0.00031
		(0.00146)		*(0.00074)*
Company fixed effect	yes	yes	yes	yes
Daily fixed effect	yes	yes	yes	yes
N. Obs.	117349	117349	115441	115441

Model 4 = from the day after the first COVID-19 death in USA only Seniority; Model 3 = from the day after the first COVID-19 death in USA, Seniority Age and interaction term. *** p < 0.01; ** p < 0.05; * p < 0.1.

4.2 Male vs Female CEOs

Table 5 shows the results of the second placebo test in which the Gender (a dummy for Female=1) of CEO ($Gender_{it}$) replaces the age of the CEO in equation (1). Results shows that the effect of gender on financial performances is not significant for returns and it is positive and significant for volatility. However, after the inclusion of the age, the effect of gender on volatility becomes negative showing that the age effect dominates.

Table 5 Regression results of Male vs Female CEOs

	Daily returns		Rolling volatility	
	Model 4	Model 5	Model 4	Model 5
$COVID19_t \times Gender_{it}$	-0.00052	0.03063	0.00241 ***	-0.19954 ***
	(0.0008)	*(0.03373)*	*(0.00041)*	*(0.01705)*
$COVID19_t \times Age_{it}$		-0.00553 ***		0.01887 ***
		(0.00165)		*(0.00083)*
$COVID19_t \times Gender_{it} \times Age_{it}$		-0.00777		0.05022 ***
		(0.00836)		*(0.00423)*
Company fixed effect	yes	yes	yes	yes
Daily fixed effect	yes	yes	yes	yes
N. Obs.	117349	117349	115441	115441

Model 4 = from the day after the first COVID-19 death in USA only Gender; Model 3 = from the day after the first COVID-19 death in USA, Gender Age and interaction term. *** p < 0.01; ** p < 0.05; * p < 0.1.

4.3 Dreaming California

Table 6 shows the results of the third placebo test in which the California (a dummy for companies having the headquarter in California=1) of CEO ($California_{it}$) replaces the age of the CEO in equation (1). Results shows that the effect of California on financial performances is positive and significant: i.e., California increases returns and decreases volatility after COVID-19. This may be partially because California's companies have both younger CEOs, and relatively more companies specializing in the Information Technology, which generally benefited from the pandemic. However, it is worth noting that after the inclusion of the age, the significance of effect of California on returns and volatility disappears showing, once again, that the age dominates the effects on financial performances.

Table 6 Regression results of California's dummy

	Daily returns		Rolling volatility	
	Model 4	Model 5	Model 4	Model 5
$COVID19_t \times California_{it}$	0.00217 ***	-0.02507	-0.00599 ***	0.01340
	(0.00053)	*(0.01702)*	*(0.00027)*	*(0.00860)*
$COVID19_t \times Age_{it}$		-0.00629 ***		0.01950 ***
		(0.00179)		*(0.00091)*
$COVID19_t \times California_{it} \times Age_{it}$		0.00670		-0.00463 **
		(0.00422)		*(0.00213)*
Company fixed effect	yes	yes	yes	yes
Daily fixed effect	yes	yes	yes	yes
N. Obs.	117349	117349	115441	115441

Model 4 = from the day after the first COVID-19 death in USA only California; Model 3 = from the day after the first COVID-19 death in USA, California, Age and interaction term. *** p < 0.01; ** p < 0.05; * p < 0.1.

4.4 The 2020 COVID-19 Shock vs the 2008 Financial Shock

Table 7 shows the results using the 2008 Financial Shock as placebo. We implement regression (1) using the dummy $Crisis\ 2008_t$ which takes value 1 after the 15 September 2008 (the day of Lehman Brothers crack) in the place of the dummy $COVID19_t$. Results shows that the effect of age on returns is not significant while there is a positive and significant effect of age on rolling volatility.

Table 7 Regression results of 2008 Financial Shock modelling age as continuous predictor

	Daily returns	Rolling volatility
$Crisis\ 2008_t \times Age_{it}$	-0.00173	0.00450 ***
	(0.00187)	*(0.00092)*
Company fixed effect	yes	yes
Daily fixed effect	yes	yes
N. Obs.	110446	108690

From the day of Lehman Brothers crack: 15 September 2008. *** p < 0.01; ** p < 0.05; * p < 0.1.

Table 8 shows regression results using regression (2) with the dummy $Crisis\ 2008_t$, and the dummy Old_{it} which takes value 1 for age higher than a specific threshold (as in Table 3, we test CEO over 60, CEO over 70, and CEO over 80). Results shows that the effect of age on returns remains not significant while the effect on volatility shows conflicting results, being positive for CEO over 60 and negative for CEO over 70 and CEO over 80.

Table 8 Regression results of 2008 Financial Shock modelling age with dummies

	Daily returns			Rolling volatility		
	Over 60	Over 70	Over 80	Over 60	Over 70	Over 80
$Crisis\ 2008_t \times Old_{it}$	-0.00093			0.00405 ***		
	(0.00058)			*(0.00029)*		
$Crisis\ 2008_t \times Old_{it}$		-0.00088			-0.00161 **	
		(0.00144)			*(0.00071)*	
$Crisis\ 2008_t \times Old_{it}$			0.00336			-0.02244 ***
			(0.00494)			*(0.00243)*
Company fixed effect	yes	yes	yes	yes	yes	yes
Daily fixed effect	yes	yes	yes	yes	yes	yes
N. Obs.	110446	110446	110446	108690	108690	108690

From the day of Lehman Brothers crack: 15 September 2008. *** p < 0.01; ** p < 0.05; * p < 0.1.

4.5 New York vs London

Table 9 shows regression results by the model specification in equation (1) using the London Stock Exchange listed companies instead of S&P500. In this case there is no significant effect of age on return while a positive and significant effect can be observed for the rolling volatility.

Table 9 Regression results for London Stock Exchange listed companies

	Daily returns			Rolling volatility		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
$COVID19_t \times Age_{it}$	0.00600			0.17407 ***		
	(0.01671)			*(0.01686)*		
$COVID19_t \times Age_{it}$		-0.01472			0.14367 ***	
		(0.01747)			*(0.01768)*	
$COVID19_t \times Age_{it}$			0.01984			0.15845 ***
			(0.01954)			*(0.01993)*
Company fixed effect	yes	yes	yes	yes	yes	yes
Daily fixed effect	yes	yes	yes	yes	yes	yes
N. Obs.	22540	22540	22540	22176	22176	22176

Model 1 = from the day after the first COVID-19 case in UK; Model 2 = from the day after the first COVID-19 death in UK; Model 3 = from the day after the first lockdown in UK. *** p < 0.01; ** p < 0.05; * p < 0.1.

These conflicting results may be partially due to the low heterogeneity in the age of the CEO of companies belonging to the London Stock Exchange. Indeed, while the age of CEO in S&P500 ranges between 36 and 89, in London the younger CEO is 42 years old, and the older is 67 years old.

5. Conclusions

Irrespective of its disastrous effects on the economy and society, the COVID-19 pandemic offers social scientists a natural experiment to test reactions to an unforeseen shock. One of the features of this pandemic which became clear early on is that its lethality is higher for males than females and increases exponentially with age. Hence, the early 2020 COVID-19 shock unexpectedly raised the probability that companies led by older CEOs might experience the sudden departure of their top executives. In turn, the pandemic heightened the risk of corporate disruption for these companies. Our research question consisted in asking whether, controlling for other factors, those companies showed market underperformance following the COVID-19 shock.

As we have discussed, unprepared CEO successions might not necessarily destroy corporate value. On the contrary, they could be beneficial when they replace entrenched CEOs. However, we posited that the beneficial view can only apply to normal situations where sudden successions are rare. Instead, this time around the systemic shock projected a possible crowding of older CEOs' successions which, against a given pool of candidates for the replacement, could lead to ex post suboptimal choices. Thus, disruption costs would presumably dominate changeover benefits.

Within this natural experiment, we examine stock returns and volatility at S&P500 listed companies distinguishing the companies on the basis of the age of their CEOs and employ the COVID-19 lethal risk shock to construct a Difference-in-Difference econometric method. Using company and daily fixed effects, we find that, indeed, corporate performance worsened for companies led by older CEOs. Namely, returns plummeted and volatility boomed as a function of CEOs' age. We also showed that our results are resilient to various robustness checks such as including CEO's seniority – a possible alternative to age – or a dummy for California – enjoying both younger CEOs and relatively more companies specializing in the Information Technology, which generally benefited from the pandemic. In contrast, we show that S&P 500 listed companies' stock performance was unrelated to CEO's age during the 2008 systemic financial crisis.

Against the possible recurrence of pandemic shocks, our findings suggest that companies ought to strengthen their contingency plans, including operational strategies to swiftly replace top managers. Indeed, our findings are not only statistically robust but reach a sizable economic impact as evidenced by the huge fitted difference in returns attributable to the COVID-19 effect, where the company led by the youngest CEO outperformed by 10 percentage points the company run by the eldest CEO.

Possibly our results suggest that it would be worth exploring how companies' stock performance reacted to the COVID-19 shock depending on the age not only of the CEO but also of other executives.

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