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Sustainability of Stock Market Against COVID-19 Pandemic

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ABSTRACT

This study explored the sustainability of the stock market against the COVID-19 pandemic. The impacts of confirmed COVID-19 cases, COVID-19 deaths, and Movement Control Order (MCO) length on the stock market were examined. The Generalized Method of Moments (GMM) estimator was employed to analyze 57 countries' weekly data from November 4th 2019 to July 5th 2020. The findings showed that the growth in confirmed COVID-19 cases has a significant negative effect on stock market returns, while the growth in COVID-19 deaths has a negative yet statistically insignificant influence on stock market returns. This study also found a non-linear inverted U-shaped relationship between the MCO period and stock market returns, implying that though the MCO has initial positive influences on the stock market, it negatively impacts the stock market after 5.7 weeks. Thus, this study argues that policy responses to the COVID-19 pandemic provide the most compelling explanation for its unprecedented impact on the sustainability of the stock market. Governments should therefore implement a partial lockdown to avoid deterioration of the national economy. Furthermore, government policies and plans to control the COVID-19 epidemic as well as economic stimulus packages to kickstart the economy play crucial roles in boosting economic growth and revitalizing the stock market.

JEL Classification: G10, G15, G18

Keywords: COVID-19; Movement Control Order; Stock Market Returns; Non-linear; Sustainability

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INTRODUCTION

The World Health Organization (WHO) has declared the current outbreak of the Coronavirus (COVID-19) disease a global pandemic. As of May 6th, 2021, a total of 156.67 million COVID-19 cases and 3.26 million COVID-19 related deaths have been reported globally. Global spread has been rapid, with more than 222 countries or territories having reported at least one case. With large uncertainties surrounding the transmission of this virus and the exponential increase in COVID-19 cases, most governments responded by imposing travel restrictions, social distancing mandates, Movement Control Orders (MCOs), and lockdowns at state and national levels.

Though the enforcement of isolation has positive externalities for health, it has negative externalities for the economy, entailing adverse effects like supply shock, demand shock, and financial market shock. In fact, COVID-19 and its containment policies have directly and massively impeded the flow of labor into businesses. The result has been a sudden and substantial reduction in the output of goods and services. Besides supply side disruptions, the large death toll has generated heightened uncertainty and panic among households and businesses, which hamper consumption and investment. The consequent large drops in demand have thus forced numerous firms to close, causing significant lay-offs and a deeper decline in consumption. Overall, the COVID-19 pandemic has created and continues to create high levels of uncertainty along with all manners of economic shocks. Uncertainty in a pandemic or economic crisis is often associated with panicked investors' sale of their assets or stocks out of fear that the assets' value will drop. This situation may increase stock market volatility and trigger stock market crashes (Chuah et al., 2018; Haritha and Rishad, 2020; Kaluge, 2017; Ng et al., 2018).

Global stock markets have experienced significant and continuous drops in share price trends since late February 2020. For example, the Dow Jones Industrial Average (DJI) declined by approximately 37 percent in a month, from its peak (29,348 on February 19th, 2020) to its lowest point of the year (18,591 on March 23rd, 2020). Clearly, the current pandemic has grave implications for public health and the economy. Previous infectious disease outbreaks such as Bird Flu (H5N1), Severe Acute Respiratory Syndrome (SARS), Swine Flu (H1N1), Ebola, or Middle East Respiratory Syndrome (MERS) did not impact the stock market as severely as the COVID-19 pandemic. Why has COVID-19 in particular exerted such powerful effects on the stock market? Part of the answer may lie in the severity of the pandemic, the apparent ease with which the virus spreads, and the non-negligible mortality rate among those who contract the virus. Still, we think this answer is highly incomplete. We therefore believe it is necessary to examine public reactions and policy responses to the COVID-19 pandemic, as appropriate policy responses to COVID-19 are important to achieve sustainable economic growth.

In the context of COVID-19's impact on the stock market, we opine that stock market returns are not only negatively affected by confirmed COVID-19 cases and COVID-19 deaths, but are also critically influenced by the length of the Movement Control Order (MCO). We argue that there is a threshold for the MCO period, whereby there is an inverted U-shaped relationship between the MCO period and stock market returns. In its initial stage, MCO reduces COVID-19 cases and strengthens market confidence, thereby positively influencing the stock market. However, as the MCO period surpasses a certain number of days, it brings a negative impact to the stock market. This is because the MCO causes a sharp decline in business activities, reduces firms' profit, and even leads to major losses for some firms. The longer the MCO period, the more severe the damage to businesses. Therefore, this study aimed to investigate COVID-19's effects on stock market returns as well as the appropriate period of an MCO for optimal stock market outcomes.

No previous infectious disease outbreak has impacted the stock market as powerfully as COVID-19. However, due to the fact that this topic is relatively recent, there is limited empirical research in this area. This study thus intends to contribute to the emerging literature in four ways. First, this study set out to cover as many countries as possible, given that COVID-19 is a global issue affecting the entire world. Based on data availability, 57 countries were included in our study. To our best knowledge, only a few studies have investigated this topic among a large group of countries, namely Ashraf's (2020b) work on 64 countries and Topcu and Gulai's (2020) analysis of 26 emerging countries. Second, this study applied the dynamic panel Generalized Method of Moments (GMM) to examine the impact of changes in confirmed COVID-19 cases/deaths on stock markets. Lagged variables were considered important for our analysis because stock markets are dynamic in nature. It is worth noting that previous studies (Ashraf, 2020b; Topcu and Gulai, 2020) employed the pooled OLS method. Third, this study compared the distinct effects of growth in confirmed COVID-19 cases and growth in COVID-19 death cases on stock market returns to investigate whether the stock market responds differently to these two measures. We posit that the growth in confirmed cases has a more significant negative impact on the stock market due to the more widespread fear of high contagion than mortality. Fourth, there are limited studies on the role of government interventions in stock market returns, with the exception of Ashraf (2020b) and Narayan et al. (2020). Ashraf (2020b) analyzed the influence of governments' social distancing measures on stock market returns. Likewise, Narayan et al. (2020) examined the effect of G7 countries' government responses to COVID-19 on stock market returns. Our study differs from these two studies as we incorporated the possible non-linearity of the MCO period into the model. To our best knowledge, this is the first study that examines the inverted U-shaped relationship between MCO period and stock market performance.

LITERATURE REVIEW

Following the outbreak of COVID-19, several scholars attempted to study COVID-19 and its impacts on stock markets. The study of Al-Awadhi et al. (2020) indicated that daily growth in both total number of COVID-19 confirmed cases and death had a significant negative impact on Chinese stock market. Similarly, Ahmar and Val (2020) showed that the increasing number of confirmed cases in Spain weakens the Spain Market Index. However, the study of Sansa (2020) found that confirmed COVID-19 cases positively affect the stock market in China and the US.

In addition, some researchers have studied COVID-19's impacts using panel data analysis. Most of them (Ashraf, 2020b; Czech at al., 2020; Liu et al, 2020; He at al., 2020; Topcu and Gulal, 2020) found that the virus has a negative impact on stock markets, with the exception of Sansa (2020). These studies were conducted in various contexts, such as countries with the largest number of confirmed COVID-19 cases (He at al., 2020; Liu at al., 2020), developed G7 countries (Narayan et al., 2020; Yousef, 2020), and emerging stock markets (Topcu and Gulai, 2020). According to their analyses, countries with the most COVID-19 cases and emerging stock markets suffer greater negative impacts on their stock markets. Besides, empirical studies have found that COVID-19 increases uncertainty and stock market volatility (Sharif et al., 2020; Yousef, 2020).

The outbreak of the highly contagious COVID-19 epidemic is an unprecedented event with extreme uncertainties. In the absence of an effective vaccine, most governments across the world have adopted a variety of policy approaches to control the spread of the disease. These approaches include lockdowns, travel restrictions, tests and quarantines, as well as financial support to mitigate the negative impact of the pandemic. These policy actions, in turn, have generated more uncertainty about their effectiveness and their consequences for financial markets. Therefore, we expanded the current research scope to analyze the effects of government interventions on the stock market. Ashraf (2020a) suggested that the announcement of social distancing measures adversely affects economic activities and leads to direct negative impacts on stock market earnings. Liew (2020) revealed that after the Wuhan lockdown, the cumulative abnormal returns of tourism shares in the Shanghai and Shenzhen stock exchanges were significantly unfavorable. However, government interventions, by decreasing the number of confirmed COVID-19 cases, have an indirect positive impact on stock market returns. Furthermore, governments' official response times and stimulus packages matter in offsetting the outcomes of the pandemic. Moreover, Narayan et al. (2020) found that lockdowns, travel bans, and economic stimulus plans to have a positive impact on G7 countries' stock markets.

In summary, research on the COVID-19 outbreak is still in its infancy due to its novelty. The limited existing studies have generally tested the effect of COVID-19 on the stock market in a single country[1], while a few have examined a panel of countries[2]. These studies have found the COVID-19 pandemic to have a negative impact on countries' economies and financial markets. Although most countries have implemented some kind of intervention to curb the spread of the epidemic (e.g., social distancing and MCOs), the influence of government interventions on the stock market has not been thoroughly investigated. This study fills this research gap by examining the role of government interventions and their possible non-linearity in stock market returns.

[1] For example, Al-Awadhi et al. (2020) in China; Baker et al. (2020) in the US; Sansa (2020) in China and the US; and Sharif et al. (2020) in Spain.
[2] For example, Ashraf (2020b); Czech at al. (2020); Liu et al. (2020); He at al. (2020); and Topcu and Gulal (2020).

METHODOLOGY AND EMPIRICAL MODELS

The main objectives of this study were to investigate: (1) the impact of COVID-19 on stock market returns and (2) the existence of a non-linear nexus between the MCO period and stock market returns. We used weekly panel data from November 4th, 2019 to July 5th, 2020 on 57 countries based on data availability. The list of countries is provided in Table 1. Variable descriptions and data sources are presented in Table 2.

In our model, we used stock index data to compute stock returns by taking the logarithm difference between two consecutive prices. To investigate the effect of the pandemic on stock market performance, two measurements were used: (1) growth in total confirmed cases ($gCOVID$) and (2) growth in total deaths caused by COVID-19 ($gDEATH$). Apart from these, another main interest variable was MCO, which captures the period of a country's MCO or lockdown. Control variables for stock market returns included VOL, which represents stock market volatility, and ER, which is the nominal effective exchange rate. These ratios were averaged over the period from t to $t+n$.

Table 1 List of Countries

No	Country	No	Country	No	Country
1	United Arab Emirates	20	Finland	39	Netherlands
2	Argentina	21	France	40	Norway
3	Austria	22	United Kingdom	41	New Zealand
4	Australia	23	Greece	42	Peru
5	Belgium	24	Croatia	43	Philippines
6	Bulgaria	25	Hungary	44	Poland
7	Brazil	26	Indonesia	45	Portugal
8	Canada	27	Ireland	46	Romania
9	Switzerland	28	Israel	47	Russia
10	Chile	29	India	48	Saudi Arabia
11	China	30	Iceland	49	Sweden
12	Colombia	31	Italy	50	Singapore
13	Cyprus	32	Japan	51	Slovenia
14	Czech Republic	33	Korea	52	Slovak Republic
15	Germany	34	Lithuania	53	Thailand
16	Denmark	35	Latvia	54	Turkey
17	Algeria	36	Malta	55	Chinese Taipei
18	Estonia	37	Mexico	56	United States
19	Spain	38	Malaysia	57	South Africa

Table 2 List of variables

Variables	Measurement	Data Source
Dependent variable:		
Stock Market Return	Weekly change in major stock index of a country, $R_t = \log(\text{Index value}_t / \text{Index value}_{t-1})$	Investing Database
Independent variables:		
Confirmed COVID-19 cases	Growth in confirmed COVID-19 cases	Kaggle Database
COVID-19 death cases	Growth in COVID-19 death cases	Kaggle Database
MCO	MCO or lockdown period by week. Week 1 = 1, Week 2 =2, etc.; country without lockdown = 0	Kaggle Database
Exchange Rate	Nominal effective exchange rate (constant 2010)	Bank for International Settlements
Volatility	Stock market volatility	Authors' calculation using GARCH procedures

The main specification of the empirical model can be expressed as:

$$R_{it} = \alpha_0 + \alpha_1 R_{i,t-1} + \alpha_2 gCOVID_{it} + \alpha_3 MCO_{it} + \alpha_4 MCO^2{}_{it} + \alpha_5 VOL_{it} + \alpha_6 ER + \varepsilon_{it} \quad (1)$$

$$R_{it} = \alpha_0 + \alpha_1 R_{i,t-1} + \alpha_2 gDEATH_{it} + \alpha_3 MCO_{it} + \alpha_4 MCO^2{}_{it} + \alpha_5 VOL_{it} + \alpha_6 ER_{it} + \varepsilon_{it} \quad (2)$$

$$R_{it} = \beta_0 + \beta_1 R_{i,t-1} + \beta_2 gCOVID_{it} + \beta_3 gDEATH_{it} + \beta_4 MCO_{it} + \beta_5 MCO^2{}_{it} + \beta_6 VOL_{it} + \beta_7 ER_{it} + \varepsilon_{it} \quad (3)$$

While α_0 and β_0 were country-specific effects, $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6$, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$, and β_7 were the coefficients to be estimated and it was the error term. A lagged dependent variable was included to represent the lagged stock market return, so α_1 and β_1 were expected to be positive/negative. For confirmed COVID-19 cases and deaths, we expected to find negative values for α_2, β_2, and β_3 which express the negative impacts of the pandemic on stock market returns. Predicting that the MCO period follows an inverted U-shape, the signs for α_3 and β_4 were expected to be positive while the signs for α_4 and β_5 were expected to be negative. The variable VOL, which measures stock market volatility, was calculated using GARCH estimators. The expected signs for α_5 and β_6 were negative to reflect that high stock market volatility decreases stock market returns. The exchange rate was measured by the nominal effective exchange rate, whereby an appreciation in the exchange rate would increase stock market returns and vice versa. Thus, α_6 and β_7 were expected to be positive.

We estimated regressions 1, 2, and 3 using the Generalized Method of Moments (GMM) estimator. We chose the GMM analytical approach for several reasons. First, the GMM works to eliminate serial correlation and heteroskedasticity. Second, the GMM manages to address important modelling issues, namely the endogeneity of regressors and fixed effects, including dynamic panel bias (Nickell, 1981). Third, the existence of the lagged dependent variable engenders autocorrelation issues with other estimators, thence the lagged level of regressors was used as an instrument as per Arellano and Bond (1991).

More specifically, the objectives of this study were achieved using the System GMM method proposed by Blundell and Bond (1998), which remedies the instrument weakness of the First Difference GMM. As suggested by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998), two specification tests were conducted, namely Hansen test of overidentifying restriction and second order (AR2), where Hansen test assesses the overall validity of the instruments with the null hypothesis that all instruments, as a group, are exogenous and moments have expectations equal to zero; second order (AR2) is to affirm that the errors of different equations are not serially correlated. We therefore used the two-step System GMM in this analysis.

In addition, in the non-linear model estimator, the relationship was determined by rejecting the null hypotheses of both original and squared variables with different signs. However, when the true relationship is convex but monotonous, problems may arise, which can lead to extreme points and imply an erroneous quadratic U-shaped curve. To overcome this issue, Lind and Mehlum (2010) conducted a test to avoid mis-inferring an accurate non-linear nexus. Accordingly, we applied this test by checking for the existence of a U-shape in intervals, whereby the relationship decreases at low values and increases at high values within the interval. This was accomplished by examining the following conditions for Models 1, 2, and 3.

$$\alpha_3 + \alpha_4(MCO_t) < 0 < \alpha_3 + \alpha_4(MCO_h) \quad (4)$$

$$\beta_4 + \beta_5(MCO_t) < 0 < \beta_4 + \beta_5(MCO_h) \quad (5)$$

These procedures jointly validated the non-linear relationship between the MCO period and stock market returns, wherein the relationship strengthens at low values and weakens at high values of the MCO period among the samples.

Based on Equations (1), (2), and (3), the marginal effects of longer MCOs can be calculated by examining the partial derivatives of stock market returns with respect to the MCO variable:

$$\frac{\partial R_{it}}{\partial MCO_{it}} = \alpha_3 + 2\alpha_4 MCO_{it} \quad (6)$$

$$\frac{\partial R_{it}}{\partial MCO_{it}} = \beta_4 + 2\beta_5 MCO_{it} \quad (7)$$

To assess whether the MCO as a quadratic term has a significant impact on stock market returns, we computed the standard error of marginal effects as suggested by Brambor et al. (2006)[3]. To check for robustness, we also performed a quantile regression on our baseline model in Equation (3) to examine the impact of COVID-19 outbreaks on stock market returns.

[3] Marginal effects are used to measure the change in the dependent variable as one specific independent variable change. Other covariates are assumed to be constant. Based on the non-linear (quadratic term) model: $\hat{Y} = \beta_0 + \beta_1 X + \beta_2 X^2$, the marginal effect of X on Y is computed as $\frac{\partial Y}{\partial X} = \beta_1 + 2\beta_2 X$ with the standard error calculated using the covariance matrix as per the formula provided by Brambor et al. (2006): $\hat{\sigma}\frac{\partial Y}{\partial X} = \sqrt{var(\hat{\beta}_1) + 4X^2 var(\hat{\beta}_2) + 4X\, cov(\hat{\beta}_1 \hat{\beta}_2)}$.

EMPIRICAL FINDINGS

Descriptive Statistics

Table 3 presents the descriptive statistics that provide an overall picture of the dataset. The statistics showed that there were 1995 observations for each variable. The average stock market returns were -0.00134 with a minimum of -0.16198 and a maximum of 0.1040. The means of $gCOVID$ and $gDEATH$ were 0.79748 and 0.34377, with standard deviations of 7.44704 and 3.28516, respectively. The MCO had an average of 1.17744 and a standard deviation 2.78889. The minimum and maximum values of the VOL were 0 and 0.05434. The ER had an average of 94.76348, with a standard deviation of 23.00593. The minimum and maximum values for the ER were 8.534 and 132.192, respectively.

Table 3 Descriptive Statistics

Variable	Mean	Minimum	Maximum	Std Dev.	Observations
R	-0.00134	-0.16198	0.10397	0.02214	1995
$gCOVID$	0.79748	-3.46429	204.00000	7.44704	1995
$gDEATH$	0.34377	-1	128.30000	3.28516	1995
MCO	1.17744	0	16.00000	2.78889	1995
VOL	0.00080	0	0.05434	0.00239	1995
ER	94.76348	8.53400	132.19200	23.00593	1995

Table 4 displays the correlation matrix of the data. The correlation between R and $gCOVID$ was -0.1432, suggesting that the growth in confirmed COVID-19 cases has a negative relationship with stock market returns. This result is in line with the findings of Ashraf (2020a). Meanwhile, there was a positive correlation between R and MCO with a coefficient of 0.1363. This positive relationship indicates that a longer MCO period is associated with higher stock market returns.

Table 4 Correlation Matrix

	R	$gCOVID$	$gDEATH$	MCO	VOL	ER
R	1					
$gCOVID$	-0.14320***	1				
$gDEATH$	0.01410	0.03020	1			
MCO	0.13630***	-0.03170	0.00990	1		
VOL	0.00950	0.13980***	0.08770***	0.03270	1	
ER	-0.01270	-0.03130	0.01700	-0.09180	0.02010	1

Note: *** indicates p < 0.01.

Results of Dynamic GMM Estimation

This study estimated the impact of the COVID-19 outbreak on stock market returns by employing the panel System GMM technique. Two specification tests verified the validity and reliability of the GMM as a suitable method for this study. First, the Hansen test for overidentifying restrictions reported that the null hypothesis was not rejected, proving that the instrument was valid. For the second diagnostic check, we used the Arellano-Bond (AB) test to check for serial correlation. The results indicated that the null hypothesis of the second order serial correlation failed to be rejected as well.

Table 5 (Panel A) shows that the lagged stock market return was statistically significant at the one percent level, indicating that the System GMM was appropriate to analyze stock market returns. Also, the coefficient of the auto regression was far below unity, indicating the absence of the weak instrument problem in the dynamic GMM estimator (Blundell and Bond, 1998). The negative sign of the lagged stock returns means that the deviations in returns would not persist, indicating a mean-reversion towards an equilibrium position (Fama and French, 2000). In this context, the lagged stock return value of -0.22611 at the one percent significance level means that the current returns are captured by previous returns.

Table 5 Results of Dynamic GMM Estimation

	Two-step System GMM		
Panel A	**Model 1**	**Model 2**	**Model 3**
Variable:			

$R_{i,t-1}$	-0.22611***	-0.22315***	-0.22558***
	(0.03506)	(0.03691)	(0.03623)
$gCOVID_{it}$	-0.00046**	-	-0.00048**
	(0.00022)		(0.00024)
$gDEATH_{it}$	-	-0.00008	-0.00006
		(0.00013)	(0.00016)
MCO_{it}	0.00847***	0.00871***	0.00846***
	(0.00134)	(0.00128)	(0.00132)
$MCO^2{}_{it}$	-0.00074***	-0.00076***	-0.00074***
	(0.00012)	(0.00012)	(0.00012)
VOL_{it}	0.61026	0.67434	0.61873
	(0.71853)	(0.67118)	(0.71276)
ER_{it}	0.00039	0.00041	0.00039
	(0.00041)	(0.00042)	(0.00040)
Constant	-0.04178	-0.04485	-0.04217
	(0.03966)	(0.04074)	(0.03863)
Hansen Test	0.99900	0.99900	0.99900
AR(2)	0.82800	0.77700	0.82700
Observations	1938	1936	1936
Number of Countries	57	57	57
Instruments	100	100	101
Panel B			
Lind and Mehlum's (2010) U-test			
Overall U test	5.71326***	5.70821***	5.69683***
t-stat	5.85000	6.10000	6.00000
Lower Bound Slope	0.00847***	0.00871***	0.00846***
Upper bound Slope	-0.01526***	-0.01571***	-0.01530***
Panel C			
Marginal Effect			
Mean	6.25664***	6.70676***	6.29100***
	(0.00108)	(0.00103)	(0.00107)
Maximum	-5.84990***	-6.10046***	-6.00460***
	(0.00261)	(0.00258)	(0.00255)
Minimum	6.33486***	6.78077***	6.39844***
	(0.00134)	(0.00128)	(0.00132)

Note: ***, and ** indicate significance at 1%, and 5% levels, respectively. Numbers in parentheses are Standard Errors except for the Hansen test and AR (2) which are p-values. The Arellano and Bond dynamic system GMM was used to estimate all variables. (Null hypothesis: Monotone or U-shape, Alternative hypothesis: Inverse U-shape).

The first two models in Panel A present the results of growth in confirmed COVID-19 cases and growth in COVID-19 death cases, respectively. We found that growth in confirmed cases significantly and negatively affects stock market performance, while growth in death cases does not significantly affect stock market returns. Model 3 exhibited similar results to Model 1 and Model 2. This indicates that a 10 percent increase in confirmed COVID-19 cases would decrease stock market returns by 0.0048 percent. Thus, growth in confirmed cases has a significant impact on stock market returns while growth in death cases does not. Our results are consistent with other studies (Ashraf, 2020a) which have reported that the stock market endures a significant inimical reaction from the increasing number of COVID-19 cases but not from the outbreak's death toll. More interestingly, the coefficient signs for the MCO and MCO squared terms across all three models conformed to the expected signs of the inverted U-shape, where they were positive for MCO and negative for MCO squared. In Model 3, the coefficient signs for MCO and MCO squared were 0.00846 and -0.00074, respectively. This signifies the existence of a non-linear inverted U-shaped relationship, which explains that the marginal effects of the MCO on stock market returns will continue to decline as the period of MCO extends. The results imply that a country's lockdown initially increases stock market returns; however, after a specific MCO period, the MCO is harmful to stock market returns. Specifically, government interventions such as the announcement of social distancing, lockdowns, and travel bans mitigate the epidemic, which in turn affects stock market performance. Initially, the MCO's implementation or any intervention to control COVID-19 increases stock market returns, which is in line with the finding of Narayan et al. (2020). However, after a certain length of the MCO period, it negatively affects stock market returns (Ashraf, 2020a; Liew, 2020). Thus, the MCO period plays an important role in determining stock market returns in a country. For the control variables, VOL and ER were found to have insignificant influences on stock market returns during the COVID-19 outbreak.

To confirm that the relationship between MCO period and stock market returns is non-linear, we also performed Lind and Mehlum's (2010) U-test. The results in Table 5 (Panel B) confirm the significance of all three models, highlighting that both the MCO and stock market return variables are indeed non-linear. For instance, in Model 3, the overall U-test result (5.69683) was significant at the one percent level, as were the lower bound slope (0.00846) and upper bound slope (-0.01530) whose coefficients turned from positive to negative. Thus, we rejected the null hypothesis of a monotone or U-shape relationship and concluded an inverse U-shape, i.e., nonlinear, relationship between stock market returns and the MCO period. In other words, the link between the MCO period and stock market returns is explained by the fact that the initial MCO period boosts stock market returns, but worsens these returns after a specific MCO period. Based on Equation (7), the optimum level of the MCO period for stock market returns is 5.7 weeks.

Table 5 (Panel C) portrays that the marginal effects' mean, minimum, and maximum values were significant at the one percent level across all three models. For example, in Model 3, the MCO period's marginal effects had mean, minimum, and maximum values of 6.29100, 6.39844, and -6.0046, respectively. This illustrates that with a shorter MCO period, stock market returns increase by 6.39 percent. Conversely, when the MCO period extends by one percent, stock market returns diminish by 6.00 percent. Therefore, a longer MCO period is harmful to stock market returns as depicted by the change from the minimum to maximum values.

Robustness Check

As a check for robustness, we performed a quantile regression on our baseline model in Equation (3) to examine the impact of COVID-19 on stock market returns. We tested the model in Equation (3) at τ =0.05, 0.25, 0.50, 0.75, and 0.95, following Racine's (2006) recommendations on testing the correct specification for each quantile at which the model is estimated. Table 6 displays the quantile regression results for these five quantiles. Growth in confirmed COVID-19 cases was negative and significant at the one percent level for all quantiles except the 95th. These results suggest that the growth in COVID-19 cases adversely affects stock market returns. Meanwhile, the correlation between growth in COVID-19 death cases and stock market returns was strong and statistically significant at the higher quantiles but weak at the lower and middle quantiles. This diverges from our earlier finding from the System GMM, where the growth in COVID-19 death cases was insignificant. More importantly, there was evidence of an inverse U-shaped nexus between the MCO period and stock market returns, as the coefficients of MCO and MCO squared were positive and negative. Specifically, stock market returns at the 50th, 75th, and 95th quantile exhibited an inverted U-shaped relationship between MCO period and stock market returns, while the evidence was weak at the lower quantiles. In addition, stock market volatility had a significant negative impact on stock returns at lower and middle quantiles but had a positive effect at higher quantiles, which means that stock market volatility worsens stock market returns when they are low but improves returns when they are high. Though it was insignificant at the 5th quantile, the exchange rate at the 25th quantile had a positive impact on stock market returns. It then had a negative impact on returns at the 50th, 75th, and 95th quantiles, thereby highlighting the existence of an asymmetric relationship between exchange rates and stock market returns. This finding is in accordance with Gopinathan and Durai (2019).

Table 6 Results of Dynamic Panel Quantile Estimation

	Quantile regressions				
Variable	Q (0.05)	Q (0.25)	Q (0.50)	Q (0.75)	Q (0.95)
$R_{i,t-1}$	0.19847	0.03454	0.00508	-0.05807***	0.03685
	(0.13144)	(0.02250)	(0.01500)	(0.02030)	(0.04740)
$gCOVID_{it}$	-0.00420***	-0.00149***	-0.00050***	-0.00031***	-0.00014
	(0.00036)	(6.11e-05)	(4.06e-05)	(5.52e-05)	(0.00013)
$gDEATH_{it}$	0.00019	2.97e-06	-0.00003	0.00065***	0.00132***
	(0.00080)	(0.00014)	(9.11e-05)	(0.00012)	(0.00029)
MCO_{it}	0.00426	0.00052	0.00132***	0.00358***	0.00547***
	(0.00277)	(0.00048)	(0.00032)	(0.00043)	(0.00100)
$MCO^2{}_{it}$	-0.00025	0.00004	-0.00009***	-0.00025***	-0.00038***
	(0.00027)	(4.54e-05)	(3.02e-05)	(4.10e-05)	(9.56e-05)
VOL_{it}	-13.42734***	-2.47607***	-0.31235**	1.64171***	4.10510***
	(1.20800)	(0.20700)	(0.13700)	(0.18700)	(0.43600)
ER_{it}	0.00008	0.00004**	-0.00002*	-0.00005***	-0.00009**
	(0.00012)	(1.98e-05)	(1.32e-05)	(1.79e-05)	(4.17e-05)
Constant	-0.03790***	-0.00926***	0.00271**	0.01047***	0.02783***
	(0.01150)	(0.00196)	(0.00130)	(0.00177)	(0.00413)
Observations	1,936	1,936	1,936	1,936	1,936

Note: ***, **, and * indicate significance at 1%, 5% and 10% levels, respectively. Numbers in parentheses are standard errors.

CONCLUSIONS AND POLICY IMPLICATIONS

The World Health Organization (WHO) has declared the current outbreak of COVID-19 a global pandemic. Most countries have responded by enforcing social distancing and MCOs to curb the spread and intensity of the epidemic (Ha et al., 2020; Kheirallah et al., 2020). Though the enforcement of isolation has positive externalities for health, it has negative externalities for the economy. Its adverse effects include supply shock, demand shock, and financial market shock. Moreover, longer lockdowns and border closures add downward pressure on countries' aggregate supply and demand. Therefore, it is important to identify the appropriate threshold level of an MCO period to avoid economic downfall and promote sustainable economic growth.

The primary objective of this study was to examine the impacts of COVID-19 and the MCO period on 57 countries' stock markets using the dynamic System GMM estimator. We further distinguished between two measures of COVID-19: (1) growth in total confirmed COVID-19 cases and (2) growth in total deaths caused by COVID-19. This study also examined whether a non-linear relationship exists between the MCO period and stock market returns. Our results revealed that the growth in confirmed COVID-19 cases has a significant negative effect on stock returns while the growth in COVID-19 death cases does not. This underscores that the market reacts strongly to the high number of confirmed cases as people are frightened by the high speed of contagion. In contrast, the mortality rate of COVID-19 is relatively low. Considering that deaths are the result of confirmed cases and are generally reported several days after an infection is confirmed, savvy stock market investors perceive the expected adverse effects of COVID-19 to derive from the growth in confirmed cases (Ashraf, 2020b). We also discovered an inverted U-shaped relationship between the MCO period and stock market returns. In its initial stage, the MCO reduces COVID-19 cases and strengthens market confidence, hence positively influencing stock market returns. However, as the MCO period surpasses 5.7 weeks, it asserts a negative impact on the stock market, as the MCO hampers business activities, reduces firms' profits, and even leads to major losses for some firms. The longer the MCO period, the more severe its damage to businesses. These findings suggest that an MCO period under 5.7 weeks will keep an economy sustainable.

The implications of our study are important for stock market players to understand and predict the behavior of market returns during the pandemic. MCO implementation has reduced the number of COVID-19 cases, yet it has done so at the expense of the economy. In particular, it has reduced stock market prices and returns, increased unemployment, and stymied economic growth. Governments should thus consider partial lockdowns to avoid the national economy from deteriorating. For example, the government can implement an unlocking circuit in the form of the Conditional Movement Control Order (CMCO) and the Recovery Movement Control Order (RMCO), which are to be carried out in stages to ensure the COVID-19 outbreak is controlled without affecting economic activities. On the other hand, governments should also introduce economic stimulus packages to bolster confidence and promote economic growth. By doing so, the economic stability of a country will be improved, which attracts more investors and in turn, increases stock market returns. Furthermore, governments must take measures to protect labor and funds in support of enterprises, especially small and medium enterprises (SMEs). Overall, government policies and plans to control the COVID-19 epidemic play a substantial role in boosting economic growth and revitalizing the stock market.

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REFERENCES

Ahmar, A. S. and del Val, E. B. (2020) 'SutteARIMA: Short-term forecasting method, a case: Covid-19 and stock market in Spain' *Science of The Total Environment*, *729*, p. 138883.

Al-Awadhi, A. M., Al-Saifi, K., Al-Awadhi, A. and Alhamadi, S. (2020) 'Death and contagious infectious diseases: Impact of the COVID-19 virus on stock market returns', *Journal of Behavioral and Experimental Finance*, *27*, p. 100326.

Arellano, M. and Bond, S. R. (1991) 'Some tests of specification for panel data: Monte Carlo evidence and application to employment equations', *Review of Economic Studies*, *58*(2), pp. 277-297.

Arellano, M. and Bover, O. (1995) 'Another look at the instrumental variables estimation of error components models', *Journal of Econometrics*, *68*(1), pp. 29-51.

Ashraf, B. N. (2020a) 'Economic impact of government interventions during the COVID-19 pandemic: International evidence from financial markets', *Journal of Behavioral and Experimental* Finance, *27*, p. 100371.

Ashraf, B. N. (2020b) 'Stock markets' reaction to COVID-19: cases or fatalities?', *Research in International Business and Finance*, *54*, p. 101249.

Baker, S. R., Bloom, N., Davis, S. J., Kost, K., Sammon, M. and Viratyosin, T. (2020) 'The unprecedented stock market reaction to COVID-19', *The Review of Asset Pricing Studies.*

Blundell, R. and Bond, S. (1998) 'Initial conditions and moment restrictions in dynamic panel data models', *Journal of Econometrics*, *87*(1), pp. 115-143.

Brambor, T., Clark, W. R. and Golder, M. (2006) 'Understanding interaction models: Improving empirical analyses', *Political Analysis*, *14*, pp. 63-82.

Chuah, L. L., Poon W. C. and Guru, B. K. (2018) 'Uncertainty and private investment decision in Malaysia', *Modern Applied Science*, *12*(9), pp. 71-86.

Czech, K., Wielechowski, M., Kotyza, P., Benešová, I. and Laputková, A. (2020) 'Shaking Stability: COVID-19 Impact on the Visegrad Group Countries' Financial Markets', *Sustainability*, *12*(15), p. 6282.

Fama, E. F. and French, K. R. (2000) 'Forecasting profitability and earnings', *The Journal of Business*, *73*(2), pp. 161-175.

Gopinathan R. and Durai S. R. S. (2019) 'Stock market and macroeconomic variables: new evidence from India', *Financial Innovation*, *5*(1), pp. 1-17.

Ha, B. T. T., Quang, L. N., Mirzoev, T., Tai, N. T., Thai, P. Q. and Dinh, P. C. (2020) 'Combating the COVID-19 Epidemic: Experiences from Vietnam', *International Journal of Environmental Research and Public Health*, *17*, p. 3125.

Haritha, P. H. and Rishad, A. (2020) 'An empirical examination of investor sentiment and stock market volatility: evidence from India', *Financial Innovation*, *6*(1), pp. 1-15.

He, Q., Liu, J., Wang, S. and Yu, J. (2020) 'The impact of COVID-19 on stock markets', *Economic and Political Studies*, *8*(3), pp. 275-288.

Kaluge, D. (2017) 'Asymmetric Spillover effect in Indonesian Stock Market', *International Journal of Economics & Management*, *11*, pp. 183-195.

Kheirallah, K. A., Alsinglawi, B., Alzoubi, A., Saidan, M. N., Mubin, O., Alorjani, M. S. and Mzayek, F. (2020) 'The Effect of Strict State Measures on the Epidemiologic Curve of COVID-19 Infection in the Context of a Developing Country: A Simulation from Jordan', *International Journal of Environmental Research and Public Health*, *17*, p. 6530.

Liew, V. K. S. (2020) 'Abnormal Returns on Tourism Shares in The Chinese Stock Exchanges Amid The COVID-19 Pandemic', *International Journal of Economics and Management*, *14*(2), pp. 247-262.

Lind, J. T. and Mehlum, H. (2010) 'With or without U? The appropriate test for a U shaped relationship', *Oxford Bulletin of Economics and Statistics*, *72*(1), pp. 109-118.

Liu, H., Manzoor, A., Wang, C., Zhang, L. and Manzoor, Z. (2020) 'The COVID-19 outbreak and affected countries stock markets response', *International Journal of Environmental Research and Public Health*, *17*(8), p. 2800.

Narayan, P. K., Phan, D. H. B. and Liu, G. (2020) 'COVID-19 lockdowns, stimulus packages, travel bans, and stock returns', *Finance research letters*, *38*, p. 101732.

Ng, C. P., Choo, W. C., Bany-Ariffin, A. N. and Annuar, M. N. (2018) 'Contemporary Event Study Test: Event-Induced Variance and Cross Correlation Among Abnormal Returns in Dividend', *International Journal of Economics and Management*, *12*, pp. 327-337.

Nickell, S. (1981) 'Biases in dynamic models with fixed effects', *Econometrica: Journal of the econometric society*, *47*, pp. 1417-1426.

Racine, J. S. (2006) 'Consistent specification testing of heteroskedastic parametric regression quantile models with mixed data', Unpublished manuscript, McMaster University.

Sansa, N. A. (2020) 'The Impact of the COVID-19 on the Financial Markets: Evidence from China and USA', *Electronic Research Journal of Social Sciences and Humanities*, *2.*

Sharif, A., Aloui, C. and Yarovaya, L. (2020) 'COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: Fresh evidence from the wavelet-based approach' *International Review of Financial Analysis*, *70*, p. 101496.

Topcu, M. and Gulal, O. S. (2020) 'The impact of COVID-19 on emerging stock markets', *Finance Research Letters*, *36*, p. 101691.

Yousef, I. (2020) ‘Spillover of COVID-19: Impact on Stock Market Volatility’, *International Journal of Psychosocial Rehabilitation*, *24*(6), pp. 18069-18081.