The Economic Implications of COVID-19 Lockdowns

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Abstract

The COVID-19 pandemic has undeniably posed severe health and economic externalities for every nation-state in the world. These negative economic outcomes have sparked a politically waxing debate with the preventative measures governments have implemented in response, such as national lockdowns, business closures, and mask mandates, being popularly scapegoated. However, we theorize counterfactually that COVID-19 fundamentally harms economies through depressed productivity and consumer confidence and that these outcomes are in fact mitigated by the policy measure we focus on, national lockdowns. This paper examines this assertion as well as the direct relationship between lockdown severity and economic outcomes for a subset of 24 OECD countries and major economies. Through an OLS regression and mediation analysis on time-series data, we find that lockdowns partially mediate the economic effects of COVID-19 and that lockdown severity positively correlates with our proxy for economic outcomes, stock returns. Our findings are robust to sensitivity checks as well as controls for factors of economic outcomes and are significant for 13 out of the 24 nation-states in our sample, with only one exhibiting a negative correlation. [1] [2]

Keywords: Lockdown Severity, Economics, COVID-19

1 Introduction

For over a year, the COVID-19 pandemic has posed severe challenges for the global economy. In adapting to the precarious environment created by the virus' spread, governments worldwide have enacted a multitude of preventative policy measures including lockdowns. These mandates on in-person business closures and stay-at-home orders theoretically lower COVID-19 rates through reduced interpersonal exposure and thus promote a faster long-term return to economic normalcy. However, given their restrictions on quotidian consumer life, lockdowns have often become a scapegoat, instead of the pandemic itself, for the economic hardships of the last year. Clearly understanding the nature of the relationship between lockdowns and economic outcomes remains of utmost importance, exemplified by Texas Governor Greg Abbott recently lifting statewide COVID-19 restrictions,

[1] Landing page for paper with interactive data visualizations at https://qss82-18w-team9.herokuapp.com/
[2] Code and plots at https://github.com/sjsig/QSS82-Team9

largely in response to partisan pressure despite the total death count in the United States eclipsing half a million people (Sullivan, Montgomery, and Pietsch 2021; "Coronavirus in the U.S.: Latest Map and Case Count" 2021). Based on regional COVID-19 case rates and polarized popular rhetoric, nation-states globally have similarly implemented lockdowns to varying degrees of severity.

Weighing into this perceived tug-of-war between the economic and epidemiological benefits of lockdowns, we theorize counterfactually that COVID-19 is the ultimate root of damaged economic outcomes. Although lockdowns do impact consumer activity, without them, the rapidly accumulating infections and deaths would severely depress economic productivity and consumer confidence. This assertion challenges popular belief but holds theoretical credence for our proxy of economic outcomes, stock returns. The recent rise of GameStop Corporation (NYSE: GME) and AMC Entertainment Holdings' (NYSE: AMC) previously struggling stocks, as a result of a contrarian Reddit cadre, saliently displays the merits of the investor-sentiment driven stock return hypothesis (Phillips and Lorenz 2021; Baker and Wurgler, 2006); essentially, the stock market reflects beliefs about future cash flows, and the presence of COVID-19 worsens future-looking outlook due to the aforementioned factors. Consequently, we seek to situate ourselves empirically in this ongoing debate and understand how policy decisions affect nation-state economic variance through the following two questions:

- *What are the effects of increasing lockdown severity on stock returns and how has this relationship varied by nation-state?*
- *How are the unique impacts of COVID-19 on global economies mitigated or enhanced by lockdown policy?*

Based on our counterfactual theory, we hypothesize that increasing lockdown severity improves investor confidence that future stock returns will not be permanently harmed by the current pandemic (see Figure 1 for our theoretical path model). Further, we posit that through reducing infections and deaths, lockdowns significantly mitigate the economic impacts of COVID-19. We execute both an OLS regression and mediation analysis on time-series data to explore these assertions. Our results find evidence that lockdown severity maintains a small but significant, positive relationship with stock returns, and that lockdown policy partially mediates the relationship between COVID-19 rates and stock returns. Our empirical findings hold implications for future studies into lockdown efficacy or the enactment of public policy to deal with the epidemiological and economic challenges of COVID-19.

2 Literature Review

Numerous studies have parsed into the wide-reaching economic implications of the global COVID-19 pandemic. Hevia and Neumeyer (2020) theorize that emerging economies are affected by COVID-19 through the following 3 vectors: the reduction of labor and industry output due to non-pharmaceutical interventions (NPIs) such as lockdowns, the decreasing prices of exported commodities, and a capital outflow due to the global liquidity shock—all of which lead to depressed currency values. Lyocsa and Molnar (2020) utilize abnormal Google searches around key terms related to the pandemic to measure fear of COVID-19; their findings suggest that the larger this measure, the more likely the market sees negative auto-correlation. Similarly, Devpura and Narayan (2020) find that COVID-19 infections and deaths cause a 14 percentage point increase in oil price volatility. Other studies focus on corporate performance. Through an analysis of Chinese industry, Fu and Shen (2020) suggest that COVID-19 has significantly restricted revenue and investment scales. Shen et al. (2020) further analyze the pandemic's impact on the performance of the global energy sector, finding similar negative financial outcomes through the lever of depressed productivity.

Previous studies have also analyzed government responses to COVID-19, though many focus specifically on estimating compliance with lockdown policies. For example, Sheikh et al. (2020) suggest two novel methods for measuring compliance with stay at-home orders: mobile phone GPS and traffic congestion data but acknowledge their limitation of data accessibility. Kuiper et al. (2020) alternatively utilize more in-depth, but less-scalable online surveys to measure compliance with COVID-19 restrictions in the Netherlands. They find that compliance is correlated both with individual character traits, such as impulse-control and intrinsic motivation as well as societal normalization of compliance. The opportunity cost of remaining at home seems to bear a role along with behavioral and sociological factors in compliance with lockdown policy. Bonardi et al. (2020) analyze the impact of lockdown policy on the growth rate in total confirmed COVID-19 cases, concluding that lockdowns are fundamentally effective in reducing the growth of new cases and deaths and are more effective in nation-states where the cost of staying at home is lowest.

While a significant body of literature surveys the impacts of COVID-19 and preventative government policy responses separately, this research area is limited in its synthesis of the two together to empirically address the economic footprint of lockdowns. Arnon et al. (2020) utilize a hybridized compartmental model incorporating an epidemiological SEIR framework to find that lockdowns boosted unemployment rates in the United States. Coibion et al. (2020) expand upon this approach by evaluating the short-term economic impacts of COVID-19 lockdowns on both household spending and unemployment for over 10,000 US residents, finding detrimental relationships in both cases. Their research does carry the qualifier that household spending, a micro-level, variably-influenced measure of economic activity, might fail to accurately portray the holistic short-term effects of a COVID-19 lockdown. Other studies prioritize macroeconomic evaluations. Mandel and Veetil (2020) use a multisector disequilibrium model of the impacts of government policy actions in 44 nation-states to suggest that lockdowns convey negative effects on economic output both domestically and through international spillover relationships. Though samples at the nation-state level offer broader implications, the many assumptions and design controls required to normalize data can detract from the findings. Matching our approach, a few studies measure stock returns as a means to evaluate the economic outcomes of COVID-19 lockdowns. Narayan et al. (2020) use predictive regression models fitted to daily time-series data to show that lockdowns positively affected G7 stock markets. Davis et al. (2020), on the other hand, find evidence that stricter lockdown policies drive large declines in national stock prices conditional on pandemic severity, workplace mobility, as well as income support and debt relief policies. The discrepancy between these two studies likely results from the variation in the time range, set of nation-states, controls, and time-series approach used by each.

Our investigation into the existing literature on the economic impacts of COVID-19 lockdowns reveals the following limitations. First, many studies were published near the beginning of the pandemic and thus build theoretical, future-oriented models for their analysis rather than offering empirical insights. Furthermore, studies typically binarily classify lockdowns, obscuring the nuanced scale of lockdown severity that exists internationally and within nation-states. Finally, most studies are limited in scope, focusing on a single nation-state or a small subset of them. Our work contributes to the existing literature by providing an empirical approach that measures lockdown severity on a continuous scale, employing over a year's worth of daily observations, and utilizing a panel data set of over 20 nation-states.

3 Theory

The path model in Figure 1 further contextualizes our hypotheses through its representation of the relationship between COVID-19 rates, lockdown policy, and economic outcomes. As evidenced by the nodes in the model, we theorize that COVID-19 rates exert both a direct and indirect influence on economic outcomes, with lockdown policy facilitating the latter effect. Similarly, through the design of our model, we posit that a multitude of tertiary factors—which we control for in analysis—further complicate this interaction by affecting our three primary variables at the nation-state level. The extent to which COVID-19 impacts a given nation-state is partially dependent on the quality and accessibility of its healthcare system. We theorize that a government's political structure directly impacts the implementation and severity of its lockdown policy. Further, a litany of factors contribute to differential economic outcomes on the nation-state level agnostic of lockdown policy, including stimulus, citizen activity, and independent financial determinants. Economic stimulus affects citizens' ability to withstand the financial shock of the COVID-19 pandemic, while citizen activity, which is impacted by a fear of COVID-19, demographics such as age, and civil liberties afforded by nation-state governments, correlates with consumer transactions. Finally, various market factors including oil prices impact economic outcomes, or in our case, stock returns.

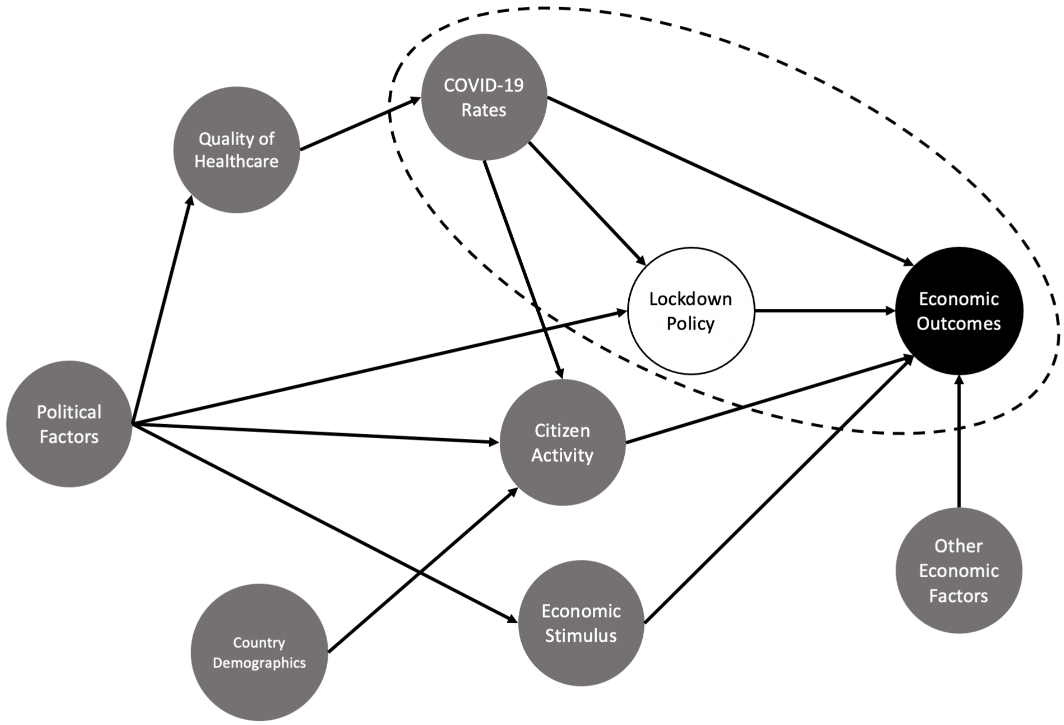

FIGURE 1: Path Model with Mediation Relationship of Focus Circled

4 Data and Methods

4.1 Data

Our independent variable, lockdown severity, is measured by a stringency index published in the University of Oxford's COVID-19 Government Response Tracker data set. This index is published daily for each nation-state and is a composite measure of nine lockdown response metrics, ranging from 0 to 100 (with 100 representing the strictest overall policy response). To account for potentially delayed effects of lockdown policy on stock returns, we calculate a seven-day rolling average of this index as the independent variable in our analysis.

To measure economic outcomes, our dependent variable, we pull stock data from Yahoo Finance, employing the daily closing price of the most prominent index for each nation-state in our scope. To address temporal auto-correlation of stock data, the measurement we include in our model is the percentage change from the previously available day.

We measure the infection rate of COVID-19 with smoothed new cases per million people from the Our World in Data COVID-19 database, which is averaged across a seven-day period to exclude short-term noise. Additionally, we employ a number of controls for exogenous demographic, healthcare, economic, and political factors within our analysis. These variables are drawn from sources including: Our World in Data COVID-19 Database, OECD, EIA, IMF, World Economics and Politics Database, Google COVID-19 Community Mobility Reports, and the Global State of Democracy Initiative.

Based on the availability of data from these sources, we focus on a scope of 24 nation-states, a combination of major economies and OECD countries, which we measure on a daily timescale between January 1, 2020 and March 9, 2021.

TABLE 1: Descriptive Statistics for Independent and Dependent Variables

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Lockdown Severity	9,292	58.901	20.597	0.000	48.811	72.690	100.000
Stock Returns (%)	6,463	0.050	1.888	−16.928	−0.690	0.943	13.908

4.2 Methods

Ordinary Least Squares Regression

To answer our first question about how lockdown severity impacts stock returns, we employ a standard OLS regression as shown in the following equation:

$$STOCKPC_{nt} = \beta_0 + \beta_1 LOCKAVG_{nt} + controls_{nt} + \varepsilon_{nt}$$

The subscripts n and t indicate that each observation represents a cross-sectional unit for a given nation-state and time, respectively. β_1, the coefficient of our independent variable, is our value of interest in this regression, with the null hypothesis being that its true mean is 0, which would indicate that lockdown severity has no effect on stock returns. We run this regression both on our panel data and on each nation-state in our sample.

As robustness checks, we further run a normalized regression and a random effects model. The normalized regression demeans and divides each variable by its standard deviation, then repeats the above regression. The resulting output is thus directly comparing the variance of the explanatory and dependent variables and, if similar to that of our primary regression, indicates that our analysis is not impacted by skewed variable distributions. Our random effects model analyzes how nation-state, categorized as a random variable, explains variance in our dependent variable. Here, we look for low explanatory power of our nation-state variable, which indicates that we have sufficiently controlled for factors, outside of lockdown severity, creating economic variance across nation-states.

Mediation Analysis

We utilize mediation analysis to address our second question about whether a nation-state's lockdown policy significantly mediates the effect that COVID-19 rates have on stock returns. This analysis involves the following two OLS regressions:

$$STOCKPC_{nt} = \beta_0 + \beta_1 COVIDRATE_{nt} + \beta_2 LOCKAVG_{nt} + controls_{nt} + \varepsilon_{nt}$$

$$STOCKPC_{nt} = \beta_0 + \beta_3 COVIDRATE_{nt} + controls_{nt} + \varepsilon_{nt}$$

In the above equations, β_3 is the total effect of COVID-19 rates on stock returns, without accounting for lockdown severity. β_1 is the average direct effect of COVID-19 on stock returns controlling for lockdown severity. We then use these regressions to estimate the value of the average causal mediation effect (ACME), $\beta_{indirect}$, calculated as $\beta_3 - \beta_1$. Further, we estimate what percentage of the effect of COVID-19 rate on stock returns is mediated by lockdown severity by calculating $\beta_{indirect}/\beta_3$. We estimate a 95% confidence intervals for each of the listed coefficients by using a bootstrap simulation for 1000 iterations.

We then employ a sensitivity analysis as a robustness check. This analysis finds the relationship between the ACME and two sets of values: the correlation of the error terms in the mediating and output regressions as well as the proportions of total variance in the mediator and the outcome variables, which would be explained by an unobserved confounder. This analysis seeks to quantify how unobserved confounding variables would obscure our ability to measure the ACME; if a quantitatively high level of confounding is necessary to affect our found mediation effect, our analysis will correspondingly maintain robustness.

5 Results

5.1 OLS Regression

As seen in Table 2, our primary OLS regression finds a positive and statistically significant relationship between lockdown severity and stock returns. Our coefficient of interest indicates that in our model a one point increase in lockdown severity corresponds with a 0.018 percentage point increase in stock returns. Therefore, for our primary OLS regression, we reject the null hypothesis that lockdown severity has no significant effect on stock returns. Repeating this regression for each nation-state finds statistically significant results for 13 out of 24 nation-states at the 90% confidence level, with 12 possessing a similarly positive relationship between lockdown severity and stock returns and one possessing a negative relationship (Table B2) . All significant coefficients possessed a magnitude within a factor of 10 of our primary coefficient of interest. This analysis provides additional confidence that our results are not skewed by a few extreme cases as nearly all nation-states matched the sign and relative magnitude of our primary regression coefficient.

Our normalized regression similarly finds a positive, statistically significant relationship between lockdown severity and stock returns. This finding establishes our analysis' robustness to skewed variable distributions. Further, being mindful of the potential for omitted variable bias within our OLS regression, we considered several controls unique to the history of nation-states. Our random effects model by nation-state finds that variance in stock returns explained by nation-state approaches 0. Additionally, the coefficient of lockdown severity, 0.02, is similar to that of our primary regression. Thus, we are reasonably confident that we appropriately capture the differential qualities of nation-states that could feed into our theoretical framework.

TABLE 2: Controlled Regression Coefficients for Independent Variable

	Stock Return Change (%)		
	Standard OLS	*Normalized OLS*	*Random Effects*
	(1)	(2)	(3)
Lockdown Severity	0.018***	0.192***	0.020***
	(0.002)	(0.024)	(0.002)
Constant	−4.235***	−0.020	−0.293
	(1.254)	(0.013)	(3.132)
Controls Present?	Yes	Yes	Yes
Observations	5,886	5,886	5,886
R^2	0.039	0.039	
Adjusted R^2	0.036	0.036	
Log Likelihood			−12,218.840
Akaike Inf. Crit.			24,483.690
Bayesian Inf. Crit.			24,637.340
Residual Std. Error (df = 5865)	1.904	1.008	
F Statistic (df = 20; 5865)	11.908***	11.908***	

Note: Control coefficients displayed in Table B1. *p<0.1; **p<0.05; ***p<0.01

5.2 Mediation Analysis

From our mediation analysis treating lockdown severity as a mediator between COVID-19 rates and stock returns, we find a positive, statistically significant ACME as seen in Figure 2. This value suggests that lockdown severity partially mediates the effects COVID-19 rates have on stock returns. Further, we observe that 42.8% of the effect of COVID-19 rates on stock returns is mediated by lockdown severity calculated by dividing the ACME by the total effect. Thus, in a typical nation-state, with mean new COVID-19 case and lockdown severity rates of 109 and 69 respectively, holding controls constant, sees an overall indirect effect, a function of new cases mediated by lockdown severity, of 0.646.

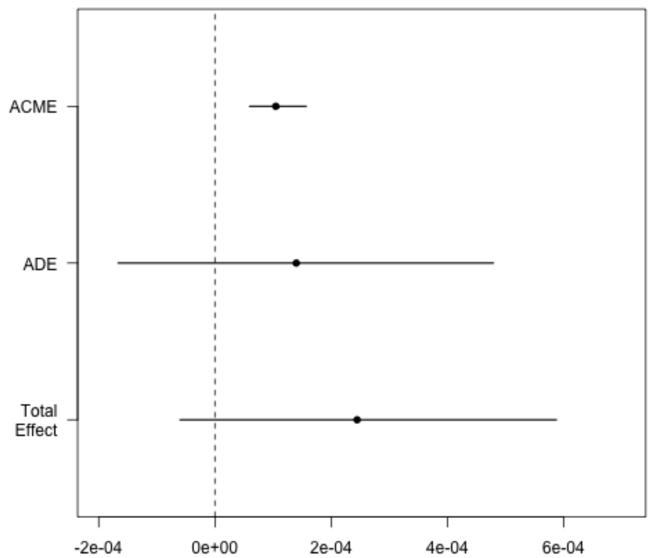

FIGURE 2: Mediation Analysis Estimates of ACME, ADE, and Total Effect

TABLE 3: Mediation Analysis Results

	Estimates
ACME	0.000105***
ADE	0.00012
Total Effect	0.000244
Proportion Mediated	0.428
Sample Size Used	5,886
Simulations	1,000

*p<0.1; **p<0.05; ***p<0.01

Figures 3 and 4 display our sensitivity analysis results. Figure 3, estimates the ACME as 0 when ρ, the correlation of the error terms in the mediating and output regressions, equals approximately 0.15. The lower bound of the 90% confidence interval of the ACME similarly reflects this result. In simple terms, the farther ρ is from 0 when the ACME crosses the x-axis, the more robust the model, as a greater presence of confounding bias is necessary to obscure the causal mediating effect. Figure 4 plots the proportions of total variance in the mediating and outcome variables, which would be explained by an unobserved confounder, against contour lines representing the ACME. The bold line, representing the values at which ACME is estimated as 0, indicates that an unobserved confounder must explain 5% of variance in both lockdown severity, the mediating variable, and stock returns, the dependent variable. Together, these findings indicate a reasonable level of robustness for our ACME, especially given our tight confidence interval in Figures 3; however, they leave open the possibility that our analysis is sensitive to confounders. This confounding could be a result of our imperfect measure of citizen compliance, as mobility data captures absolute movement, not whether movement is congruent with the presiding lockdown policy. Additionally, we are unable to account for the potential circularity between lockdown severity and COVID-19 rates. A larger sample size in terms of both nation-states and temporal observations would be instrumental in justifying the robustness of this analysis.

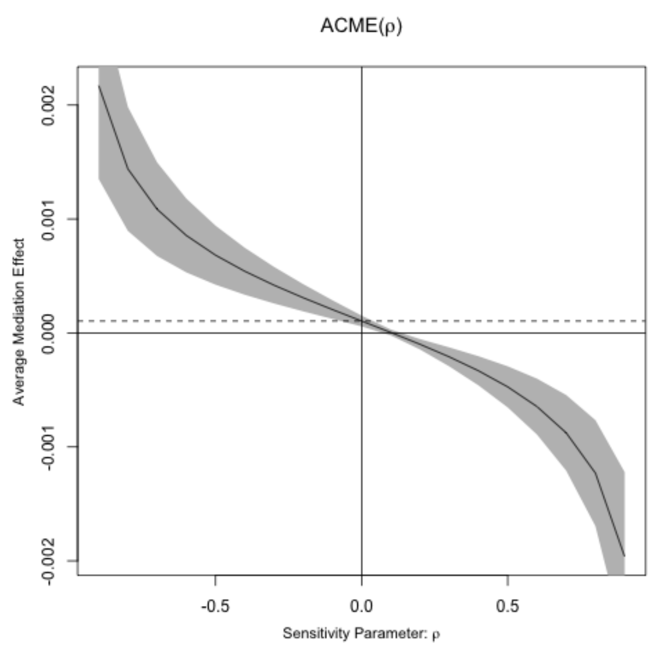

FIGURE 3: Sensitivity With Respect to Error Correlation

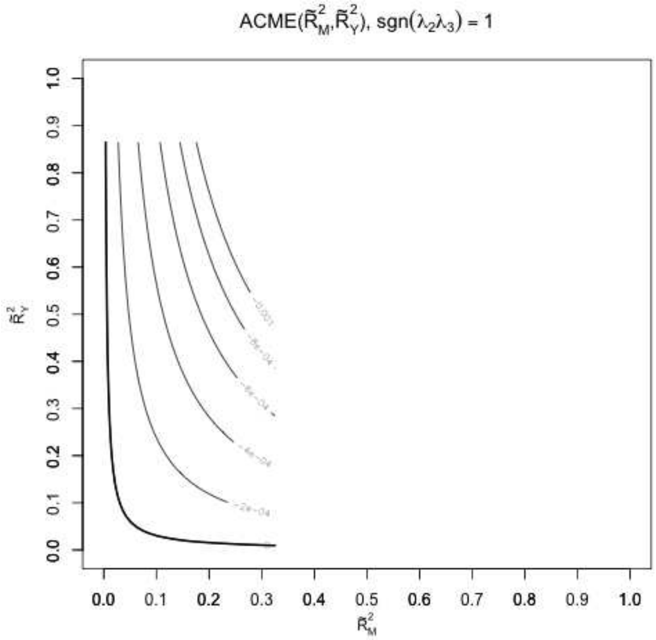

FIGURE 4: Sensitivity With Respect to Proportion of Variance Explained

6 Discussion

The first OLS regression suggests that increasing lockdown severity has a slight positive effect on changes in stock prices. While this may seem counterintuitive, it is important to keep in mind that stock prices reflect what investors believe future cash flows will be. Thus, while initial declines in economic activity brought on by stricter lockdowns may harm other measures, if investors feel like short-term losses will be offset by future gains, this sentiment will be reflected positively in stock prices. By increasing lockdown severity, governments may increase investor confidence that the spread of COVID-19 will decrease and that the economy will eventually return to normalcy, which would have a positive effect on expectations for future cash flows. This finding possibly suggests that, in order to improve their nation's stock returns, governments should continue enacting severe lockdown measures in reaction to the high case counts of COVID-19, at least until there has been adequate distribution of the vaccine.

When the OLS regression was run on each nation-state separately, this effect remained positive and statistically significant for half of our sample. The lack of significance in other nations can potentially be attributed to data availability issues in our findings or a lack of variance in the independent variable, lockdown severity. Overall, this consistency suggests that our results could be generalized to nation-states outside of our scope. However, given our focus on OECD countries and major economies, these results may not apply to less developed nation-states. In future work, it would be useful to broaden our scope to include nation-states with a wider range in development and income levels in order to determine if this positive relationship is consistent on a global scale.

The results of the mediation analysis also match our initial hypothesis and heighten findings for the theory that lockdowns partially mediate the impact that COVID-19 has on stock returns. However, it is worth noting this mediation's partial nature. One possible explanation could be that the ultimate impact of lockdown policies on the spread of COVID-19 is dependent on citizen compliance. Thus, if citizens fail to comply with lockdown measures, cases will still rise, correspondingly harming stock returns. Likewise, if investors doubt that people within their nation-state will follow these regulations, this doubt may reduce their existing positive sentiment for future cash flows, preventing a full mediation of COVID-19's effect. While we attempt to control for citizen compliance to lockdown policy using a proxy of Google Mobility Data, future research should employ additional measurements to better determine how compliance affects our relationship of interest.

It is necessary to keep in mind that these results are only based on a single component of the economy: the stock market. Economic outcomes can be measured through several distinct factors, and to get a holistic view of the true economic impacts of lockdowns, each must be considered. We initially considered measuring the impact of lockdowns on additional factors — including GDP, unemployment, and consumption data — but data was only accessible at infrequent time intervals; given our one-year time frame, our models would not have been able to produce meaningful results. Future work could implement our approach with these additional measurements.

7 Limitations

There are a few limitations to our approach that need to be addressed. First, there plausibly exists a feedback relationship between lockdowns and COVID-19 rates, with more severe lockdowns eventually decreasing the spread of COVID-19, but our approach does not control for this potential feedback loop. The time range of our analyses spans only seven days, however, so this issue would not significantly complicate the short-term economic results we find. While we looked at 24 nation-states, which is a larger scope than most comparable studies, our sample size was limited by accessibility to reliable data, particularly stock indexes.

Our analysis is also subject to certain oversimplifications. Within nation-states, certain regions might impose significantly different lockdown restrictions or see other forms of variance. For instance, in the United States, lockdown policy and COVID-19 rates vary tremendously by state; however, these variances are ignored when aggregated to a single nation-state-level measurement. Similarly, the lockdown index is calculated from nine different policy metrics but may obscure the unique economic impact of each one individually. Further analyses could distinguish each of these metrics to isolate their distinct effects.

8 Conclusion

This paper investigates the relationship between lockdown severity and stock returns on an international scale in a two-part approach. Our results contribute to an evolving body of research and expands on existing studies by utilizing over a year's worth of daily observations, including a scope of over 20 nation-states, and considering a nuanced measurement of lockdown severity. Through an OLS regression, we first find evidence that suggests increasing lockdown severity has a slight positive effect on stock returns and that this effect is generally consistent across different nation-states. Then, through mediation analysis, we find that lockdowns partially mediate the impact that COVID-19 rates have on stock returns. Our findings exhibit reasonable robustness to several checks and are significant for 13 out of the 24 nation-states in our sample, with only one exhibiting a negative correlation.

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Appendix

Appendix A: Data

Description A1: Codebook

Our codebook as well as data, scripts, and visualization for full replication of this paper can be found here.

Description A2: Additional Information on the Independent Variable

The Stringency Index that is used as the independent variable in our analysis is calculated by the Oxford Coronavirus Government Response Tracker (OxCGRT) project as a composite measure of nine out of the 19 response metrics that they track. These nine metrics are:

1. School closures
   0 - no measures
   1 - recommend closing or all schools open with alterations resulting in significant differences compared to non-COVID-19 operations
   2 - require closing (only some levels or categories, e.g. just high school, or just public schools)
   3 - require closing all levels
2. Workplace closures
   0 - no measures
   1 - recommend closing (or recommend work from home)
   2 - require closing (or work from home) for some sectors or categories of workers
   3 - require closing (or work from home) for all-but-essential workplaces (eg grocery stores, doctors)
3. Cancellation of public events
   0 - no measures
   1 - recommend cancelling
   2 - require cancelling
4. Restrictions on gatherings
   0 - no restrictions
   1 - restrictions on very large gatherings (the limit is above 1000 people)
   2 - restrictions on gatherings between 101-1000 people
   3 - restrictions on gatherings between 11-100 people
   4 - restrictions on gatherings of 10 people or less
5. Closure of public transportation
   0 - no measures

1 - recommend closing (or significantly reduce volume/route/means of transport available)
2 - require closing (or prohibit most citizens from using it)

6. Stay at home requirements
0 - no measures
1 - recommend not leaving house
2 - require not leaving house with exceptions for daily exercise, grocery shopping, and 'essential' trips
3 - require not leaving house with minimal exceptions (e.g. allowed to leave once a week, or only one person can leave at a time, etc)

7. Restrictions on internal movement
0 - no measures
1 - recommend not to travel between regions/cities
2 - internal movement restrictions in place

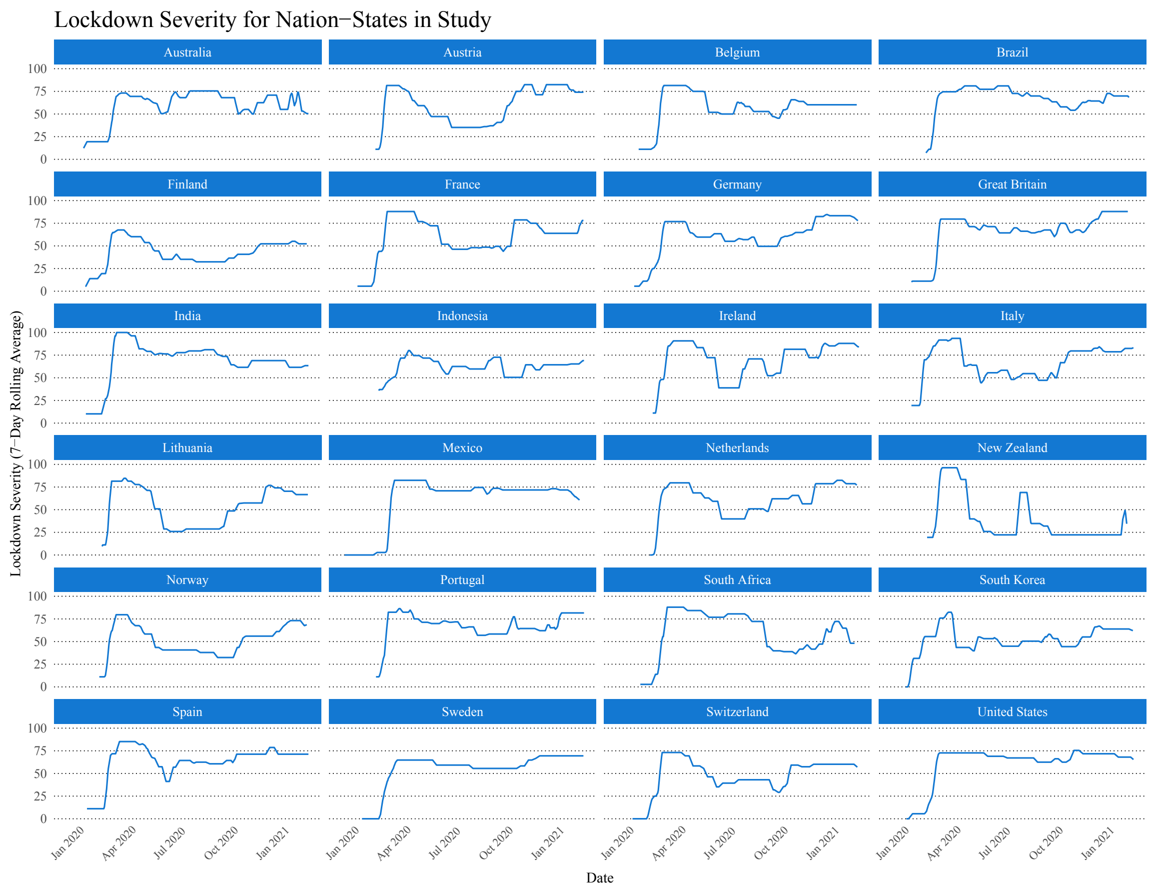
8. International travel controls
0 - no restrictions
1 - screening arrivals
2 - quarantine arrivals from some or all regions
3 - ban arrivals from some regions
4 - ban on all regions or total border closure

9. Public info campaigns
0 - no COVID-19 public information campaign
1 - public officials urging caution about COVID-19
2 - coordinated public information campaign (e.g. across traditional and social media)

The index on any given day is calculated as the mean score of the nine metrics, each taking a value between 0 and 100. For a more detailed description of the calculation: they calculate the per-indicator score $I_{j,t}$ for any given indicator j on a given day t with maximum value of the indicator N_j, recorded policy value on the ordinal scale $v_{j,t}$, recorded binary flag for the indicator $f_{j,t}$, and a binary variable for whether or not that variable has a corresponding flag variable F_j is:

$$I_{j,t} = 100 * \frac{v_{j,t} - .5(F_j - f_{j,t})}{N_j}$$

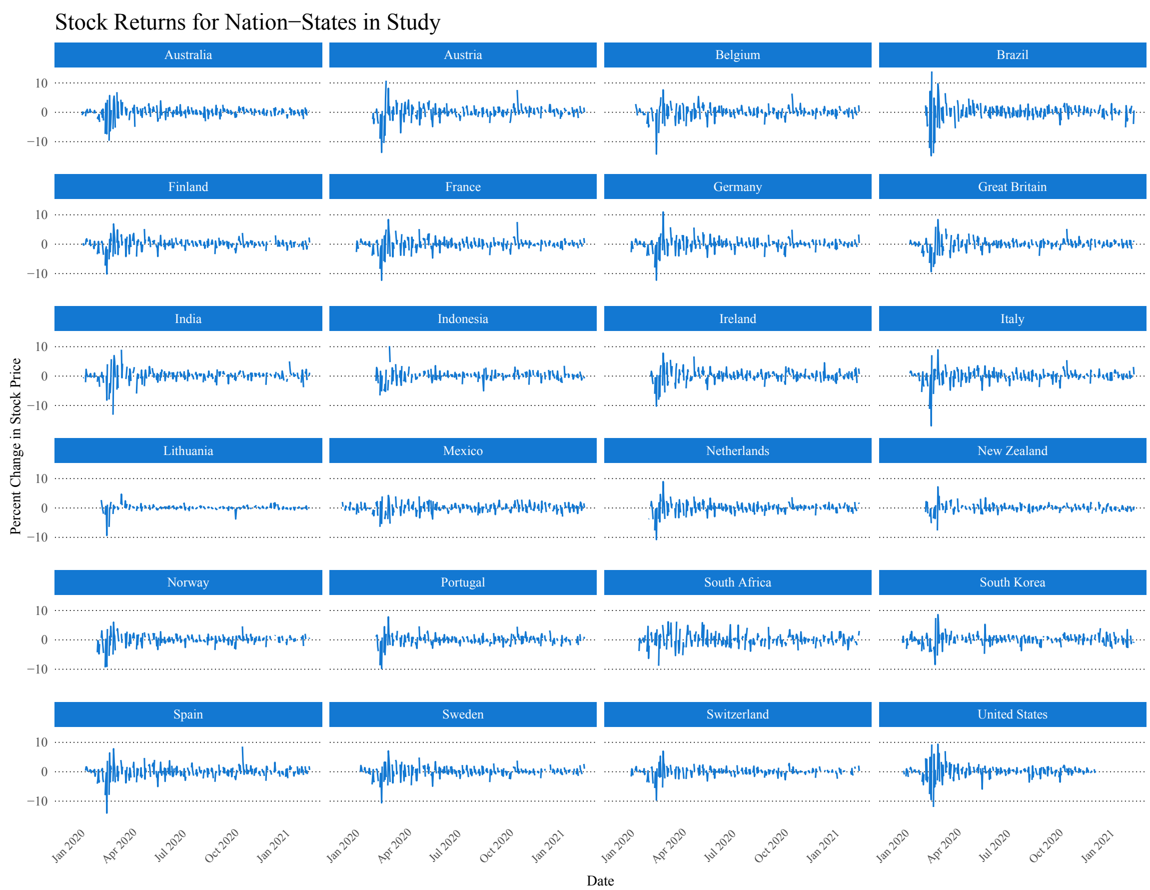
These per indicator scores are calculated for each of the above indicators, and the composite index is a simple average of all the indicator scores. A higher score indicates a stricter response (i.e. 100 = strictest response), and in the case that policies vary at the subnational level, the index selects the response level of the strictest sub-region. This description comes from information gathered on the Oxford COVID-19 Government Response Tracker "covid-policy-tracker" GitHub Repository and from the Our World in Data website.



Description A3: Stock Index Selected per Nation-State

1. Australia - S&P/ASX 300
2. Belgium - BEL 20
3. Brazil - IBOVESPA
4. Switzerland - SMI
5. Germany - DAX
6. Spain - IBEX 35
7. Finland - OMXH25
8. France - CAC 40
9. United Kingdom - FTSE 250
10. Indonesia - Jakarta Composite Index
11. India - S&P BSE SENSEX

12. Ireland - ISEQ 20
13. Italy - FTSE MIB
14. South Korea - KOSPI
15. Lithuania - OMX Vilnius GI
16. Mexico - IPC / “Bolsa Index”
17. Netherlands - AEX
18. Norway - Oslo Bors All-Share IndexGI
19. New Zealand - NZX 50 Index
20. Portugal - PSI-20
21. Sweden - OMXS30
22. United States - S&P 500
23. South Africa - JSE



Description A4: Control Variable Selection

For our regressions, we derive COVID-19 case data from the Our World in Data COVID-19 database. More specifically, we use their smoothed COVID-19 case data. This data is smoothed across a 7-day period and enables us to gather accurate case data while excluding noise that might harm analysis.

We employ a number of controls for exogenous demographic, healthcare, economic, and political factors within our analysis. The majority of these variables are drawn from the Our World in Data COVID-19 database, with population distribution and healthcare spending drawn from OECD, and oil prices drawn from the U.S. Energy Information Administration (EIA). Demographically, we control for the share of a nation-state's population living in urban areas and its human development index. The human development index aggregates salient features of nation development including education, standard of living, and health.

In determining healthcare controls, we consider the accessibility of a nation-state's healthcare systems. Healthcare accessibility is measured using a nation-state's healthcare hospital beds per 1000 people. While we originally expected to control for vaccination roll-out, the recency with which the vaccine became available severely limited data availability for this variable.

Our economic controls include oil prices, sectoral composition, and COVID-19 stimulus spending. We calculate oil prices from the WTI daily crude oil spot price. We obtain sectoral composition data from the World Bank, using percentages of GDP that originate in the agriculture, service, manufacturing, and industry sectors. Lastly, we measure COVID-19 stimulus spending as the percentage of GDP these packages make up since the start of the pandemic.

Regarding political factors, we control for government fractionalization and polity score. Government fractionalization refers to the extent that a nation-state's political system is divided into ideological subsets. On the other hand, polity score evaluates a nation-state's political efficacy on an individual level, aggregating citizen access to justice, civil liberties, and social equality into one index.

Finally, we proxy citizen activity amidst the presence of lockdowns by using Google mobility data. This data displays the total number of visitors to various types of locations including residential areas, parks, and grocery stores in a time-series capacity. In establishing our proxy, we only focus on visitors to retail, recreation, and residential areas on the assumption that the nature of travel to these location classifications remains primarily non-essential.

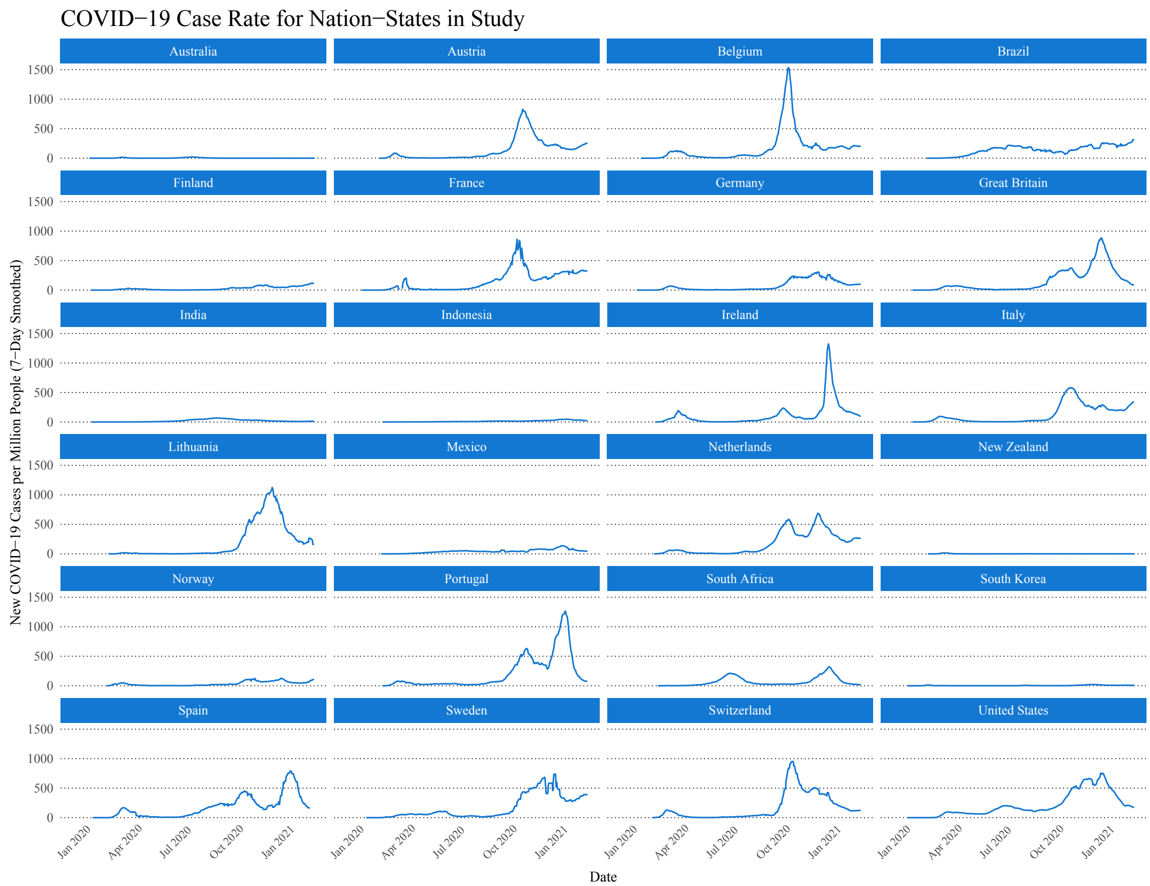

COVID−19 Case Rate for Nation−States in Study
Australia
Austria
Belgium
Brazil
Finland
France
Germany
Great Britain
India
Indonesia
Ireland
Italy
Lithuania
Mexico
Netherlands
New Zealand
Norway
Portugal
South Africa
South Korea
Spain
Sweden
Switzerland
United States
0
500
1000
1500
New COVID−19 Cases per Million People (7−Day Smoothed)
Jan 2020
Apr 2020
Jul 2020
Oct 2020
Jan 2021
Date

Table A1: Descriptive Statistics for Lockdown Severity by Nation-State

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Australia	402	59.620	16.905	12.300	53.851	70.830	75.460
Austria	372	59.327	19.977	11.110	38.627	77.780	82.410
Belgium	390	57.256	17.281	11.110	51.850	63.890	81.480
Brazil	363	67.992	13.346	7.146	63.956	77.112	81.020
Finland	396	42.756	13.946	5.560	34.144	52.310	67.590
France	404	59.623	21.295	5.560	47.951	75.859	87.960
Germany	400	60.496	19.603	5.560	55.090	76.850	84.659
Great Britain	387	65.775	21.049	10.316	65.011	79.630	87.960
India	398	68.622	21.389	10.190	63.425	79.630	100.000
Indonesia	367	62.259	8.798	35.849	58.800	68.060	80.090
Ireland	369	70.560	19.048	11.110	55.487	85.846	90.740
Italy	397	66.664	17.823	19.440	54.630	79.630	93.520
Lithuania	368	53.494	21.154	9.523	28.700	72.389	84.657
Mexico	420	59.515	28.569	0.000	68.619	73.150	82.410
Netherlands	370	61.497	17.658	0.000	50.930	78.700	82.410
New Zealand	357	38.199	24.568	19.440	22.220	39.810	96.300
Norway	371	51.570	16.348	11.110	40.740	65.940	79.630
Portugal	372	67.710	13.584	11.110	63.031	76.453	86.374
South Africa	383	59.798	23.945	2.780	41.670	80.560	87.960
South Korea	406	52.389	13.097	0.000	44.910	61.956	82.410
Spain	396	63.532	18.509	11.110	60.650	71.300	85.190
Sweden	396	55.499	18.848	0.000	55.560	64.810	69.440
Switzerland	402	47.754	18.752	0.000	39.350	60.190	73.150
United States	406	61.640	20.354	0.000	64.518	71.760	75.460

Table A2: Descriptive Statistics for Change in Stock Price (%) by Nation-State

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Australia	284	0.001	1.786	−9.678	−0.687	0.817	6.861
Austria	262	0.039	2.316	−13.649	−0.853	1.107	10.744
Belgium	279	0.045	1.999	−14.211	−0.785	1.088	7.638
Brazil	251	0.071	2.803	−14.780	−1.173	1.388	13.908
Finland	276	0.057	1.728	−10.128	−0.536	0.953	6.892
France	288	0.017	1.952	−12.277	−0.689	0.897	8.389
Germany	284	0.042	1.995	−12.239	−0.671	0.964	10.976
Great Britain	280	0.018	1.839	−9.353	−0.762	0.895	8.371
India	273	0.091	2.003	−13.153	−0.542	0.961	8.975
Indonesia	246	0.067	1.711	−6.579	−0.698	0.829	10.191
Ireland	261	0.114	2.004	−10.216	−0.782	1.094	7.805
Italy	281	0.024	2.124	−16.928	−0.732	1.053	8.927
Lithuania	258	0.089	1.012	−9.366	−0.175	0.415	4.701
Mexico	298	0.038	1.504	−6.423	−0.728	1.006	4.269
Netherlands	264	0.072	1.754	−10.753	−0.590	0.974	8.971
New Zealand	256	0.026	1.341	−7.639	−0.611	0.632	7.183
Norway	250	0.077	1.782	−9.364	−0.612	1.118	6.016
Portugal	252	0.023	1.687	−9.758	−0.847	0.964	7.823
South Africa	273	0.042	2.065	−8.817	−1.047	1.136	6.217
South Korea	279	0.114	1.797	−8.394	−0.803	1.083	8.601
Spain	282	−0.013	2.065	−14.059	−0.997	1.053	8.573
Sweden	273	0.077	1.736	−10.571	−0.563	0.920	7.089
Switzerland	274	0.020	1.476	−9.637	−0.474	0.690	7.016
United States	239	0.074	2.228	−11.984	−0.655	1.049	9.383

Table A3: Descriptive Statistics for Control Variables Used in Analysis

Statistic	N	Mean	St. Dev.
Agriculture Sector Share of GDP	9,518	3.056	3.636
Industry Sector Share of GDP	9,518	24.193	5.777
Manufacturing Sector Share of GDP	9,518	14.162	5.618
Service Sector Share of GDP	9,518	63.446	7.005
Political Fractionalization Index	9,518	72.486	11.436
Share of Population Older Than 65	9,518	15.910	5.412
New COVID-19 Cases Per Million People	9,266	108.991	180.243
New COVID-19 Deaths Per Million People	9,266	2.475	3.669
Human Development Index	9,518	88.350	8.797
Retail and Recreational Mobility	9,124	−28.148	22.095
Residential Mobility	9,124	9.857	6.971
Oil Spot Price	6,386	39.996	11.802
Total Stimulus Spending as % of GDP	9,518	7.219	4.937
Healthcare Spending as % of GDP	9,518	9.212	2.800
New COVID-19 Vaccinations Per Million People	9,518	210.789	709.952
GDP Per Capita	9,518	37,332.980	15,930.720
Polity Score	9,518	79.097	12.096
Hospital Beds per 1000 People	9,518	3.949	2.574
Population Density (Log)	9,518	4.413	1.286

Appendix B: Results

Table B1: OLS Regression Results for Control Variables (*Table 2 Supplement*)

	Stock Returns (%)		
	Standard OLS (1)	*Normalized OLS* (2)	*Random Effects* (3)
Agriculture GDP Share (%)	0.024	0.047	0.020
	(0.017)	(0.034)	(0.030)
Industry GDP Share (%)	−0.003	−0.008	0.002
	(0.013)	(0.040)	(0.024)
Manufacturing GDP Share (%)	−0.004	−0.012	−0.005
	(0.008)	(0.025)	(0.014)
Services GDP Share (%)	−0.017	−0.061	−0.008
	(0.014)	(0.053)	(0.023)
Fractionalization Index	0.0001	0.001	0.001
	(0.003)	(0.019)	(0.005)
Population Aged 65 and Older (%)	−0.025*	−0.072*	−0.016
	(0.015)	(0.043)	(0.022)
New Cases per Million Smoothed	0.0001	0.013	0.0001
	(0.0002)	(0.018)	(0.0002)
New Deaths per Million Smoothed	−0.023**	−0.044**	−0.021*
	(0.011)	(0.021)	(0.011)
Human Development index	0.043***	0.202***	0.058
	(0.017)	(0.077)	(0.042)
Retail and Recreation Mobility	−0.004	−0.047	−0.003
	(0.003)	(0.040)	(0.004)
Residential Mobility	0.013	0.049	0.014
	(0.011)	(0.041)	(0.012)
Oil Spot Price	0.013***	0.080***	0.013***
	(0.003)	(0.018)	(0.003)
Stimulus Spending GDP Share (%)	−0.016*	−0.042*	−0.015
	(0.009)	(0.024)	(0.015)
Healthcare Spending GDP Share (%)	0.055**	0.082**	0.046
	(0.025)	(0.037)	(0.040)

Note: Table continues on next page. *p<0.1; **p<0.05; ***p<0.01

Table B1 (*Continued from Previous Page*):

	Stock Returns (%)		
	Standard OLS	*Normalized OLS*	*Random Effects*
	(1)	(2)	(3)
New Vacc. per Million Smoothed	−0.0002***	−0.090***	−0.0003***
	(0.0001)	(0.021)	(0.0001)
GDP Per Capita	−0.00001**	−0.104**	*(NA)*
	(0.00001)	(0.052)	
log(GDP Per Capita)	*(NA)*	*(NA)*	−0.617
			(0.594)
Polity Score	0.005	0.029	0.003
	(0.007)	(0.045)	(0.011)
Hospital Bed Capacity	0.008	0.011	0.017
	(0.020)	(0.027)	(0.030)
log(Population Density)	−0.029	−0.020	−0.040
	(0.033)	(0.022)	(0.054)
Constant	−4.235***	−0.020	−0.293
	(1.254)	(0.013)	(3.132)
Observations	5,886	5,886	5,886
R^2	0.039	0.039	
Adjusted R^2	0.036	0.036	
Log Likelihood			−12,218.840
Akaike Inf. Crit.			24,483.690
Bayesian Inf. Crit.			24,637.340
Residual Std. Error (df = 5865)	1.904	1.008	
F Statistic (df = 20; 5865)	11.908***	11.908***	

Note: (NA) means control excluded from regression in favor of opposite (logged or normal) version of same control. *p<0.1; **p<0.05; ***p<0.01

Table B2: OLS Regression Coefficients by Country

	Coefficients
Australia	0.0188
Austria	0.0848***
Belgium	0.0432***
Brazil	0.0611*
Finland	0.0788***
France	0.0209
Germany	0.0442***
Great Britain	0.0296***
India	-0.0166
Indonesia	0.0106
Ireland	0.0079
Italy	-0.0358*
Lithuania	0.0120
Mexico	0.0221*
Netherlands	0.0206
New Zealand	0.0150
Norway	0.0575***
Portugal	0.0399***
South Africa	0.0012
South Korea	0.0195
Spain	0.0281**
Sweden	0.0273***
Switzerland	0.0341*
United States	0.0021
Sample Size Used	5,886

*p<0.1; **p<0.05; ***p<0.01