# COVID-19 Lockdown Intensity and Stock Market Returns: A Spatial Econometrics Approach

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26 May 2020

**COVID-19 lockdown intensity and stock market returns: A spatial econometrics approach**

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## Abstract

We investigate the impact of governments' social distancing measures against the novel coronavirus disease 2019 (*COVID-19*) on 45 major stock market indices. We find evidence of negative direct and indirect (spillover) effects for the initial period of containment measures (lockdown).

**JEL classifications**: C23, G15, I18

**Keywords**: COVID-19; government policy responses; spillover effects; stock market volatility

## 1. Introduction

The coronavirus disease 2019 (*COVID-19*) outbreak shocked the world and triggered an unprecedented wave of economic uncertainty in stock markets around the globe.

The confinement measures that were utilized by governments limited economic activity for months. While the economic consequences of the pandemic cannot be fully estimated yet, their extent will depend not only on the direct effects of the lockdown measures, but also on the spillover effects that these measures have on trade and financial partners.

The way the international community handled the *COVID-19* outbreak is unprecedented in the history of pandemics, due to the synchronized global lockdown which traumatized financial markets. In addition, the risk of multiple waves of lockdowns remains and until a vaccine or a suitable treatment is adopted, economic agents will behave with extreme caution, since they will expect that the recession will persist for several time periods (Kohlscheen et al., 2020).

In this note, we contribute to two strands of the literature. The first is the growing literature of the novel *COVID-19* pandemic and its side effects on international stock markets (Zhang et al., 2020; Zaremba et al., 2020). The second is the literature of international stock market spillovers. The outbreak offers a unique opportunity to assess the impact of an exogenous shock (infectious disease) on the stock markets by estimating the effect the containment measures had on these markets.

In order to evaluate the spillovers of the lockdown measures, we account for two alternative transmission mechanisms (trade and financial channels), thus being in line with Boissay and Rungcharoenkitkul (2020) who highlight the need for understanding the different transmission channels of the *COVID-19* shock to the economy.

We utilize spatial econometric techniques to account for both the direct and the indirect effects of the *COVID-19* social distancing measures and analyze the negative impact the latter had on international stock markets. In such a way, we can better assess the policy trade-offs that the governments had to undertake in their attempt to control the spread of the epidemic.

Our work follows the lines of Asgharian et al. (2013) who study financial markets co-movements and market sensitivity to exogenous shocks. To the best of the authors' knowledge, this is the first empirical assessment of the spillover effects of *COVID-19* containment measures on international stock markets.

## 2. Methodology

We estimate a dynamic Spatial Durbin Model (DSDM) with fixed effects, which enables us to account for the increased degree of interdependency between stock markets. This specification also allows us to control for omitted variable bias. Specifically, the dynamic nature of our model accounts for time-varying omitted variables (autoregressive approach; see Wooldridge, 2002), while time-invariant omitted variables are modeled through the fixed effects specification (see Baltagi, 2005). Two variants of the DSDM are estimated: one with and one without the spatial lag of the time lag of the dependent variable.

We use MLE (Maximum Likelihood Estimation) to estimate our spatial model. MLE is the preferred estimation method for our specification since it alleviates the endogeneity problem caused by the inclusion of the spatial autoregressive variable and the time lagged dependent variable (Elhorst, 2005; Lee & Yu, 2010). The need for a spatial specification is tested through the Pesaran test for cross-sectional dependence (Pesaran, 2004). The null hypothesis of cross-section independence is rejected for all variables indicating the need for a spatial specification (the corresponding results are available upon request).

## 3. Trade and financial linkages

To construct the interaction matrix ($W$), we consider two different market interconnectedness mechanisms. The trade relations mechanism, according to which trade partners with more intense trade flows have correlated business cycles (Frankel and Rose, 1998) and the degree of financial integration (as proxied by the portfolio foreign holdings of each country). The data for the construction of the trade relations (financial linkages) matrix were retrieved from the World Bank's WITS database (the IMF's Coordinated Portfolio Investment Survey) for the year 2018 (2019).

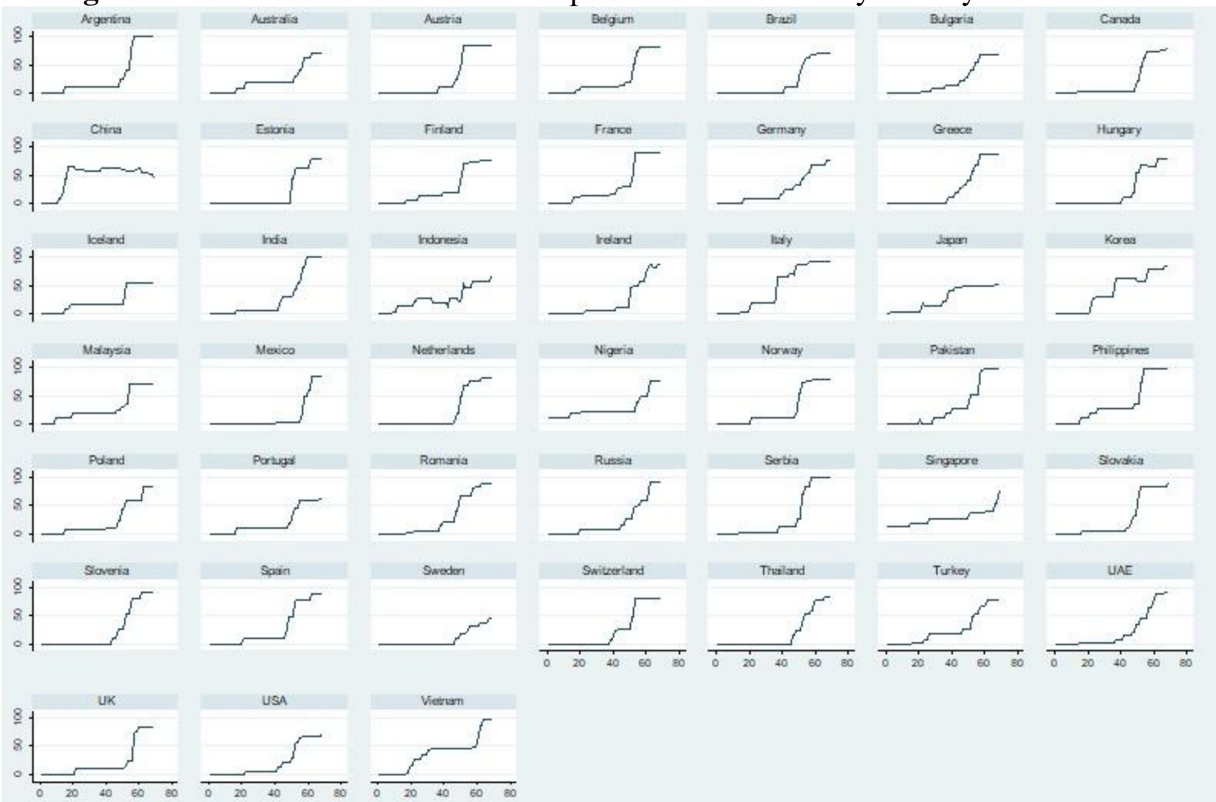
## 4. Data and descriptive statistics

The dataset used is a balanced panel that spans from January 1$^{st}$ to April 8$^{th}$ 2020. The dependent variable (*smi*) consists of the daily stock market index returns.

The corresponding data were retrieved from investing.com and finance.yahoo.com websites.

The independent variable (*cgr*) is the daily relative change [1] of the Coronavirus Government Response Tracker index (Hale et. al, 2020). The values of this index range from 0 (no lockdown measures in place) to 100 (total lockdown). An overview of the data about the aforementioned index is presented in Figure 1, while the descriptive statistics for both variables are reported in Table 1.

**Figure 1:** Coronavirus Government Response Tracker index by country




Notes: Each graph illustrates the Coronavirus Government Response Tracker index by each country. The horizontal axis depicts the time dimension and the vertical axis the corresponding index.

Since we use a high frequency dataset over a short time period, we do not control for other global factors and macroeconomic fundamentals (data unavailability and zero variance issues).[2]

[1] The midpoint relative change ( $\Delta x / \bar{x}$ ) was used in order to avoid issues related to infinite percentage changes when lockdown measures are first introduced.

[2] Exchange rates are the only exception. However, the inclusion of exchange rates in our specification did not change qualitatively our results.

**Table 1**: Descriptive statistics

| Variables | Obs. | Mean | Standard deviation | Min. | Max. |
|---|---|---|---|---|---|
| Stock market index returns (*smi*) | 3,105 | -0.0038 | 0.0284 | -0.1854 | 0.1302 |
| Relative change of Coronavirus government response index (*cgr*) | 3,105 | 0.062 | 0.274 | -2 | 2 |

Notes: The countries included in our analysis are the following: Argentina, Brazil, Canada, Mexico, USA, Nigeria, Austria, Belgium, Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Greece, Hungary, Bulgaria, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, UK, China, India, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Singapore, Thailand, UAE, Vietnam and Australia.

## 5. Results and discussion

Our estimation results (Table 2) indicate a negative relationship between stock market returns and changes in the intensity of *COVID-19* containment measures (columns 2 through 5). In particular, an increase in the intensity of *COVID-19* non-pharmaceutical interventions in a given country leads to a decrease in the stock market returns of the same country (short and long-run direct effects). Moreover, our findings show the existence of negative spillover effects, since an increase in the government response intensity in a given country leads to a decrease in the stock market returns in the interrelated countries (short and long-run indirect effects). All in all, spillover effects complement direct effects, thus intensifying the negative impact of lockdown measures on the performance of stock markets. The above results hold for all four specifications and irrespective of the linkage measure considered.

**Table 2**: Stock market index returns and coronavirus government response

| | Dependent variable: Stock market index returns (*smi*) | | | |
|---|---|---|---|---|
| interaction matrix (*W*): | trade relations | trade relations | financial linkages | financial linkages |
| $smi_{t-1}$ | -0.066** | -0.159*** | -0.008 | -0.169*** |
| | (0.0299) | (0.0416) | (0.0302) | (0.0401) |
| *cgr* | -0.003** | -0.003** | -0.004*** | -0.003*** |
| | (0.0012) | (0.0011) | (0.0012) | (0.0011) |
| $W^*smi_{t-1}$ | | 0.202*** | | 0.210*** |
| | | (0.0431) | | (0.0289) |
| $W^*cgr$ | -0.015*** | -0.014*** | -0.014*** | -0.011*** |
| | (0.0033) | (0.0032) | (0.0025) | (0.0022) |
| $\rho$ | 0.769*** | 0.734*** | 0.592*** | 0.617*** |
| | (0.0424) | (0.0409) | (0.0356) | (0.0344) |
| *cgr* short-run effects | | | | |
| *Direct* | -0.005*** | -0.004*** | -0.004*** | -0.004*** |
| | (0.0013) | (0.0011) | (0.0012) | (0.0011) |
| *Indirect* | -0.075*** | -0.061*** | -0.038*** | -0.034*** |
| | (0.0189) | (0.0140) | (0.0064) | (0.0061) |
| *Total* | -0.079*** | -0.065*** | -0.043*** | -0.038*** |
| | (0.0195) | (0.0146) | (0.0068) | (0.0065) |
| *cgr* long-run effects | | | | |
| *Direct* | -0.004*** | -0.004*** | -0.004*** | -0.004*** |
| | (0.0012) | (0.0011) | (0.0012) | (0.0009) |
| *Indirect* | -0.057*** | -0.075*** | -0.038*** | -0.039*** |
| | (0.0126) | (0.0195) | (0.0062) | (0.0072) |
| *Total* | -0.061*** | -0.079*** | -0.042*** | -0.042*** |
| | (0.0131) | (0.0201) | (0.0066) | (0.0076) |
| Country fixed effects | *Yes* | *Yes* | *Yes* | *Yes* |
| LogL | 7578.613 | 7608.783 | 7563.880 | 7654.781 |
| No. of countries/observations | 45/3,060 | 45/3,060 | 45/3,060 | 45/3,060 |
| SDM vs. SEM likelihood ratio test ($\chi^2(1)$) | 27.89*** | 26.32*** | 42.42*** | 34.04*** |

Notes: LogL: Log-pseudolikelihood. The last row reports the likelihood ratio test statistic for testing the common factor constraint (see Florax et al., 2003); failing to reject the null hypothesis indicates a Spatial Error Model (SEM) nested within a Spatial Durbin Model (SDM) (i.e., $H_0$: $\theta = -\rho\beta$). Based on the results, the common factor constraint is rejected for all specifications implying the superiority of the SDM. Regression results were generated in Stata using the -xsmle- command (Belotti, et al., 2017). Robust standard errors are reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

## 6. Conclusion

In this study, we apply spatial econometric techniques to estimate the effect of *COVID-19* containment measures on 45 stock market indices. The results indicate that stock market returns and the intensity of lockdown measures are negatively related. The examination of *COVID-19* pandemic impact on a number of areas such as social trust and concomitant transaction costs, social security, costs of capital and political stability can be considered as topics for future research (an early review of possible future research agendas is extensively discussed in Goodell (2020)).

## References


Asgharian, H., Hess, W., Liu, L. (2013). A spatial analysis of international stock market linkages. *Journal of Banking & Finance* 37(12), 4738-4754.

Baltagi, H.B. (2005). *Econometric Analysis of Panel Data* (3rd ed.). Chichester: John Wiley and Sons.

Belotti, F., Hughes, G., Mortari, A. (2017). Spatial panel-data models using Stata. *The Stata Journal* 17(1), 139-180.

Boissay, F., Rungcharoenkitkul, P. (2020). Macroeconomic effects of Covid-19: An early review. *BIS Bulletin*, No 7, 7 April.

Elhorst, J.P. (2005). Unconditional maximum likelihood estimation of linear and log-linear dynamic models for spatial panels. *Geographical Analysis* 37(1), 85-106.

Florax, R.J.G.M., Folmer, H., Rey, S.J. (2003). Specification searches in spatial econometrics: The relevance of Hendry's methodology. *Regional Science and Urban Economics* 33, 557-579.

Frankel, J.A., Rose, A.K. (1998). The endogeneity of the optimum currency area criteria. *Economic Journal* 108(449), 1009-1025.

Goodell, J.W. (2020). COVID-19 and finance: Agendas for future research. *Finance Research Letters*, 101512 (forthcoming), https://doi.org/10.1016/j.frl.2020.101512.

Hale, T., Webster, S. , Petherick, A., Phillips, T., Kira, B. (2020). Oxford COVID-19 Government Response Tracker, Blavatnik School of Government. Data use policy: Creative Commons Attribution CC BY standard.

Kohlscheen, E., Mojon, B., Rees, D. (2020). The macroeconomic spillover effects of the pandemic on the global economy. *BIS Bulletin*, No. 4, 6 April.

Lee, L., Yu, J. (2010). A spatial dynamic panel data model with both time and individual fixed effects. *Econometric Theory* 26(2), 564-597.

Pesaran, M.H. (2004). General diagnostic tests for cross section dependence in panels (Cambridge Working Papers in Economics 0435). Cambridge: Faculty of Economics, University of Cambridge.

Zaremba, A., Kizys, R., Aharon, D.Y., Demir, E. (2020). Infected arkets: Novel coronavirus, government interventions, and stock return volatility around the globe. *Finance Research Letters*, 101597 (forthcoming), https://doi.org/10.1016/j.frl.2020.101597.

Zhang, D., Hu, M., Ji., Q. (2020). Financial markets under the global pandemic of COVID-19. *Finance Research Letters*, 101528 (forthcoming), https://doi.org/10.1016/j.frl.2020.101528.

Wooldridge, J.M. (2002). *Introductory Econometrics: A Modern Approach* (2nd ed.). Cincinnati, Ohio: South-Western College Publishing.