Proximity Penalty of COVID-19 "Outbreak" on Stock Markets

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Abstract

The COVID-19 pandemic had a significant impact on global stock markets, particularly during the early stages before its official declaration as a pandemic by the World Health Organization (WHO). As the outbreak rapidly spread, the potential for spillover effects became a substantial risk for financial markets. This paper investigates the effect of COVID-19 on stock market returns, specifically focusing on the geographical proximity to the epicenter of the outbreak, Wuhan. By examining the relationship between distance to Wuhan and stock market returns, this study aims to shed light on the influence of geographical proximity on the financial implications of the pandemic.

Contents

1 Introduction

The study of major shocks and their impact on stock market returns has been a subject of considerable interest in financial economics. Events such as wars, pandemics, and economic crises have historically been identified as significant drivers of stock market performance. While the immediate effects of these events are typically experienced within the borders of the countries where they occur, their consequences often transcend national boundaries. Consequently, understanding the cross-border spillover effects of these events, particularly in relation to the geographical proximity of neighboring countries, is a crucial aspect of financial research.

The outbreak of a war not only poses direct risks to the countries and firms within its borders but also exposes those in close proximity to the risk of military escalation. As a result, the overall disaster risk increases, leading to a decline in stock markets. This hypothesis, which highlights the influence of geographical proximity on stock market responses to major shocks, is empirically supported by the study conducted in *"Proximity to War: The Stock Market Response to the Russian Invasion of Ukraine"* (Federle et al., 2022).

In their research, the authors identify a significant "proximity penalty" in the stock market reaction to the Russian invasion of Ukraine. By analyzing the equity returns within a four-week window around the start of the war, they find that countries and firms located closer to Ukraine experience more negative stock market performance. This effect holds true not only at the country level but also within individual firms operating in different regions.

To account for potential trade-related spillovers, the study controls for these effects. The findings reveal that an additional 1,000 kilometers of distance from Ukraine corresponds to a 1.1 percentage point increase in equity returns, even after considering trade-related factors. These results highlight the quantitative importance of proximity in driving stock market responses to major shocks, such as armed conflicts.

Considering geographical proximity, it is possible to think about whether the same methodology can be applied to other types of major disasters, such as the COVID-19 pandemic. However, measuring the proximity penalty becomes challenging in the context of the pandemic, given its rapid global spread and ubiquitous presence. Unlike localized conflicts or geopolitical events, the COVID-19 outbreak transcended borders swiftly, making it difficult to assess the impact of geographical proximity in the same manner. Nonetheless, the early phase when the virus was spreading provides a unique opportunity to potentially measure the proximity penalty on stock markets.

To comprehend the dynamics of the COVID-19 outbreak, it is essential to consider the temporal dimension and trace its inception before it evolved into a global pandemic. Pertinent dates published

by the World Health Organization (*WHO* 2023) serve as crucial reference points in understanding the chronology of the outbreak. On December 31, 2019, the Wuhan Municipal Health Commission of China reported cases of pneumonia of unknown etiology, which would later be attributed to COVID-19. Shortly thereafter, WHO issued its initial Disease Outbreak News, shedding light on the emergence of this novel virus. The first case outside of China was reported in Thailand on January 13, signifying the international spread of the disease. Subsequently, on January 30, WHO declared the outbreak a Public Health Emergency of International Concern (PHEIC), emphasizing its global significance. Finally, on March 11, 2020, the WHO officially declared COVID-19 a global pandemic, acknowledging its rapid and widespread transmission worldwide.

The underlying hypothesis of this study revolves around the effect of COVID-19 and geographical proximity. This research posit that geographical proximity plays a pivotal role in shaping the stock market returns during the early stages of the pandemic. Specifically, it is anticipated that as the distance from Wuhan, the epicenter of the outbreak, increases, stock market returns will exhibit a negative relationship with proximity. Thus, prior to embarking on the empirical analysis, this paper anticipates observing an inverse correlation between stock market performance and the geographical proximity to Wuhan.

By exploring the interplay between the early days of the COVID-19 outbreak and the geographical proximity of countries, this research seeks to contribute to the existing literature on major shocks and their impact on financial markets. This endeavor not only extends our understanding of the COVID-19 pandemic but also sheds light on the broader mechanisms through which major shocks influence stock market returns.

2 Data and Methodology

This study utilizes three datasets to examine the geographical proximity effect of the early days of the COVID-19 pandemic on stock market returns. The first dataset consists of MSCI indices of stock market returns, obtained from Thomson Reuters Datastream. To determine the distances of countries from Wuhan, the longitude and latitude coordinates of capital cities were obtained from Simple Maps, and the distances were calculated using the *distance.great_circle* function of the *geopy* library in Python. COVID-19 cases are included as a control variable, and the dataset is sourced directly from "Our World In Data" website under the "Cases" directory.

$$LogReturn_i^{\tau} = \alpha + \rho \times DistanceWuhan_i + \varepsilon_i \tag{2.1}$$

The effect of proximity to the outbreak center is measured using Equation 2.1, which employs ordinary least squares regression. The logarithm of stock market returns, denoted as $\text{LogReturn}_i^{\tau}$, is calculated between the first and last day of the event windows. Here, τ represents the event window, and the index i pertains to specific countries. The parameter α captures the constant effect of the outbreak, while ρ is the coefficient of the distance to Wuhan, indicating the change in stock market returns associated with proximity to Wuhan. Lastly, ε represents the error term for each country.

Although there are studies (Roberts, Rossman, and Jarić, 2021) suggesting that the first case occurred earlier than the officially confirmed case, this study relies on officially published cases since it is unlikely that publicly unknown information regarding early cases could significantly impact stock market returns.

To precisely measure the geographic effect of the outbreak on stock exchanges, three dates are considered (*WHO* 2023): January 1, January 30, and March 11. January 1 marks the first case in the dataset (Mathieu et al., 2020), while January 30 when WHO announced public emergency alert, represents an early stage of the pandemic and can be seen as an initial signal to the world regarding the outbreak. March 11 denotes the day when information about the pandemic spread globally since WHO named the outbreak as a pandemic. Consequently, three event windows are used to construct the regression models.

The first event window, [01.01.2020 – 11.03.2020], captures the effect of the outbreak from the first case until its official designation as a pandemic by the WHO. The second event window, [01.01.2020 – 30.01.2020], is chosen to assess the impact of the outbreak prior to the WHO's declaration of a pub-

lic health emergency. This date is an alternative to March 11, as it is highly likely that stock markets responded to the outbreak before the official announcement. Finally, the last event window, [30.01.2020 – 11.03.2020], encompasses the dates between two significant announcements, aiming to capture potential global effects contrary to the hypothesis of this study.

Overall, the methodology involves analyzing the relationships between stock market returns, distances to Wuhan, and COVID-19 cases during specific event windows. This approach allows for the examination of the geographical proximity effect of the early days of the COVID-19 pandemic on stock market performance.

3 Analysis

3.1 First Regression

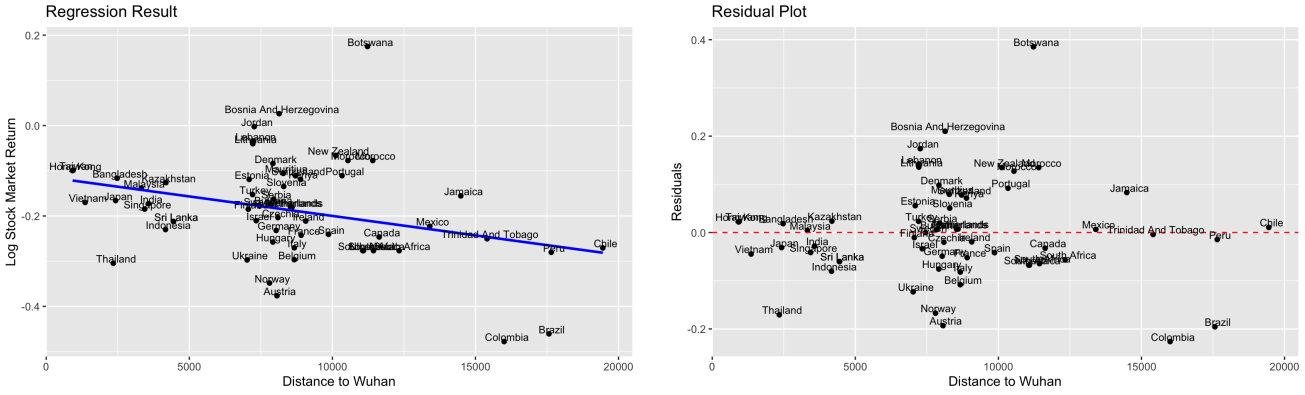

Figure 3.1: Regression Analysis and Residuals

In the first regression model, there are 57 countries, the starting date is 01.01.2020 and the end date is 11.03.2020. In Figure 3.1, on the left graph, the MSCI log-returns of countries are plotted with the country names and the residuals of the regression model is on the right. In both graphs, we can see Far East countries accumulated on the left and the majority of the remaining countries are in the middle. Within the regression plot, the change in the log-return is clearly visible. Nearby countries have higher returns and distant countries have less MSCI returns respected by their distance to Wuhan.

Table 3.1: Regression Summary

	Estimate	**Standard Error**	**t value**	**Pr(>|t|)**
Intercept	-1.137e-01	3.169e-02	-3.587	0.000695
Distance to Wuhan	-8.617e-06	3.395e-06	-2.539	0.013884

In Table 3.1, the intercept in this regression is -0.1137 with a standard error of 0.03169. It represents the estimated stock market return when the distance to Wuhan is zero. The negative coefficient suggests that as the distance to Wuhan increases, stock market returns tend to decrease. The coefficient for the distance to Wuhan variable is -8.617e-06 with a standard error of 3.395e-06. It indicates that for each unit increase in the distance to Wuhan, stock market returns decrease by 8.617e-06 units. The coefficient is statistically significant at the 0.05 level (p-value: 0.01388), suggesting that there is

evidence of a relationship between the distance to Wuhan and stock market returns during this event window. The adjusted R-squared value is 0.08582, indicating that the distance to Wuhan explains about 8.6 percent of the variation in stock market returns during this period.

3.1.1 COVID-19 Cases As A Control Variable

Table 3.2: Regression Summary

	Estimate	**Standard Error**	**t value**	**Pr(>|t|)**
Intercept	-1.190e-01	2.872e-02	-4.144	0.000121
Distance to Wuhan	-5.713e-06	3.002e-06	-1.903	0.062321
Case Difference	-1.146e-05	8.371e-06	-1.369	0.176695

In order to check the statistical significance of the Distance to Wuhan variable in the first regression model, the Case Difference variable was added as an additional control variable. The Case Difference variable represents the difference in the total number of COVID-19 cases between the last day and the first day of the event window. By including this control variable, we aimed to examine whether the observed relationship between distance to Wuhan and stock market returns remained significant after accounting for the effect of COVID-19 cases.

Table 3.2 presents the results of the regression analysis examining the relationship between LogReturn (dependent variable) and two independent variables: distance to Wuhan and Case Difference, with the latter representing COVID-19 Cases added as a control variable. The control variable, Case Difference, is defined as the difference in the total number of COVID-19 cases between the last day and the first day of the event window. The estimated coefficients reveal that the intercept is statistically significant, indicating a negative effect on Log Return. However, the distance to Wuhan variable loses its statistical significance in this regression, suggesting that there is no significant association between the distance from Wuhan and stock market returns when controlling for COVID-19 cases. Similarly, the control variable, Case Difference, does not exhibit statistical significance either.

Contrary to our hypothesis, the results of the regression analysis indicate that the Distance to Wuhan variable loses its statistical significance in the presence of the Case Difference control variable. This implies that, when controlling for the number of COVID-19 cases, there is no contrary effect observed on stock market returns with respect to the distance from Wuhan. Additionally, the Case Difference variable itself does not pose statistical significance. Hence, based on this analysis, we find no statistically significant effect of the distance to Wuhan on stock market returns, which contradicts our initial expectation.

3.2 Second Regression

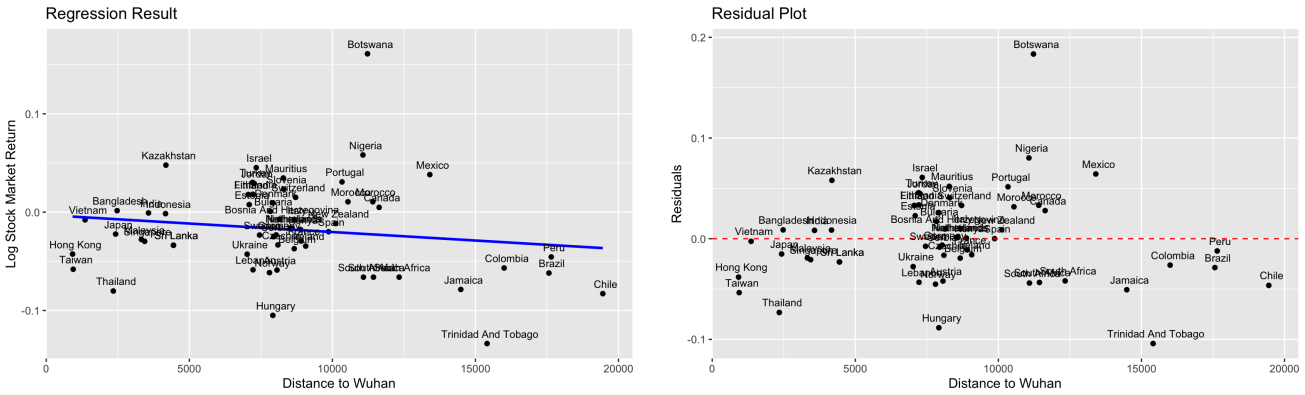

Figure 3.2: Regression Analysis and Residuals

In the second regression model, the starting date is 01.01.2020 and the end date is 30.01.2020. In Figure 3.2, on the left graph, the MSCI log-returns of countries are plotted with the country names and the residuals of the regression model is on the right. In both graphs, we can see Far East countries accumulated on the left and the majority of the remaining countries are in the middle. Within the regression plot, the change in the log-return is clearly visible. Nearby countries have higher returns and distant countries have less MSCI returns respected by their distance to Wuhan.

Table 3.3: Regression Summary

	Estimate	**Standard Error**	**t value**	**Pr(>|t|)**
Intercept	-2.994e-03	1.381e-02	-0.213	0.832
Distance to Wuhan	-1.728e-06	1.480e-06	-1.168	0.248

In Table 3.3, The intercept in this regression is -0.002944 with a standard error of 0.01381. The coefficient for the distance to Wuhan variable is -1.728e-06 with a standard error of 1.480e-06. However, neither the intercept nor the distance to Wuhan coefficient is statistically significant at conventional levels. This suggests that there is no strong evidence of a relationship between the distance to Wuhan and stock market returns during this event window. The adjusted R-squared value is 0.006237, indicating that the distance to Wuhan explains only a small portion of the variation in stock market returns during this period.

3.3 Third Regression

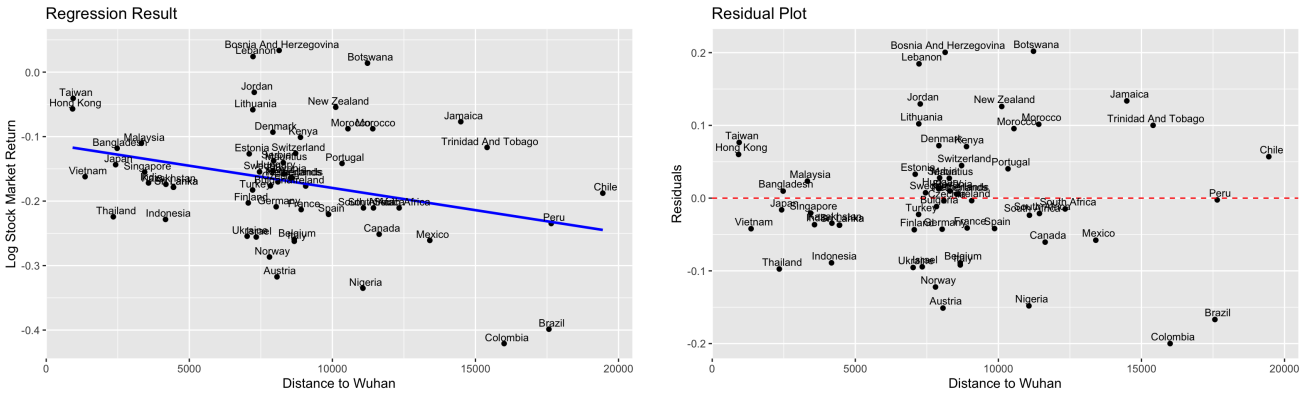

Figure 3.3: Regression Analysis and Residuals

In the third regression model, the starting date is 30.01.2020 and the end date is 11.03.2020. In Figure 3.3, on the left graph, the MSCI log-returns of countries are plotted with the country names and the residuals of the regression model is on the right. In both graphs, we can see Far East countries accumulated on the left and the majority of the remaining countries are in the middle. Within the regression plot, the change in the log-return is clearly visible. Nearby countries have higher returns and distant countries have less MSCI returns respected by their distance to Wuhan.

Table 3.4: Regression Summary

	Estimate	**Standard Error**	**t value**	**Pr(>|t|)**
Intercept	-1.107e-01	2.636e-02	-4.201	9.44e-05
Distance to Wuhan	-6.889e-06	2.823e-06	-2.440	0.0178

In Table 3.4, the intercept in this regression is -0.1107 with a standard error of 0.02636. The negative coefficient for the distance to Wuhan variable is -6.889e-06 with a standard error of 2.823e-06. Similar to the first regression, it suggests that as the distance to Wuhan increases, stock market returns tend to decrease. The coefficient is statistically significant at the 0.05 level (p-value: 0.01782), indicating a relationship between the distance to Wuhan and stock market returns during this event window. The adjusted R-squared value is 0.07869, meaning that the distance to Wuhan explains approximately 7.9 percent of the variation in stock market returns during this period.

3.4 Results and Comparison of Regression Analyzes

The results of the regression analysis provide valuable insights into the geographical proximity effect of the early days of the COVID-19 pandemic on stock market returns. The first regression model, which is considered the main model in this study, yielded unexpected but statistically significant findings. Contrary to the hypothesis, the results indicate that as the distance from the center of the outbreak, Wuhan, increases, stock market returns actually tend to increase. This finding challenges the initial assumption that there would be a negative impact on stock market returns due to geographical proximity to the outbreak. Moreover, the significance of this relationship is supported by the results of the second and third regression models with different event windows.

The second regression model, which focuses on the very early days of the pandemic until the emergency announcement by the WHO, did not yield statistically significant results for both the intercept and the distance to Wuhan parameter. This suggests that during this period, the geographical proximity effect may not have had a substantial impact on stock markets. It is possible that other factors were more influential in driving stock market returns during this specific time frame.

In contrast, the third regression model, which considers a period closer to the official pandemic announcement and captures global awareness through media coverage, demonstrates statistically significant results. As the dates approach the pandemic announcement, there is evidence of a negative relationship between the distance to Wuhan and stock market returns. This implies that the global effects of the pandemic were more apparent during this event window. However, it is worth noting that the magnitude of the effect may not be equivalent to what was initially hypothesized.

Several explanations can be considered for the differing results with the hypothesis. Firstly, measuring the effects of the pandemic on stock markets can be challenging due to the presence of various confounding factors that might have influenced stock market returns. Other economic, social, and political factors may have counteracted or outweighed the geographical proximity effect. Additionally, it is possible that the third event window captured the later effects of the pandemic, as neighboring countries may have experienced the initial shock before the rest of the world.

4 Conclusion

The findings of this study provide some evidence regarding the relationship between the distance to Wuhan and stock market returns during the early days of the COVID-19 pandemic, particularly in the first and third event windows. Surprisingly, contrary to the initial hypothesis, the regression results revealed an unexpected inverse relationship between the distance to Wuhan and MSCI returns in the first instance. However, the strength and significance of this relationship varied across different event windows, particularly when controlling for the number of COVID-19 cases as a covariate. Inclusion of the control variable resulted in the loss of statistical significance, suggesting that the observed impact of geographical proximity on stock market returns before the official announcement of the pandemic by the WHO may not hold.

Overall, the results challenge the notion of a significant and direct effect of geographical proximity on stock market returns. This indicates that the relationship between these factors is more complex and multifaceted than initially anticipated. The findings highlight the importance of considering additional factors, such as the number of COVID-19 cases, in understanding the dynamics of stock market returns during the early stages of a pandemic.

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