African Review of Economics and Finance | ISSN 2042-1478 |

The impact of COVID-19 on stock market liquidity: Evidence from the Johannesburg Stock Exchange

Damien Kunjal

School of Accounting, Economics and Finance, University of KwaZulu-Natal, South Africa
Author's email: damien.kunjal7@gmail.com

Abstract

Liquidity is an important feature of any well-functioning financial market. The recent outbreak of COVID-19 has created economic turbulence around the world, subsequently, exacerbating the volatility of global financial markets. Therefore, the objective of this study is to examine the impact of COVID-19 on the liquidity of firms trading on the Johannesburg Stock Exchange (JSE). Using a sample period of March 5, 2020 to June 12, 2020, the findings of this study suggest that growth in confirmed COVID-19 cases dries up the liquidity of firms constituted in the JSE All Share Index. However, growth in deaths caused by COVID-19 leads to an increase in the liquidity of these firms. Further analysis reveals that the negative relationship between growth in confirmed cases and changes in liquidity holds for companies of all sizes whilst the positive relationship between growth in deaths and changes in liquidity holds only for medium and small market capitalization stocks. Overall, for companies of all sizes, growth in confirmed COVID-19 cases exhibits a greater impact on liquidity relative to growth in COVID-19 deaths.

Keywords: Coronavirus; COVID-19; liquidity; pandemic; stock market.

Article history:
Received: 1st June, 2020
Accepted: 12th September, 2020
Handling editor: Muazu Ibrahim (PhD)

1. Introduction

The rampant spread of the Coronavirus (COVID-19) continues to create economic turmoil around the world. According to the World Health Organization (WHO) (2020a), the first case of COVID-19 was detected in Wuhan city in China's Hubei province. On 12 June 2020, the WHO (2020b) reports that there are 216 countries and territories affected by COVID-19 with a combined total of approximately 7.4 million confirmed cases, including around 400 000 deaths caused by the virus. With regards to South Africa, the WHO (2020c) reports that there are around 58 000 confirmed COVID-19 cases which include approximately 1 200 deaths as at June 12, 2020. Given the rapidly accelerating number of confirmed COVID-19 cases and deaths, national governments are faced with the tough decision of whether to protect the lives of their citizens or to protect the stability of their national economies. Nicola, *et al*. (2020) mention that governments have responded to the COVID-19 outbreak by adopting policies that aim to slow down the spread of the virus, thus, protect the lives of their citizens. In an attempt to 'flatten the curve', the South African government has declared a national state of disaster and enforced several measures to contain the virus, including, strict quarantine policies and prohibitions on travel (IMF, 2020a).

Policies adopted by national governments may help curb the spread of the COVID-19 virus. However, such policies have inadvertently impacted national economies and financial markets. For instance, quarantine policies have disrupted global supply chains (Ivanov and Dolgui, 2020), while travel bans have reduced revenue from tourism (Ayittey, *et al.*, 2020). Other factors contributing to the economic turmoil around the world, include; decreased consumption and demand, increased unemployment rates, volatile exchange rates, reduced capital flows, and unstable commodity prices. Due to dampening global financial shocks, the International Monetary Fund (IMF) expects that the COVID-19 pandemic will give rise to a recession that is greater than the recession experienced during the 2009 global financial crisis (IMF, 2020b). Specifically, for the 2020 fiscal year, the IMF predicts a -3 percent growth in the global economy and a 5.8 percent decline in South Africa's real GDP (IMF, 2020b). As a result, the rising uncertainty about the economic impacts of the COVID-19 epidemic has amplified the volatility of financial markets (Zhang, *et al.*, 2020). According to the World Bank Group (2020), increased financial market volatility due to the COVID-19 pandemic has created a liquidity crunch in global financial markets because firms and investors who are seeking liquidity are selling off high-risk assets.

Liquidity is an important feature of any financial market. In financial markets, the term 'liquidity' is associated with how easily traders can buy or sell assets without incurring high costs (Roch, 2011). Thus, a financial market is liquid when traders can execute large transactions without having a significant impact on the prices of securities. Increased liquidity enhances market efficiency by inducing arbitrage activities (Chordia, *et al*., 2008). Moreover, liquid stock markets contribute to economic growth by reducing transaction costs, facilitating the diversification of risk exposures, and helping firms to raise capital through the sale of shares (Cooray, 2010). This being so, financial markets with low liquidity levels may reduce the speed at which trades are executed, contribute to market inefficiencies, and hamper the growth of the economy. Thus, assets with low liquidity levels trade at low prices (Amihud and Mendelson, 1991). This is because investors who hold assets with low liquidity levels require high returns or higher premiums for bearing liquidity risk (Ma, *et al.*, 2016).

Classical price formation theories assert that increases in volatility lead to a decline in liquidity by widening the bid-ask spread (Copeland and Galai, 1983). Similarly, market microstructure theories contend that liquidity is adversely related to market volatility and uncertainty (Stoll, 2003). Given that the COVID-19 pandemic has increased the volatility of financial markets, it is rational to expect the liquidity of the financial markets to respond negatively to the impact of COVID-19. Existing empirical evidence suggests that the outbreak of viruses impacts the liquidity of stock markets. For instance, McTier, *et al.* (2013) discover that an increase in the number of influenza cases in the United States is associated with higher bid-ask spreads and, thus, a decline in stock market liquidity. On the contrary, Funck and Gutierrez (2018) find that news about the Ebola crisis is associated with higher trading volumes and increased share turnover in the United States.

Christensen (2020) studies the impact of the COVID-19 pandemic on the liquidity of firms in the United States by using a dummy variable to represent the pandemic timeframe whilst the impact on liquidity is measured using Amihud's (2002) illiquidity measure. Christensen (2020) reports that the COVID-19 pandemic increased the illiquidity of the electrical equipment, carry, and other industries but decreased the illiquidity of the smoke, meals, retail, and food industries. In addition to bid-ask spreads, Baig, *et al.* (2020) also employ Amihud's (2002) illiquidity measure and discover that increases in the total number of confirmed COVID-19 cases and deaths lead to a decline in the liquidity of stocks constituted in the S&P 500 index. Therefore, the objective of this study is to investigate the impact of the COVID-19 pandemic on the liquidity of the Johannesburg Stock Exchange (henceforth, JSE).

This study contributes to existing research in several ways. Firstly, there exists only a few studies examining the impact of pandemics and COVID-19 on financial markets (Goodell, 2020). Hence, the present study enhances existing research surrounding the influence of COVID-19 on financial markets by offering insight into the impact of COVID-19 on the liquidity of stock markets. Boako and Alagidede (2018) note that research on how African stock markets respond to global economic crises remains scanty. While existing studies (Baig, *et al*., 2020; Christensen, 2020) have examined the impact of COVID-19 on the liquidity of the stock market in the United States, to the knowledge of the author, there has been no attempts to examine the impact of COVID-19 on the liquidity of African stock markets. Therefore, the second contribution of this study is that it sheds light on how African stock markets respond to pandemics which create turmoil in the global economy. Specifically, the results of this study provide insight into how the liquidity of the South African stock market responds to the COVID-19 pandemic.

Christensen (2020) measures the liquidity impact using Amihud's (2002) illiquidity measure; however, the bid-ask spread percentage is used as the measure of liquidity in this paper. Therefore, the third contribution of this paper is that it provides insight into the impact of COVID-19 on stock market liquidity by employing an alternative measure of liquidity, that is, the bid-ask spread percentage. Market makers provide liquidity for traders in exchange for a compensation for bearing risks associated with inventory-holding (Bollen, *et al*., 2004). Bid-ask spreads represent the compensation earned by market makers, thus, bid-ask spreads signify transaction costs for traders. Hence, Cannon and Cole (2011), Chung and Zhang (2014) and Liu, *et al.* (2019) acknowledge that the bid-ask spread percentage is a frequently used measure of liquidity since it is associated with transaction costs. Given that illiquidity diminishes asset returns, the results of this study are particularly useful to traders whose trading decisions are guided by market liquidity. Additionally, the findings of this study are important for policymakers who are responsible for promoting the liquidity and efficiency of stock markets.

Using a sample period of March 5, 2020 to June 12, 2020, the results of the panel data regressions suggest that growth in confirmed COVID-19 cases dries up the liquidity of firms constituted in the JSE All Share Index. However, growth in deaths caused by COVID-19 lead to an increase in the liquidity of these firms. Further analysis reveals that the negative relationship between growth in confirmed cases and changes in liquidity holds for companies of all sizes whilst the positive relationship between growth in deaths and changes in liquidity holds only for medium and small market capitalization stocks. Overall, for companies of all sizes, growth in confirmed cases exhibits a greater liquidity impact relative to growth in deaths.

The rest of the paper is outlined as follows: Section 2 provides a discussion on the data and methodology that is employed for this study while Section 3 presents and discusses the findings of this study. Section 4 discusses the concluding remarks and implications for policymakers and investors.

2. Data and methodology

South Africa confirmed its first case of COVID-19 on 5 March 2020 (WHO, 2020d). Accordingly, this study surveys stocks constituted in the FTSE/JSE All Share (J203) Index from March 5, 2020 to June 12, 2020. Companies included in the FTSE/JSE All Share Index represent 99 percent of the total market capitalization of all companies trading on the JSE (Bloomberg, 2020). At the end of the June 12, 2020 trading day, a total of 152 companies constituted the FTSE/JSE All Share Index. However, 2 companies (Ninety One Limited and Ninety One Plc) are excluded from the sample data due to not having a full set of data since these companies were listed on the JSE on March 16, 2020 (JSE, 2020). As a result, only 150 companies (each with 99 daily observations) constituted in the FTSE/JSE All Share Index are included in the sample of this study.

In addition to daily trading volume, daily observations of the bid, ask, high, low, and closing prices are obtained for each company from the Infront Analytics database. The Infront Analytics database is also used to obtain daily closing prices of the FTSE/JSE All Share Index, while the IRESS database is used to acquire daily closing prices of the South African Volatility Index (SAVI). Daily statistics about the total number of confirmed COVID-19 cases and deaths in South Africa are obtained from the WHO (2020e) database.

The measure of liquidity employed in this study is the bid-ask spread percentage. Bid-ask spread percentages capture the “tightness” characteristic of liquidity since they are linked to the costs of the transaction (Cannon and Cole, 2011). Accordingly, an increase in the bid-ask spread percentage is associated with a decline in liquidity. The bid-ask spread percentage is calculated as follows:

$$Spread\ Percentage_{i,t} = \frac{Ask_{i,t} - Bid_{i,t}}{M_{i,t}} \tag{1}$$

where *spread percentage*$_{i,t}$ represents the bid-ask spread percentage of stock i on day t, $ask_{i,t}$ represents the ask price of stock i on day t, $bid_{i,t}$ represents the bid price of stock i on day t, and $M_{i,t}$ denotes the midpoint of the bid-ask quote on stock i on day t calculated as $\frac{Ask_{i,t} + Bid_{i,t}}{2}$.

Panel data analysis is employed to examine the impact of COVID-19 on the liquidity of the JSE. The use of panel data regressions is motivated by their ability to mitigate problems related to heteroscedasticity and multicollinearity (Al-Awadhi, *et al*., 2020). Barro, *et al.* (2020) mention that the number of people infected by COVID-19 and the number of people killed by COVID-19 represent suitable gauges of the impact of the COVID-19 pandemic. Accordingly, the model estimated to examine the impact of COVID-19 on liquidity, after controlling for company-specific and market-related characteristics, follows Equation (2):

$$Ln(Spread\ Percentage_{i,t}) = \alpha_o + \alpha_1\ COVID-19_{i,t-1} + \beta_1\ Ln(Price)_{i,t} + \beta_2\ Ln(Volatility)_{i,t} + \beta_3\ Ln(Volume)_{i,t} + \beta_4\ Ln(Implied\ Volatility)_{i,t} + \beta_5\ Market\ Return_{i,t} + \mu_i + e_{i,t} \quad (2)$$

where the subscript i signifies individual firms (i=1,2,…,150), t denotes time periods, *Ln* is the natural logarithm, α_o denotes a constant term, β_1, β_2, β_3, β_4, and β_5 represent coefficient estimates, μ_i is the company-specific fixed effect, and $e_{i,t}$ is the error term. In Equation (2), the *spread percentage*$_{i,t}$ is a function of *COVID-19*$_{i,t-1}$ which represents either (i) the growth in the total number of confirmed COVID-19 cases in South Africa or (ii) the growth in the total number of deaths caused by COVID-19 in South Africa. To account for alternative explanations of stock market liquidity, in Equation (2), *spread percentage*$_{i,t}$ is also dependent on company-specific characteristics (that is, share price, return volatility, and trading volume) and market-related characteristics (implied volatility and market return). Table (1) provides a summary of how each variable is measured.

Table 1: Measurement of Variables

Variable	Measurement
Panel A: Dependent variable	
Spread percentage	Bid-ask spread percentage as defined in Equation (1)
Panel B: COVID-19 variables	
Growth in cases	Percentage change in the total number of confirmed COVID-19 cases
Growth in deaths	Percentage change in the total number of COVID-19 deaths
Panel C: Firm-specific variables	
Price	Daily closing share price
Volatility	Daily volatility estimate computed using the Parkinson (1980) volatility estimator where $volatility_{i,t} = \sqrt{\frac{ln\left(H_{i,t}/L_{i,t}\right)^2}{4ln(2)}}$ when $H_{i,t}$ and $L_{i,t}$ represent the high and low prices for stock i on day t, respectively.
Volume	Daily volume traded
Panel D: Market-related variables	
Implied volatility	Daily closing price of the South African Volatility Index (SAVI)
Market return	Daily return on the FTSE/JSE All Share (J203) Index

3. Empirical results

3.1. Preliminary data analysis

Table (2) summarizes the descriptive statistics of each variable. The mean value for the natural logarithm of spread percentage is -2.442, suggesting that, on average, the change in the daily spread percentage is -2.442%. Notably, the natural logarithm of the daily spread percentage ranges from a minimum of -8.347% to a maximum of 0.693%. Average daily growth in cases is equal to 12.876% while average daily growth in deaths is equivalent to 8.241%. Both daily growth in cases and daily growth in deaths have minimum values of 0.000% whilst the maximum growth in cases and deaths is 133.333% and 100.000%, respectively.

TABLE 2: DESCRIPTIVE STATISTICS

	Mean	Standard deviation	Minimum value	Maximum value
Ln (Spread percentage)	-2.442	0.962	-8.347	0.693
Growth in cases	12.876	19.487	0.000	133.333
Growth in deaths	8.241	14.483	0.000	100.000
Ln (Price)	7.972	1.586	4.205	12.682
Ln (Volatility)	-3.237	0.688	-8.228	0.201
Ln (Volume)	13.707	1.757	2.303	20.015
Ln (Implied volatility)	3.464	0.214	3.120	3.893
Market return	0.015	2.535	-10.227	7.261

The correlation matrix in Table (3) shows that the correlation between the natural logarithm of the spread percentage and the growth in the cases is 0.187 indicating that an increase (decrease) in the number of confirmed cases is accompanied by an increase (decrease) in the bid-ask spread percentage. On the contrary, the correlation between the natural logarithm of the spread percentage and the growth in the deaths is -0.007 suggesting that an increase (decrease) in the number of deaths is associated with a decrease (increase) in the bid-ask spread percentage. Interestingly, growth in the number of confirmed cases is negatively correlated with growth in the number of deaths. The highest correlation coefficient in Table (3) is 0.375, suggesting that the variables exhibit low to medium correlations. To ensure that the estimated models do not display multicollinearity, variance inflation factors (VIF) are computed for each explanatory variable in the estimated panel regression. VIF values greater than 10 indicate that severe multicollinearity is present in the estimated model (Kennedy, 1992).

TABLE 3: CORRELATION MATRIX

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (Spread percentage)	1.000							
Growth in cases	0.187	1.000						
Growth in deaths	-0.007	-0.229	1.000					
Ln (Price)	-0.283	0.010	-0.009	1.000				
Ln (Volatility)	0.367	0.188	-0.004	-0.255	1.000			
Ln (Volume)	-0.202	0.035	-0.013	-0.019	0.163	1.000		
Ln (Implied volatility)	0.276	0.374	0.150	-0.025	0.375	0.057	1.000	
Market return	-0.105	-0.203	0.052	-0.005	-0.049	0.009	-0.094	1.000

3.2. The impact of COVID-19 on stock market liquidity

The results of the panel data regressions estimated for the panel of companies constituted in the JSE All Share (J203) Index are presented in Table (5). In this study, particular importance is given to the response of the spread percentage to growth in cases and growth in deaths. However, before interpreting the results of the estimated regressions, it is important to ensure that multicollinearity is not present in the estimated models. The VIF values in Table (4) below indicate that multicollinearity is not a problem in Models (2) and (4) presented Table (5) since the highest VIF value is 1.550.

TABLE 4: VARIANCE INFLATION FACTORS

	Model 2	**Model 4**
Growth in casesi$_{,t-1}$	1.294	
Growth in deathsi$_{,t-1}$		1.029
Ln (Price)$_{t-1}$	1.123	1.074
Ln (Volatility)$_{t-1}$	1.285	1.284
Ln (Volume)$_{t-1}$	1.060	1.060
Ln (Implied volatility)$_{t-1}$	1.550	1.291
Market return$_{t-1}$	1.017	1.032

TABLE 5: RESULTS OF ESTIMATED PANEL REGRESSIONS

Variable	**Ln (Spread Percentage)$_{i,t}$**			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Growth in cases$_{i,t-1}$	0.009*** (0.000)	0.003*** (0.000)		
Growth in deaths$_{i,t-1}$			-0.0002 (0.677)	-0.001 (0.166)
Ln (Price)$_{i,t}$		0.109*** (0.003)		0.171*** (0.000)
Ln (Volatility)$_{i,t}$		0.271*** (0.000)		0.274*** (0.000)
Ln (Volume)$_{i,t}$		0.011 (0.136)		0.012* (0.099)
Ln (Implied volatility)$_{i,t}$		0.799*** (0.000)		0.917*** (0.000)
Market return$_{i,t}$		-0.028*** (0.000)		-0.028*** (0.000)
Constant	-2.554*** (0.000)	-5.390*** (0.000)	-2.438*** (0.000)	-6.259*** (0.000)
Fixed effect		Yes		Yes
R-squared	0.032	0.490	0.000	0.488

Notes: 1. Values in parentheses represent probability values (that is, p-values). 2. ***, **, * denotes statistical significance at a 1%, 5%, and 10% level of significance, respectively.

Model (1) suggests that growth in cases exhibits a positive relationship with changes in the spread percentage. This positive relationship between growth in cases and changes in the spread percentage is statistically significant at a 1% level of significance when alternative determinants of the spread percentage are not included in the panel regression. Model (2) shows that, even when alternative explanations of liquidity and company-specific fixed effects are controlled for, growth in cases is positively related to changes in the spread percentage and this relationship remains significant at a 1% level of significance. Overall, Models (1) and (2) indicate that an increase in the number of confirmed COVID-19 cases leads to an increase in the spread percentage. Given that an increase in the bid-ask spread percentage is associated with a decline in liquidity, these findings suggest that increases in the total number of COVID-19 confirmed cases in South Africa leads to a significant decline in the liquidity of firms constituted in the JSE All Share Index. Therefore, the liquidity of the JSE responds negatively to the impact of growth in confirmed COVID-19 cases.

With regards to growth in deaths caused by COVID-19, Model (3) in Table (5) suggests that growth in deaths is negatively related to changes in the spread percentage. However, this negative relationship between growth in deaths and changes in the spread percentage is not statistically significant. Likewise, Model (4) shows that, after controlling for other possible explanations of the bid-ask spread and company-specific fixed effects, growth in deaths and changes in the spread percentage exhibit a negative relationship that is statistically insignificant. Overall, Models (3) and (4) suggest the spread percentage does not significantly respond to growth in deaths. This finding indicates that the liquidity of firms constituted in the JSE All Share Index is not significantly impacted by growth in deaths related to COVID-19. In summary, Models (1), (2), (3), and (4) suggest that the liquidity of the JSE is significantly impacted by growth in confirmed COVID-19 cases but not by growth in deaths caused by COVID-19.

3.3. Further analysis

3.3.1. Random effects model

To examine the impact of COVID-19 on the liquidity of firms constituted in the JSE All Share Index after controlling for unobserved company-specific random effects, the company-specific fixed effect (μ_i) in Equation (2) is replaced with a company-specific random effect. Table (6) reports the results of the random effects model.

Model (5) in Table (6) shows that, after controlling for alternative explanations of the spread percentage and company-specific random effects, growth in cases exhibits a positive relationship with changes in the spread percentage. Consistent with Model (2), this positive relationship between growth in cases and changes in the spread percentage is statistically significant at a 1% level of significance. Therefore, the results from the random effects model also suggest that increases in the total number of confirmed COVID-19 cases lead to an increase in the bid-ask spread, and thus, a decline in liquidity. On the contrary, the negative relationship between growth in deaths and changes in the spread percentage becomes statistically significant at a 10% level of significance after controlling for company-specific random effects. This finding suggests that an increase in the total number of deaths caused by COVID-19 leads to a decrease in the bid-ask spread percentage. Given that a reduction in the bid-ask spread percentage implies an increase in liquidity, these findings suggest that an increase in the total number of deaths caused by COVID-19 leads to an increase in the liquidity of firms constituted in the JSE All Share Index.

Table 6: Results of the Panel Data Regression with Random Effects

Variable	**Ln (Spread Percentage)$_{i,t}$**	
	Model 5	**Model 6**
Growth in cases$_{i,t-1}$	0.003*** (0.000)	
Growth in deaths$_{i,t-1}$		-0.001* (0.073)
Ln (Price)$_{i,t}$	-0.081*** (0.000)	-0.063*** (0.001)
Ln (Volatility)$_{i,t}$	0.277*** (0.000)	0.280*** (0.000)
Ln (Volume)$_{i,t}$	-0.011 (0.103)	-0.011 (0.122)
Ln (Implied volatility)$_{i,t}$	0.754*** (0.000)	0.880*** (0.000)
Market return$_{i,t}$	-0.028*** (0.000)	-0.029*** (0.000)
Constant	-3.399*** (0.000)	-3.937*** (0.000)
Fixed effect	Yes	Yes
R-squared	0.177	0.172

Notes: 1. Values in parentheses represent probability values (that is, p-values).

2. ***, **, * denotes statistical significance at a 1%, 5%, and 10% level of significance, respectively.

Overall, the results of Models (5) and (6) in Table (6) suggest that even though the liquidity of the JSE responds positively to growth in COVID-19 deaths and negatively to growth in COVID-19 confirmed cases, the impact of growth in COVID-19 cases (0.003) is greater than the impact of growth in deaths (-0.001). Notably, the results of the Hausman test in Table (7) indicate that the fixed effects models are more appropriate for modelling the liquidity of firms constituted in the JSE All Share Index. This implies that, relative to Models (5) and (6), Models (2) and (4) with company-specific fixed effects provide a better explanation of the liquidity of the surveyed companies. Unreported [1] VIF values indicate that multicollinearity is not a problem in Models (5) and (6).

Table 7: Results of the Hausman Test

Model	Chi-square statistic	Probability value
Model (5)	123.467	0.000
Model (6)	143.467	0.000

3.3.2. Alternative measure of liquidity

Following Cannon and Cole (2011), the price impact is employed as an alternative measure of liquidity. The price impact captures the 'depth' component of liquidity, in which case, low price impact values are associated with more depth and liquidity (Cannon and Cole, 2011). Price impact is computed as the absolute return of stock *i* on day *t* divided by the dollarized trading volume [2] for stock *i* on day *t*. The daily spread percentage in Equation (2) is replaced with the daily price impact, and the results for the panel data regressions are presented in Table (8).

Models (7) and (8) suggest that growth in cases is positively related to changes in the price impact. This implies that an increase in the number of confirmed cases leads to an increase in the price impact. Given that an increase in the price impact is associated with a decrease in liquidity, Models (7) and (8) provide further evidence that growth in confirmed COVID-19 cases leads to a decline in the liquidity of firms constituted in the JSE All Share Index. Models (9) and (10) suggest that growth in deaths is negatively related to changes in the price impact. However, this negative relationship between growth in deaths and changes in the price impact is only statistically significant after controlling for alternative

[1] Results available on request.

[2] Dollarized trading volume is computed as the daily trading volume multiplied by the daily closing price.

explanations of the price impact. Therefore, the results of Model (10) indicate that increases in the total number of deaths caused by COVID-19 lead to a decrease in the price impact, and therefore, an increase in liquidity. Nevertheless, after controlling for other possible explanations of the price impact, the impact of growth in confirmed cases (0.045) is greater than the impact of growth in deaths (-0.010). Unreported [3] VIF values indicate that multicollinearity is not a problem in Models (8) and (10).

Table 8: Results of the Panel Data Regressions with alternative liquidity measure

Variable	**Ln (Price impact)$_{i,t}$**			
	Model 7	**Model 8**	**Model 9**	**Model 10**
Growth in cases$_{i,t-1}$	0.036*** (0.000)	0.045*** (0.000)		
Growth in deaths$_{i,t-1}$			-0.008 (0.154)	-0.010* (0.054)
Ln (Price)$_{i,t}$		-2.251*** (0.000)		-1.226** (0.011)
Ln (Volatility)$_{i,t}$		0.183 (0.211)		0.233 (0.112)
Ln (Volume)$_{i,t}$		-0.760*** (0.000)		-0.741*** (0.000)
Ln (Implied volatility)$_{i,t}$		-1.386*** (0.002)		0.573 (0.161)
Market return$_{i,t}$		0.004 (0.883)		0.004 (0.904)
Constant	-21.708*** (0.000)	11.916** (0.015)	-21.178*** (0.000)	-2.469 (0.598)
Fixed effect		Yes		Yes
R-squared	0.005	0.071	0.0001	0.065

Notes: 1. Values in parentheses represent probability values (that is, p-values).
2. ***, **, * denotes statistical significance at a 1%, 5%, and 10% level of significance, respectively.

3.3.3. Company-size analysis

Al-Awadhi, *et al*. (2020) document that the impact of COVID-19 differs across stocks of different market capitalization. Hence, the impact of COVID-19 on the liquidity of firms with different sizes is examined by estimating Equation (2) for a panel of large market capitalization stocks, medium market capitalization stocks, and small market capitalization stocks. Large market capitalization

[3] Results available on request.

stocks, medium market capitalization stocks, and small market capitalization stocks are represented by companies constituted in the JSE Top 40 (J200), JSE Mid Cap (J201), and JSE Small Cap (J202) indices, respectively. At the end of the June 12, 2020 trading day, a total of 41, 55, and 60 companies constituted the JSE Top 40 (J200), JSE Mid Cap (J201), and JSE Small Cap (J202) indices, respectively. All companies in the JSE Top 40 (J200), JSE Mid Cap (J201), and JSE Small Cap (J202) indices had full sets of data, and thus, were included in the panel representing large market capitalization stocks, medium market capitalization stocks, and small market capitalization stocks. The results for each group are presented in Table (9).

Table 9: Results of Panel Data Regressions estimated for Companies of Different Sizes

	Large caps.		**Medium caps.**		**Small caps.**	
	Model 11	**Model 12**	**Model 13**	**Model 14**	**Model 15**	**Model 16**
Growth in casesi,$_{t-1}$	0.004*** (0.000)		0.003*** (0.000)		0.003*** (0.000)	
Growth in deaths$_{i,t-1}$		0.001 (0.337)		-0.001 (0.116)		-0.001* (0.051)
Ln (Price)$_{i,t}$	-0.136* (0.052)	-0.054 (0.434)	0.204*** (0.001)	0.289*** (0.000)	0.144** (0.015)	0.201*** (0.001)
Ln (Volatility)$_{i,t}$	0.299*** (0.000)	0.306*** (0.000)	0.288*** (0.000)	0.292*** (0.000)	0.261*** (0.000)	0.262*** (0.000)
Ln (Volume)$_{i,t}$	-0.045* (0.078)	-0.019 (0.464)	(0.464) (0.702)	0.007 (0.626)	0.013 (0.158)	0.012 (0.188)
Ln (Implied volatility)$_{i,t}$	0.499*** (0.000)	0.631*** (0.000)	0.965*** (0.000)	1.088*** (0.000)	0.763*** (0.000)	0.899*** (0.000)
Market return$_{i,t}$	-0.043*** (0.000)	-0.045*** (0.000)	0.392*** (0.007)	0.429*** (0.003)	-0.016*** (0.000)	-0.016*** (0.000)
Constant	-1.848** (0.033)	-3.400*** (0.000)	-6.572*** (0.000)	-7.647*** (0.000)	-5.167*** (0.000)	-5.975*** (0.000)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.410	0.403	0.397	0.395	0.424	0.422

Notes: 1. Values in parentheses represent probability values (that is, p-values).
2. ***, **, * denotes statistical significance at a 1%, 5%, and 10% level of significance, respectively.

Models (11), (13), and (15) indicate that growth in cases exhibits a significant positive relationship with the spread percentage of large market capitalization stocks, medium market capitalization stocks, and small market capitalization stocks, respectively. These findings suggest that, for companies of all sizes, increases in the number of confirmed COVID-19 cases leads to an increase in the bid-ask spread percentage, and therefore, a decline in liquidity. Notably, growth in confirmed COVID-19 cases has the greatest impact on large market capitalization stocks (0.004). Model (12) suggests that growth in deaths exhibits a positive relationship with changes in the spread percentages of large market capitalization stocks; however, this relationship is statistically insignificant. On the contrary, Models (14) and (16) show that growth in deaths is negatively related to the spread percentage. This implies that increases in the number of deaths lead to a decrease in the bid-ask spread percentages of medium market capitalization stocks and small market capitalization stocks; however, this relationship is only significant for small market capitalization stocks. These findings suggest that growth in deaths caused by COVID-19 significantly and positively impacts the liquidity of small market capitalization stocks. Interestingly, the magnitude of the impact of growth in deaths on liquidity remains the same (that is, 0.001) for all companies of all sizes. Overall, for companies of all sizes, the impact of growth in confirmed cases is greater than the impact of growth in deaths. Unreported[4] VIF values indicate that multicollinearity is not a problem in Models (11) to (16).

In summary, the results of all panel regressions with growth in cases as an explanatory variable (that is, Models 1, 2, 5, 7, 8, 11, 13, and 15) suggest that the liquidity of firms listed on JSE significantly decreases as the total number of confirmed COVID-19 cases in South Africa rise. On the contrary, Models (3), (4), (6), (9), (10), (14), and (16) suggest that the liquidity of firms listed on the JSE increase as the total number of deaths caused by COVID-19 in South Africa rise. Therefore, these findings suggest that growth in confirmed cases and growth in deaths have an opposite effect on the liquidity of firms trading on the JSE. This opposing effect of growth in confirmed cases and growth in deaths on liquidity can be explained through their connection with the number of active COVID-19 cases. All else equal, an increase in the number of confirmed COVID-19 cases leads to an increase in the number of active COVID-19 cases. This increase in active cases may be perceived as a negative outlook, subsequently, increasing market uncertainty. As a result, the increase in market uncertainty dries up the liquidity of the stock market. Hence, this finding suggests that the liquidity of firms decrease as the number of active cases increase which occurs when confirmed cases increase.

Other things being equal, an increase in the total number of COVID-19 deaths leads to a decrease in the number of active COVID-19 cases. Investors may

[4] Results available on request.

perceive this decrease in the number of active COVID-19 cases as a positive outlook. This positive outlook may cause investors to trade more, subsequently, increasing the liquidity of firms. Therefore, this finding implies that the liquidity of firms increase as the number of active COVID-19 decrease which occurs when there is an increase in COVID-19 deaths. Put together, these findings suggest that the liquidity of firms is negatively related to the growth in active COVID-19 cases. That is, the liquidity of firms increase (decrease) as the number of active COVID-19 cases decrease (increase) which occurs when confirmed COVID-19 cases decrease (increase) or when COVID-19 deaths increase (decrease). Notably, the results of this study indicate that growth in confirmed cases exhibits a greater impact on the liquidity of firms relative to growth in deaths. Similarly, Ashraf (2020) reports that stock markets react more to growth in confirmed cases and react less to growth in deaths caused by COVID-19.

4. Conclusion

This paper examines the impact of COVID-19 on the liquidity of firms listed on the JSE. The sample dataset includes companies constituted in the JSE All Share (J203) Index while the period of study ranges from March 5, 2020 to June 12, 2020. The results of the panel data regressions suggest that an increase in confirmed COVID-19 cases leads to a decline in the liquidity of firms constituted in the JSE All Share Index but an increase in deaths caused by COVID-19 leads to an increase in the liquidity of these firms. Further analysis reveals that the negative relationship between growth in confirmed cases and changes in liquidity holds for companies of all sizes while the positive relationship between growth in deaths and changes in liquidity holds only for medium market capitalization stocks and small market capitalization stocks. Overall, for all companies, growth in confirmed COVID-19 cases exhibits a greater impact on liquidity relative to growth in COVID-19 deaths.

The findings of this study have significant implications for policymakers and investors. For policymakers, these findings indicate that the liquidity of firms can be enhanced by a reduction in the number of active COVID-19 cases. Thus, in order to enhance the liquidity of firms on the JSE, policymakers and regulators should implement policies and strategies that reduce that number of active COVID-19 cases. However, regulators should be cautious of the effect of these policies on financial markets and the economy as a whole. Moreover, the results of this study suggest that the liquidity of South African firms respond to growth in COVID-19 deaths in a manner that is not consistent with the response of U.S.-listed firms as reported by Baig, *et al*. (2020). Therefore, policies implemented to promote the liquidity of developed stock markets may not necessarily yield the same results in emerging stock markets, like the JSE. Hence, it is important that policymakers and regulators customize such policies based on the characteristics of their local stock markets. For investors, it is important that investors who require highly liquid stocks avoid stocks whose liquidity has been negatively impacted by the COVID-19 pandemic. However, risk-seeking investors may opt for stocks with higher liquidity risk since these stocks may generate higher returns due to an increased liquidity risk premium.

Biographical Notes

Damien Kunjal recently completed a Master of Commerce in Finance at the University of KwaZulu-Natal, South Africa. Currently, he is the academic development officer for finance in the School of Accounting Economics and Finance at the University of KwaZulu-Natal, South Africa. His research interests include financial markets, behavioural finance, investment analysis and portfolio optimization.

References

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. https://doi.org/10.1016/j.jbef.2020.100326

Amihud, Y. (2002). Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets*, 5 (1), 31–56. https://doi.org/10.1016/S1386-4181(01)00024-6

Amihud, Y. and Mendelson, H. (1991). Liquidity, asset prices and financial policy. *Financial Analysts Journal*, 47 (6), 56-66. https://doi.org/10.2469/faj.v47.n6.56

Ashraf, B.N. (2020). Stock markets' reaction to COVID-19: Cases or fatalities?. *Research in International Business and Finance*, 50. https://doi.org/10.1016/j.ribaf.2020.101249

Ayittey, F.K., Ayittey, M.K., Chiwero, N.B., Kamasah, J.S., and Dzuvor, C. (2020). Economic impacts of Wuhan 2019□nCoV on China and the world. *Journal of Medical Virology*, 92 (5), 473-475. https://doi.org/10.1002/jmv.25706

Baig, A., Butt, H.A., Haroon, O., and Rizvi, S.A.R. (2020). Deaths, panic, lockdowns and US equity markets: the case of COVID-19 pandemic. http://dx.doi.org/10.2139/ssrn.3584947

Baltagi, B.H. (2008). Econometric analysis of panel data, 4th ed. John Wiley and Sons, West Sussex.

Barro, R.J., Ursúa, J.F., and Weng, J. (2020). The coronavirus and the great influenza pandemic: lessons from the "Spanish flu" for the coronavirus's potential effects on mortality and economic activity. National Bureau of Economic Research, working paper no. 26866.

Bloomberg (2020). JALSH:IND. https://www.bloomberg.com/quote/JALSH:IND [Accessed 15 June 2020]

Boako, G. and Alagidede, P. (2018). African stock markets in the midst of the global financial crisis: Recoupling or decoupling? *Research in International Business and Finance*, 46, 166-180. https://doi.org/10.1016/j.ribaf.2018.02.001.

Bollen, N.P., Smith, T., and Whaley, R.E. (2004). Modeling the bid/ask spread: measuring the inventory-holding premium. *Journal of Financial Economics*, 72 (1), 97-141. https://doi.org/10.1016/S0304-405X(03)00169-7

Cannon, S.E. and Cole, R.A. (2011). Changes in REIT liquidity 1988–2007: evidence from daily data. *Journal of Real Estate Finance and Economics*, 43, 258-280. https://doi.org/10.1007/s11146-010-9270-3

Chordia, T., Roll, R., and Subrahmanyam, A. (2008). Liquidity and market efficiency. *Journal of Financial Economics*, 87(2), 249-268. https://doi.org/10.1016/j.jfineco.2007.03.005

Christensen, C. (2020). The relative industry specific effects of COVID-19 on market volatility and liquidity. https://digitalcommons.usu.edu/gradreports/1470

Chung, K.H. and Zhang, H. (2014). A simple approximation of intraday spreads using daily data. *Journal of Financial Markets*, 17, 94-120. https://doi.org/10.1016/j.finmar.2013.02.004

Cooray, A. (2010). Do stock markets lead to economic growth?. *Journal of Policy Modeling*, 32 (4), 448-460. https://doi.org/10.1016/j.jpolmod.2010.05.001

Copeland, T.E. and Galai, D. (1983). Information effects on the bid-ask spread. *Journal of Finance*, 38 (5), 1457-1469. https://doi.org/10.1111/j.1540-6261.1983.tb03834.x

Funck, M. and Gutierrez, J.A. (2018). Has Ebola infected the market: a contagious reaction to a (media) health care crisis? *Journal of Business Strategies*, 2018. http://dx.doi.org/10.2139/ssrn.2786001

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

Hsiao, C. (2014). Analysis of panel data, 3rd ed. Cambridge University Press, Cambridge.

IMF (2020a). Policy responses to COVID-19. https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19#S [Accessed 15 June 2020].

IMF (2020b). World economic outlook, April 2020: the great lockdown. https://www.imf.org/en/Publications/WEO/Issues/2020/04/14/weo-april-2020 [Accessed 15 June 2020].

Ivanov, D. and Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research*, 58 (10), 2904-2915. https://doi.org/10.1080/00207543.2020.1750727

JSE (2020). Ninety One Limited and Ninety One Plc ("Ninety One" or the "Ninety One Group") lists on the JSE. https://web.jse.co.za/news/press-releases/ninety-one-limited-and-ninety-one-plc-ninety-one-or-ninety-one-group-lists-jse [Accessed 16 June 2020]

Kennedy, P.E. (1992). A guide to econometrics, 4th ed. The MIT Press, Cambridge.

Liu, W., Wan, D., and Chen, W. (2019). A closed-form quasi-maximum likelihood estimator of bid-ask spread. Communications in Statistics-Simulation and Computation. https://doi.org/10.1080/03610918.2019.1662042

Ma, R., Anderson, H.D., and Marshall, B.R. (2016). International stock market liquidity: A review. *Managerial Finance*, 42 (2), 118-135. https://doi.org/10.1108/MF-04-2015-0096

McTier, B.C., Tse, Y., and Wald, J.K. (2013). Do stock markets catch the flu?. *Journal of Financial and Quantitative Analysis,* 48 (3), 979-1000. https://doi.org/10.1017/S0022109013000239

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., and Agha, R. (2020). The socio-economic implications of the coronavirus and COVID-19 pandemic: A review. *International Journal of Surgery*, 78, 185-193. https://doi.org/10.1016/j.ijsu.2020.04.018

Parkinson, M. (1980). The extreme value method for estimating the variance of the rate of return. *Journal of Business*, 53 (1), 61–65.

Roch, A.F. (2011). Liquidity risk, price impacts and the replication problem. *Finance and Stochastics*, 15. https://doi.org/10.1007/s00780-011-0156-x

Stoll, H.R. (2003). Chapter 9 - market microstructure. Handbook of the Economics of Finance. 1, 553-604. https://doi.org/10.1016/S1574-0102(03)01013-6

WHO (2020a). Novel Coronavirus (2019-nCoV) - situation report - 1. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf?sfvrsn=20a99c10_4 [Accessed 15 June 2020].

WHO (2020b). Weekly update on COVID-19 – 12 June 2020. https://www.who.int/publications/m/item/weekly-update-on-covid-19---12-june-2020 [Accessed 15 June 2020].

WHO (2020c). Coronavirus disease (COVID-19) - situation report - 144. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200612-covid-19-sitrep-144.pdf?sfvrsn=66ff9f4f_4 [Accessed 12 June 2020].

WHO (2020d). Coronavirus disease 2019 (COVID-19) - situation report - 46. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200306-sitrep-46-covid-19.pdf?sfvrsn=96b04adf_4 [Accessed 15 June 2020].

WHO (2020e). WHO coronavirus disease (COVID-19) dashboard. https://covid19.who.int/?gclid=CjwKCAjwt-L2BRA_EiwAacX32V9xH14UwD_q3bh9L8cYKSOF4Km8L4I1BHjXHl3hjRpiNfdYEiO8OhoC2Q0QAvD_BwE [Accessed 16 June 2020].

Woolridge, J.M. (2010). Econometric analysis of cross section and panel data, 2nd ed. The MIT Press, Cambridge.

World Bank Group (2020). COVID-19 outbreak: capital markets implications and response. http://pubdocs.worldbank.org/en/776691586478873523/COVID-19-Outbreak-Capital-Markets.pdf [Accessed 15 June 2020].

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