Liquidity, Trading Activity, and Stock Price Volatility: Evidence from a Stressed Market

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Research Article

Abstract

Purpose: *While the bulk of previous research focused on security-level volatility and the relationship of its determinants, the current study considers the relationship between the number of trades, lagged absolute returns, trading volume, bid-ask spread, and price volatility on the Zimbabwe stock market.*
Methods: *The study applied Hausman's (1982) tests of the specification. The parameters and elasticity of explanatory variables have been estimated by utilizing the Generalized Method of Moments (GMM) procedure in a five-equation structural model. The data were obtained from a web-based financial market platform, Investing.com between 2009 and 2021.*
Results: *Results show that inflation had a positive relationship with stock price volatility which provided a hedge against inflation. There exists an indistinguishable difference between the random effects (RE) and fixed effects (FE) results and those obtained using the Pooled Ordinary Least Squares (POLS) on the total sample reflecting a cohesion of these findings.*
Implications: *Understanding the relationship between inflation and market risk (volatility) can be beneficial to the investor in selecting the appropriate and most convenient investment strategy. From a policy-making perspective, strategic policy measures employed towards reducing inflation would certainly reduce stock market volatility and boost investor confidence.*

Keywords: Dynamic models, Liquidity, Pooled OLS, Trading activity, Stock Price Volatility, Stock Market, Zimbabwe

1. Introduction

Numerous factors determine stock market volatility. These include, but are not limited to, trading volume, bid-ask spread, number of transactions, inflation, and lagged absolute return. However, trading volume, bid-ask spread, and price volatility are some of the most heavily studied variables in finance since they affect policymakers, equity investors, and regulators. Amongst traders, there exist players who take different positions in their approach to investment that include speculators, hedgers, and arbitrageurs who take their strategies based on information centered on the behavior of these variables as they react to new information that filters in the market in anticipating possible future prices. It is noteworthy that from policymakers' and regulators' perspective market activity hinges on these fundamental variables and hence the study of volatility and its determinants is relevant in the microstructure literature of financial markets. Needless to mention that proper trading strategy is not feasible without adequate knowledge of these stock market fundamentals. Importantly, this is an indication that volatility in the exchange rate affects economic growth negatively through the inflation rate: the higher the level of volatility in the exchange rate, the worse the inflationary-growth relationship of the region, (Olamide, Ogujiuba & Maredza, 2022). In most existing

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studies, one common feature is the assumption of considering model variables as exogenous to each other. Some studies applied ordinary least squares (OLS) to determine the determinants of bid-ask spread with transaction volume, the number of transactions, and many more variables as independent/explanatory variables (Wojtowicz, 2014). In their study, Chinloy, Cheng, and Kose (2022) established that there is a positive volume–return relationship in house returns. In like manner, Blume and Keim (2012), instituted a study on the effect of institutional holdings on bid-ask spread on which trade volume was considered as an exogenous variable by applying an OLS regression model. Another study, (International organization of securities commissions, 2022) discovered that the relationship between estimated trade-size pricing and bid-ask spread inverted. On a close analysis of past research work, it is prudent to infer that some variables in this regard do not qualify to fall under the exogenous category. Such variables include the likes of transaction volume, bid-ask spread, price volatility, and the number of transactions. Most recent studies have focused on the application of structural equations to model such stock market behavior. These include Karki (2017) and Yang *et al.* (2021) among others. There seems to be a consensus in findings reinforcing that these variables are not exogenous but rather endogenously determined. However, this has put to rest the critical bone of contention as to how these variables relate to one another and thereby recommending a suitable methodological solution. To produce proper, robust, and consistent estimates underpinning any study the researcher needs to utilize an appropriate model.

This research makes several contributions to the academic literature. While the bulk of previous research focused on security-level volatility and its determinants relationship, our study considered a full sample comprising of a hundred percent counters composition which was functional from 2009 until 2022 in addition to breaking it into sub-samples that encompasses stock market sectors defined in line with the Zimbabwe stock market guidelines. Whereas the researcher recognizes limiting constraints posed by multicollinearity issues amid stock market variables, due diligence was carried out to reduce its impact in this research by embracing an augmented econometric model to go along with activity-adjusted volatility variables to outmaneuver this aspect. The relationship that exists in the stock market was examined by applying Hansen (1982) test in a five-equation simultaneous structural model which accommodates the endogeneity of five variables, that is, number of transactions, trade volume, lagged absolute return, bid-ask spread, and volatility. These variables have been viewed as exogenous in previous studies. In this study, we focused on (a) the relationship between stock market volatility, number of transactions, trade volume, bid-ask spread conditioning on inflation and (b) the relationship between stock market volatility, bid-ask spread, trade volume, and number of transactions conditioning on interest rates. Secondly, we applied both the generalized method of moments (GMM) and OLS and concluded that the GMM methodology produces consistent coefficients of elasticity relative to the OLS counterpart. The OLS has been extensively used in a majority of previous studies to yield results. The third contribution pertains to the methodological framework that has been adopted which is robust in that it produces consistent and dependable estimates.

In 2008 there was an outbreak of the worldwide financial/economic crisis that earmarked the quest for a comprehensive appreciation of the dynamics of stock market volatility and liquidity as the distinct intense precedencies facing stock market investors and regulators universally. There is a divergence of theories and schools of thought about the relationship between stock market liquidity and volatility at a portfolio level. Nevertheless, although this relationship is evident, a big sample has been engaged in the study of the relationship between the principal factors that interact that encompass trading business and equity market returns (e.g., see Bank for International Settlements and International Organization of Securities Commissions (2012); and Bernanke and Kuttner (2004)). Strong market returns, in large part driven by venture

Capital-backed companies generated large amounts of private wealth, which served to fuel investments in hedge funds (World Economic Forum, 2020). The principal aim here is to shed more light on the

relationship among trading activity, trading volume, bid-ask spread, number of transactions and lagged absolute return using a compressed, lengthy, and recent set of data extracted from a distressed economy.
The paper estimates stock market volatility and its determinants on a full sample and sub-samples (sectors) using four principal experiential methodologies that encompass fixed effects (FE), random effects (RE), pooled ordinary least squares (POLS), and system generalized method of moments (sys-GMM). The remaining part of the paper is arranged as follows: the methodology is discussed in Section 2, the data and model in Section 3, the results in Section 4, and the conclusion and recommendations in Section 5.

2. Methodology

2.1. Data
We selected all the counters that participated in the Zimbabwe stock exchange activities as a representative of the whole portfolio. We employed daily weighted market capitalization for the number of transactions performed, bid-ask spread, trading volume, and realized volatility of all listed firms on the Zimbabwe Stock Exchange from 1 February 2009, to 30 April 2020.
The source of the data for this research is https://www.investing.com and the Institute for the Study of Securities Markets (ISSM). The weighted market capitalization bid-ask spread is considered to be a proxy to market liquidity and/or trading cost whilst the number of transactions and trading volume act as a measure to represent trading activities. In this study, we constructed the overall liquidity based on bid-ask spread and trading activity variables through the use of the weighted market capitalization average of these variables across counters using each counter's daily market capitalization as the relative weight. The volatility of the market is obtained by calculating the daily stock return index standard deviation over a month (30-calendar-day almost equivalent to 22 trading days).
The study uses data on 62 Zimbabwe Stock Exchange (ZSE) - Listed Companies from 2009 to 2020. The companies are classified under the following categories; consumer goods (16), consumer services (14), Industrial (7), basic materials (6), telecom (3), and financials (16). The grouping of counters follows that adopted by the ZSE as reflected on the website of the African market [https://www.african-markets.com/en/stock-markets/zse/listed-companies]. The main reasons for limiting the sample size are listed below although due diligence was taken to make the sample size more representative of the equity market. Furthermore, the primary purpose of this research study is to unearth the benefaction of trade volume, bid-as spread, and the number of transactions to volatility on the ZSE, it is essentially important to split the full specimen into eight sub-samples across sector delineations as elaborated above to show variations across the sub-categories.

2.2. Inclusion requirements
A counter is incorporated or precluded in the course of a particular budget year if the subsequent benchmarks link up: (1) the counter should subsist during the inception and at the close of the calendar year in the day-long databases. (2) If the counter deregisters from the exchange during the period under study, then it was dropped from the group. (3) Primarily ordinary equities and those assets whose trading characteristics might coincide with them are included. (4) In a bid to circumvent the probable impact of expensive shares, given that the stock somehow in the course of the period is three or more times the least priced, then the counter is eliminated from the group.
If the counter is incorporated in the specimen, the transaction data is embraced or precluded by adopting the following benchmarks: (1) Out-of-sequence commercial dealings are excluded from the series, implying that those trades documented before and after the opening and closure of the market respectively, or those that have a particular settlement state of affairs. (2) Negative bid-ask spreads are discarded.

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2.3. The Variables

In line with similar studies of this nature, the main variables to be embraced are volatility (*vo*l), weighted market capitalization bid-ask spread (*bas*), trade volume (*volm*), number of transactions (*ntt*), and lagged absolute return (*lar*).

Volatility, in this paper, is quantified as the standard deviation of weighted stock return series from counters in the same sector. This indicator is included because it captures the riskiness of the counters in a particular sector which in turn affects an investment decision.

Bid-ask spread or buy-sell is defined as the quantity on which the security selling price (the lowest amount that a seller is willing to accept) is more than the offer price (the highest amount that a buyer is willing to pay) for security in any market. An individual looking to sell will receive the bid price whilst the one looking to buy will pay the asking price. It is a priori reason to expect that a positive relationship exists between volatility and bid-ask spread i.e. the more liquid a stock, the tighter spread. To cater to the potential liquidity effect on volatility the inclusion of quoted spread is embraced. A situation in which today's security return greatly impacts unconditional variance for infinitely many future periods is called volatility persistence. To account for this component, the researcher will employ adopt the lagged absolute return. It has been calculated as a daily weighted market capitalization value for the defined sector. This variable has been included because it has the potential to affect the price at which a purchase or sale is made, and thus an investor's overall portfolio returns and final investment decision.

Trade exchange volume is regarded as the total quantity of discharged trades for a specified financial asset or covering the entire trading platform in a designated time frame. This predictor variable is included based on its indispensable role in prescribing to investors the activities on the market besides its liquidity condition. A hyperactive trading market that connects buyers and sellers is reflected by high trade volumes for particular financial security presupposing higher liquidity. It is therefore important to note that trading volume is a fundamental driver in technical analysis as it can be used as a proxy to measure the relative gravity of a market move. In the technical analysis domain, a slight security price movement resulting in an over-the-odds trade volume adjustment signifies a more volatile and contrariwise. Thus, the significance of the variable in the GMM model is to capture and assess the strength of the relative significance of any market sector move. A relatively large market movement in a particular time phase that will impact on strength of that particular signal may either acquire integrity or be grounded on the trading volume for that period can be contemplated with skepticism.

Lagged absolute return: many econometric models including the GMM are highly dynamic in that they embrace lagged variables to incorporate feedback over time. Lagged absolute return variables are incorporated in the model on an assuredly theoretical question basis. Their inclusion makes real sense because lagged dependent variables in the analysis are based on stylized facts on financial data and we expect that the current level of the dependent variable is largely determined by its immediate past level and also to make the data mean stationary. In that case, not including the lagged dependent variable will lead to omitted variable bias and results might be unreliable. In such a scenario, including the lagged dependent variable, will take out a lot of variances and may most probably make our other dependent variables' effects less significant (which means both make the coefficient(s) smaller and the standard errors bigger).

The number of transactions is the number of completed buy and sell orders performed for a defined security per a given time frame. These are herein expressed as the value-weight averaged over ZSE stocks that are viewed as the aggregate activity that affects stock market movements. It can be used as a proxy for the rate of information arrivals that has a significant influence on stock market volatility.

Dummy variables: Zimbabwe is a unique country in that it has gone through numerous phases of economic development and monetary dispensations. These range from the dollarization of the economy into multiple currency regime, the introduction of a quasi-currency regime in the name of bond notes, implementation of

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the real-time gross settlement (RTGS) regime up to the current system whereby she has reverted to the use of a basket of currencies in addition to its local one. To cater to this currency evolution, the dynamic fixed effects (DFE) model is additionally employed. A 12-year non-overlapping period is used to further capture variations that may be exhibited across the different time phases. This aspect is captured by the inclusion of year dummies to attribute some exhibited data variation to unperceived circumstances that took place during a particular year.

Lastly, five other dummy variables are constructed to cater to and capture variations that exist across the five stock market sectors that exist on the ZSE. In this case, the dummy will have a 1 for counters in that sector and 0 otherwise. The dummies are only captured in the pooled OLS estimations.

The indicator variables outlined above, their measurements, and their sources are given in Table 1. This takes cognizance of the general structure of the empirical model and the distinct heterogeneities exhibited across the stock market sectors.

3. Results and Analysis

3.1. Econometric models

The built regression framework is constructed using Hansen's (1982) Generalized Method of Moment methodology and also adopting the Newey and West (1987) correction for anticipated serial correlation. The estimates obtained from the GMM are highly robust in the presence of autocorrelation and heteroscedasticity. These two features are a common phenomenon in this type of data and hence justify the use of GMM. To evaluate the impact of trading volume, the number of transactions, bid-ask spread, and lagged absolute returns on stock market volatility using the full and sub-samples (sectors), the study adopts a Panel data model. In as much as the proposed econometric methodology makes use of GMM, it is mandatory to test all the variables on whether they satisfy the necessary and sufficient suppositions required for GMM approximation.

Table 1: Variables and sources.

S/No.	Variables and Measurements	Source
1	Volatility	Authors' Computation
2	Bid-ask spread	https://www.investing.com
3	Trading volume	https://www.investing.com
4	Lagged absolute return	Authors' Computation
5	Number of transactions	WBGFDD
6	Dummy variables	Authors' Computation

Note: WBGFDD: World Bank Global Financial Development Database

Source: Author's Compilations.

All variables must meet the stationarity requirement. That can be done using the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests (Table 2). In this test, the null hypotheses of a unit root are not accepted for all five variables at the 1% level of significance. If a researcher is using quantitative data, it is important to perform a stationarity test to ensure that they are stationary.

Table 2: Results for unit root

Variable	ADF test			Phillips-Perron test		
	None	Constant	Constant and trend	None	Constant	Constant and trend
vol	-54.264*	-54.274*	-54.265*	-54.301*	-54.298*	-54.291*
volm	-57.944*	-57.958*	-57.949*	-57.901*	-57.919*	-57.909*
bas	-56.618*	-56.626*	-56.617*	-56.697*	-56.715*	-56.705*
ntt	-59.130*	-59.145*	-59.135*	-59.090*	-59.129*	-59.119*
lar	-59.059*	-59.072*	-59.062*	-58.955*	-58.956*	-58.947*

Note: * denotes significance at the 1% level

Source: Author's computations.

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Modeling with nonstationary data results in spurious regression. It simply means that the data-generating process of that series does not evolve around zero. So it is always good to test the data of the variables you are using to make sure that those variables are stationary. The unit root tests for all variables to be used in this research are summarized in Table 2. The unit root test for the null hypothesis test and the alternative hypothesis of stationarity is jointly performed using the ADF and PP tests. The empirical tests for the full sample of the ZSE counters yield relatively large negative values in all cases for levels such that the individual indicator variables series reject the null hypothesis at the 1% significance level so that all variables are stationary. To realize the study's end goal, a row vector of control variables, X^', and sector dummy variables (to capture dissimilarities exhibited by the five sub-sectors) are incorporated into the model. Without imposing certain restrictions, the model becomes:

$$\boldsymbol{Y}_{it} = \alpha_0 + \boldsymbol{X}_{it}\beta + \gamma_i + \varphi_i + \mu_{it}$$

With $\boldsymbol{Y}_{it}$ being stock return volatility in which *t* represents time in years ($t = 1, 2, \ldots, 12$) and i denotes the counter number ($i = 1, 2, \ldots, 62$); α_0 is the constant value; $\boldsymbol{X}_{it}$ is the vector of control variables (bid-ask spread, number of transactions, the volume of trade and lagged absolute returns); φ_i represents year dummies (which controls for common shocks such as the global financial crises of 2007-2009), γ_i indicates sectoral dummies; and μ_{it} is the general error term.

Additionally, the sample is divided according to sectors and five of them are delineated as; Consumer goods (CG), Consumer services (CS), Industrials (IN), Basic Materials (BM), Tel-com (TL), and Financials (FI). Furthermore, to consistently produce the significance of these control variables on stock market volatility, the research has adopted static and dynamic models. The study uses a long panel of 62 counters (N) across 12 years (T), implying that T<N. The adoption of both the fixed and dynamic model techniques enhance robustness checks for one another to discover the consistency of the impact of the control variables on stock market volatility. There are two classes of static models that is the pooled ordinary least squares (POLS) which is relatively restrictive in that it specifies constant coefficients and mitigates problems of heteroscedasticity of the error term and reduces the impact of outliers in the data for cross-sectional analysis, i.e. across the panels and the within or in other terms the FE models which recognizes panel heterogeneities. Furthermore, the dynamic model is adopted which in more technical terms is the systems generalized method of moments (sys-GMM) that is designed for short panel analysis. Some distributional assumptions that are withheld for the adoption of sys-GMM include the fact that the data-generating process is dynamic. The analysis in this research is nevertheless done both on the whole stock market spectrum and as well as on the sectors of the stock market. The standard model, POLS is utilized to quantify a measure of the full and sub-samples, whereas the FE and sys-GMM techniques do not apply to sub-samples and hence are employed exclusively on the full sample regressions owing to the minimal number of observations. The specification carried out on the sys-GMM encompasses the lagged absolute returns as an acceptable regressor. In statistical data analysis, colinearity is a big challenge; and to elude this ugly scenario the built model will exclude some variables that exhibit a high degree of substitutability.

3.3 System Generalized Method of Moments (Sys-GMM) Estimator

Endogeneity amongst variables poses a serious drawback in establishing an acceptable degree of robustness of estimators and this can be comfortably addressed by the use of system generalized methods of moments estimator. According to Arellano and Bond (1991) and Blundell and Bond (1998) the non-static and spirited dynamic panel estimators are employed provided the following circumstances are satisfied: (1) there is a large *N* and a small *T*, implying more groups and a few periods; a linear functional relationship exists between variables; (2) there is one dependent variable that is regarded as dynamic, i.e. depending on its past observations; (3) not strictly exogenous independent variables, implying that there is a serial correlation with the error term; (4) there are fixed individual effects; and (5) according to Roodman et al. (2006),

Roodman and Morduch (2014) there must exist heteroscedasticity and autocorrelation within individual variables but not across them.
It is ideal to transform all regressor variables before serious estimation begins (Arellano and Bond, 1991). The principal transformation procedure is through differencing, and this gives fertile grounds for the application of the Generalized Methods of Moments (Hansen (1982); Holtz-Eakin et al. (1988)) which is known as difference GMM.
To add more substance to that the Arellano–Bover, and Blundell–Bond estimators make further presumptions in saying that differenced data are not correlated with the fixed effects which by and large increase the robustness and the general efficiency of the solution by incorporating a transformed equation together with the original one to make it a systems-GMM. Since in this study lagged absolute return series are going to be employed, it is prudent to test for autocorrelation on GMM regressor variables on the panels (Arellano and Bond, 1991). To test for the efficiency and consistency of the system GMM estimators, the Hansen test is going to be employed to examine for serial autocorrelation of error terms as well as test for the validity of instruments through over-identification restrictions tests. Accepting the research hypothesis automatically surely strengthens the model (Arellano and Bond (1991); Ogundipe et al. (2014); Sghaier and Abida (2013)). Duru, et al. (2022), investigate the effect of exchange rate volatility, real exchange rates, and real GDP of China on ASEAN member nations' bilateral exports to China using the same GMM technique.
The justification for the use of the empirical model is because of the nature of the data in which 62 counters are examined across 12 years (2009-2020 inclusive). This satisfies all necessary and sufficient conditions for the use of the sys-GMM which is applicable for short panels, (Roodman et al. (2006); Roodman and Morduch (2014)). The application of the dynamic system-GMM has the advantage of controlling estimate bias and its associated problems, which is propounded in the name of endogeneity, panel/counter-specific heterogeneity, and the fact that it adequately captures both the short and long-run impacts of the regressors on the regressand. This strength is not enshrined in the so-called static models.

3.4. Descriptive statistics
The market-wide volatility, trading volume, bid-ask spread, number of transactions, and lagged absolute return relative statistics used in this study are exhibited in Table 3 for both the full representative and across the five sectors of the economy as defined by the ZSE. The average volatility for the full sample is 0.1542 with Basic materials having the highest at 0.1762 and Telecoms showing the lowest at 0.1402. In like manner across sectoral classification, the average trading volume ranges between 237 and 1900. The average weighted-bid ask spread is highest in Financials at 0.1074 and lowest in Consumer services at 0.0297. The largest average number of transactions in Consumer goods with 910 (72.45%) followed by Basic materials at 562 (61.94%). The highest average lagged absolute return occurs in Basic Materials with 0.0911 and the lowest is recorded for Consumer goods with 0.0279.
On the skewness; Telecoms, Consumer Services, and Financials have high positive values for all the explanatory variables while there is no negative skewness for all the sectors. A tight exploration of the figures conveys the fact that compared to other sectors, Financials and Telecoms have high kurtosis on all indicators even-though Consumer Goods and Consumer Services underscore relatively low kurtosis. The correlation matrix with the natural logarithms of the variables as reflected in Table 4 shows that trading volume, number of transactions, and lagged absolute returns have a positive and statistically significant association with volatility while the weighted bid-ask spread has a negative and statistically significant association. However, a strong and positive Pearson correlation is detected between trading volume and the number of transactions (0.707).

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Table 3: Descriptive statistics

Panel A												
	Full sample				Consumer goods				Consumer services			
Variable	Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis
vol	0.1542	0.124	5.0776	44.1337	0.1410	0.0261	0.1459	-1.1968	0.1480	0.1187	10.5092	112.7271
volm	567	1.309	6.7516	23.1112	1900	2.7178	17.9166	21.2307	412	3.1723	6.3241	30.4051
bas	0.0587	0.109	15.5561	583.2978	0.0290	0.0559	2.1604	3.5343	.0297	0.0539	5.5623	74.5424
ntt	471	2.132	4.2397	12.3452	910	4.2871	22.1176	19.2123	372	6.3217	7.2541	26.5612
lar	0.0396	0.888	54.0774	347.7328	0.0279	0.0525	2.0859	3.2012	0.0320	0.1288	30.2461	1045.9342
PanelB												
	Industrials				Basic materials				Financials			
Variable	Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis
vol	0.1586	0.089	2.1760	4.2482	0.1762	0.0442	0.7682	2.4067	0.1617	0.2132	7.3476	54.2519
volm	967	2.791	4.2171	11.3252	810	3.3248	20.6151	19.3287	712	2.4567	8.1238	30.4571
bas	0.0605	0.071	0.8684	-0.6867	0.0599	0.0991	2.8760	16.6221	0.1074	2.9034	35.7944	1281.8235
ntt	542	1.301	6.1239	13.2319	562	6.3428	19.2317	20.7102	212	9.4051	5.9782	39.3216
lar	0.0597	0.069	0.8587	-0.6657	0.0582	0.0911	1.9457	5.6316	0.0354	0.2287	19.2757	386.7097
Panel C												
	Telecoms											
Variable	Mean	SD	Skewness	Kurtosis								
vol	0.0402	0.166	9.5186	92.3650								
volm	237	3.172	5.1392	9.1373								
bas	0.1660	2.147	46.0754	2123.9515								
ntt	123	7.892	6.2310	78.2341								
lar	0.0250	0.177	24.9152	645.5860								

Note: Descriptive statistics are given for the value-weighted average daily natural logarithm of volatility (*lnvol*), the natural logarithm of volume (*lnvolm*), the market capitalization-weighted natural logarithm of bid-ask spread (bas), the market capitalization-weighted natural logarithm of lagged absolute return (*lnlar*) and the number of transactions (*lnntt*) measures from ZSE over 2009–2020 inclusive. The weights attached are proportional to market capitalization at the end of the previous trading calendar year.

From Table 4, a correlation matrix of the natural logarithms of the variables exhibits that volatility and lagged absolute returns and as well as trading volume and number of transactions have a strong positive and statistically significant association. On the other hand, there subsists a direct and statistically significant association between the volatility and volume of trade and also between the volume of trade and bid-ask spread. The principal reason for the adoption of Kendall and Spearman's rank correlation is based on its robustness in dealing with data when at least one of the variables is skewed and capable of handling outliers. Volatility, bid-ask spread, and lagged absolute returns are persistent up to at least five daily lag whilst the number of transactions is continuous up to lag one. Trading volume has no autocorrelation of any significance. Consequently, the Zimbabwe stock exchange seems to take instantaneous exposition of the foreseeable segment of the persistence in volatility, bid-ask spread and lagged absolute returns. It is worth noting a compelling feature of the number of transactions series in that its first differences display strong negative autocorrelation which decays very rapidly. The changes in the bid-ask spread are significantly negatively autocorrelated at all five lags.

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Table 4: Rank correlation, linear correlation, and Autocorrelation

Panel A: Correlation				Panel B: Autocorrelation					
Pair	**Kendall's τ**	**Spearman's ρ**	**Pearson**	Lag	vol	volm	bas	ntt	lar
lnvol-lnvolm	0.106**	0.154**	0.061*	1	**0.265**	0.023	**-0.465**	**-0.321**	**0.376**
lnvol-lnbas	-0.039*	-0.056*	-0.045	2	**0.241**	0.019	**-0.421**	-0.096	**0.322**
lnvol-lnntt	-0.024	-0.0306*	-0.027	3	**0.230**	-0.018	**-0.400**	-0.022	**0.97**
lnvol-lnlar	0.968**	0.970**	0.982**	4	**0.228**	-0.026	**-0.399**	-0.022	**0.290**
lnvolm-lnbas	0.037	0.052	0.025	5	**0.227**	-0.035	**-0.384**	-0.018	**0.271**
lnvolm-lnntt	0.524*	0.637*	0.707						
lnvolm-lnlar	0.102**	0.148**	0.053*						
lnbas-lnntt	0.612*	0.618*	0.619						
lnbas-lnlar	-0.064*	-0.064*	-0.051*						
lnntt-lnlar	-0.012*	-0.018*	-0.013*						

Note: Panel A shows the correlation coefficients for both the Kendall's and the Spearman's. These quantify the degree of and direction of the relationship that prevails between two variables. The other measure is the Pearson correlation coefficient, which measures the linear correlation between variables. ** and * designate relevance at 0.01 and 0.05 (two-tailed) levels respectively. *lnvol*: value-weighted average daily natural logarithm of volatility; *lnvolm*: natural logarithm of volume; bas: market capitalization-weighted natural logarithm of bid-ask spread; *lnlar*: market capitalization-weighted natural logarithm of lagged absolute return; *lnntt*: number of transaction measures. The weighted values are calculated the same, pro rata, as proportionate to market capitalization realized at the terminal of the preceding trading calendar year. Panel B reports autocorrelations. The bolded font reflects significant values that depict an asymptotic p-value that is strictly less than 0.00001.

3.5. Pooled Ordinary Least Squares (POLS) results.

The stock market full sample results are shown in Table 5 which have been obtained from the POLS estimator. The main regressions column is obtained with inflation as the control variable whilst the robustness checks column is found with an interest rate as the control variable. Results in column 2 show the positive and statistically significant association at 1% between the weighted average of trading volume, the number of transactions, lagged absolute return, and volatility. The effect of these on stock volatility of the Zimbabwe stock market is 0.2239, 0.1305, and 0.0968, respectively.

Table 5: Full sample POLS results (Dep. Variable: Volatility (*lnvol*), log)

Variables	**Regressions**	**Robustness checks**
Constant	0.5032***	0.5078***
Trading volume (*lnvolm*), log	0.2239***	0.2253***
Bid-ask spread (*lnbas*), log	-0.0718**	-0.0625**
Number of transactions (*lnntt*), log	0.1305***	0.1871***
Lagged absolute return (*lnlar*), log	0.0968**	0.0970**
Inflation	0.0010***	
Interest rate		0.0517
Consumer goods	1.132***	1.129***
Industrials	1.232***	1.229***
Telecoms	0.016	0.014
Financials	0.811***	0.817***
Basic materials	0.561**	0.611**
Year Dummies	Yes	Yes
No. of Obs.	62	62
R-Squared	0.875	0.854
F Statistic	120.508	141.345

Note: ***, ** and * reflect statistically significant values at the 1%, 5% and 10% levels, respectively. The t-statistics exhibited in the parentheses are based on White heteroscedasticity-consistent standard errors.

This reflects that a percentage change in the weighted average of trading volume, number of transactions and lagged absolute return is associated with a 0.2239%, 0.1305%, and 0.0968%, respectively increase in volatility in the short run, at the 1% significant level, on average ceteris paribus. Hence, these variables

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exhibit an elastic relationship with stock market volatility. These output/yield elasticities are not significantly different from those attained from the robustness checks with output elasticities of 0.2253%, 0.1871%, and 0.0970%. Based on the output it can be revealed that; the elasticity for weighted average trading volume is the largest implying that an increase in trading volume has a greater impact on the volatility relative to other variables. The positive coefficients of these three variables are consistent with a priori expectations an increase in trading activities leads to a more volatile market. Accordingly, results obtained from the analysis demonstrate that trading activities substantially influence trade information release. These findings are compatible with the theories revolving around information as well as Barclay and Warner's (1993) stealth trading hypothesis. Such discoveries also reinforce Jones et al. (1994) findings which state that both measures of trading activity under consideration, i.e., number of transactions and trading volume have similar information content and hence pose similar effects on volatility. Since trading activities can be decomposed into two principal components which are trading volume and number of trades, it is prudent to note that from the ZSE perspective the trading size is much more important than the number of trades (trade frequency) in affecting stock price volatility. This evidence appears to concur with the dominant market microstructure theories of stock price determination, which place more emphasis on the role of trade size as a means of detecting likely informed trading and adverse selection. Earlier studies by Karpoff (1987) made a similar revelation and reported that stock price volatility is positively related to trading volume. Nevertheless, these so-called earlier studies ignore competing measures of trading activity which might have a significant influence in determining volatility/liquidity, nor did they examine the number of trades as a measure of trading activity, which is a different case from our study.

The market capitalization-weighted proportional bid-ask spread is used in this research as a proxy for the security/market-wide liquidity/trading cost. Interestingly one of the striking findings is that there exists a negative statistically significant relationship at the 5% level between volatility and liquidity for both the regressions column and the robustness column which aligns with what was expected a priori. This implies that a proportionate decrease in volatility (-0.0718%) occurs when the proportional bid-ask spread changes by 1%, on average, ceteris paribus (lower proportional bid-ask spread implies greater liquidity). In this regard, the sixth sense would submit that incessant stock market price changes (volatility) and liquidity might be further actively influenced by frequent outrageous order disparity, notwithstanding volume. From the inventory theory perspective, a random large order aggravates the inventory trouble encountered by the market maker, who can respond by changing bid-ask spreads and revising price quotations. These large orders may most often suggest hidden information that would temporarily diminish liquidity and could ultimately shift the market price in perpetuity. As a result, order disparity ought to be a fundamental factor in influencing stock returns, volatility, and liquidity, possibly even more important than volume. For the control variables, inflation has excellent predictive capacity for Zimbabwe stock market volatility whilst interest rate reflects a statistically insignificant asymmetric relationship. This suggests that the higher the rate of inflation, the greater the stock market volatility, that is, higher rates of inflation are coincident with greater stock market risk.

The coefficients of the sectoral dummies reveal that the volatility of the Industrials and Consumer goods is 242.81%[1] and 210.19% respectively higher than that of Consumer services (the base sector) for the regressions ceteris paribus. In like manner Financials, Basic materials and Telecoms appear to have higher volatility relative to Consumer services by 125.02%, 75.24%, and 1.61%, respectively. It is worth noting

[1] The value is obtained from the formula: $\left(\mathbf{e^{\beta}-1}\right) * \mathbf{100}$, where $\boldsymbol{e}$ is the exponent of the natural logarithm and $\widehat{\boldsymbol{\beta}}$ is the coefficient. As is consistently the case the regressand is pronounced in natural logarithm and the regressor variable is a dummy (1/0) measure.

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that indistinguishable discoveries are delineated from the comparative robustness checks. Additionally, in the built model, year dummies have been used as control variables. Concluding from the R-squared value, its magnitude reflects that the proportion of imbalance in the regress and variable transmitted by the regressors ranges from 85.4% to 87.5% based on the goodness-of-fit of the two specified models. Regressors are jointly statistically significant in explaining volatility as indicated by the F- statistics in both model specifications.

Table 6: Sector sample POLS results (Dep. Variable: Volatility (lnvol), log).

Variables	**CG**	**CS**	**IN**	**BM**	**TL**	**FI**
Constant	0.7832***	0.5163***	0.3279***	0.1121	0.0159***	0.1267***
Trading volume	0.5233***	0.1013***	0.4765***	0.1738	0.0323	0.0262***
Bid-ask spread	-0.0718**	-0.0625**	0.1325	0.4659	-0.1733***	-0.2897***
No. of transactions	0.1105***	0.1071***	0.0975***	0.0201***	0.1065***	0.0820***
Lag. absolute return	0.0968**	0.0970**	0.0390	0.2128	0.0820	-0.0442
No. of Obs.	62	62	62	62	62	62
R-Squared	0.875	0.854	0.810	0.821	0.873	0.869
F Statistic	120.508	141.345	45.234	70.619	112.517	87.491

Note: CG: Consumer goods; CS: Consumer services; IN: Industrials; BM: Basic materials; TL: Telecoms; FI: Financials; ***, ** and * reflect statistically significant values at the 1%, 5%, and 10% levels, respectively. The t-statistics exhibited in the parentheses are based on White heteroscedasticity-consistent standard errors.

Sector sample regression results using the pooled ordinary least squares (POLS) are shown in Table 6. The elasticity for trading volume is largest for Consumer goods (0.5233%) followed by Industrials (0.4765%) whilst the bid-ask spread though not significant is largest for Basic materials (0.4659%). It can be inferred that Consumer goods and Industrials are the major drivers of stock market volatility relative to other sectors.

4.3 Random and fixed effects results

The random effects and fixed effects results are obtained after consideration for homogeneity. The estimators for the full stock market sample are shown in Table 7. There exists an indistinguishable difference between these results and those obtained using the POLS on the full sample reflecting a cohesion of these findings. Furthermore, it is worth observing that the number of transactions has the largest output elasticities prescribing further evidence that it impacts greatly the volatility of the Zimbabwe stock market followed by trade volume and lagged absolute returns.

Table 7: Random and fixed effects results (Dep. Variable: volatility, log)

Variables	**Main regressions**		**Robustness checks**	
	RE	FE	RE	FE
Constant	0.7438***	0.4578***	0.7344***	0.4127***
Trading volume (*lnvolm*), log	0.2236***	0.2543***	0.0468	0.1257***
Bid-ask spread (*lnbas*), log	-0.0916**	0.1627**	0.6183*	0.1734*
Number of transactions (*lnntt*), log	1.1365***	1.2512***	0.2237	0.1863
Lagged absolute return (*lnlar*), log	0.1937**	0.2970**	0.1820**	0.2783**
Inflation	0.3422***	0.3062***		
Interest rate			-0.0000	-0.0000
Year Dummies	Yes	Yes	Yes	Yes
No. of Obs.	62	62	62	62
R-Squared		0.785	0.696	0.769
F-Statistic		341.345	286.424	385.477
Hausman (p −value)	0.979	0.084	0.000	0.000

Note: ***, ** and * reflect statistically significant values at the 1%, 5%, and 10% levels, respectively. The t-statistics exhibited in the parentheses are based on White heteroscedasticity-consistent standard errors. RE: Random Effects; FE: Fixed Effects.

The same results further stipulate that the bid-ask spread negatively influences stock market volatility. The discrepancy between the explanatory variables and the dependent (volatility) under the model in question

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reflects that the proportion of variation so explained varies from 69% to 79% and the regressors are highly statistically significant and jointly influence volatility as revealed by the F-statistics.
To detect endogenous regressors (predictor variables) in the built regression model, the Hausman Test technique is adopted. However, it is a known fact that a variable whose values are determined by others in the system falls under endogenous variables. Based on the results obtained, the researcher fails to accept H0, implying that the built models exhibit similar features, even though they are different when considering the estimated coefficients and their corresponding p values. Inflation still is posing its ugly face in influencing stock market volatility in Zimbabwe.

4.4. System GMM results

Table 8: Long-run System GMM results (Dep. Variable: volatility, log)

Volatility, log	0.9502***	1.1017***
Trading volume (*lnvolm*), log	0.1022	0.1025
Bid-ask spread (*lnbas*), log	-0.2100	-0.3074
Number of transactions (*lnntt*), log	0.0458	0.0676
Lagged absolute return (*lnlar*), log	0.1008	0.1102
Inflation	1.2329*	
Interest rate		-0.0001
Year Dummies	Yes	Yes
No. of Obs.	62	62
Instruments/Groups	936/949	936/948
Hansen p −value	0.231	0.261
AR(2) p −value	0.872	0.872
F-Statistic	109419.321	99771.867

Note: ***, **, and * reflect statistically significant values at the 1%, 5%, and 10% levels, respectively. The t-statistics exhibited in the parentheses are based on White heteroscedasticity-consistent standard errors. RE: Random Effects; FE: Fixed Effects.

From a broader perspective endogeneity is viewed as a situation where there exists a correlation between an explanatory variable and its corresponding error terms. There arise serious problems of endogeneity when the explanans are influenced by the explanandum or both may be jointly influenced by an abysmal third force. The endogeneity problem is one facet of the wider question of selection bias. Table 8 shows the system generalized method of moments (sys-GMM) estimators after controlling for omitted variables, endogeneity, and heteroscedasticity results obtained from the sys-GMM estimator. Inflation exhibits a positive (1.2329) and statistically significant relationship at the 10% level with volatility in the short-run, on average, ceteris paribus. This reflects that a percentage change in inflation is associated with a 1.2329% increase in volatility in the short-run on average ceteris paribus. There is an elastic association. One lag Volatility variable shows a positive statistically significant relationship with volatility implying that it has a great impact on future volatility with output elasticity of 0.9502% and 1.1017% for main regression and robustness checks, respectively.
Given the autoregressive [AR (2)] statistics and their corresponding p values, second-order serial correlation is not an issue in this regard. Considering the p values against the Hansen statistics the hypothesis of instrument validity is accepted at the 5% level of significance. On that account, there is sufficient evidence that deductions can be made based on the outcome.

4. Conclusion and Recommendations

While the importance of volatility and liquidity in equity markets is well documented, the relative importance of the different components that impact them and their different respective dimensions is not as clear. In this paper, we determined the parameter coefficients and elasticity of volatility, liquidity, trading

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activity, stock price volatility, and bid-ask spread as evidence from a stressed stock market in a seven-equation structural model using the generalized method of moments (GMM) procedure. Bid-ask spread has been adopted as a proxy for liquidity. The data were subdivided into 5 sectors from a full sample of 62 counters to highlight the heterogeneity across them. The estimators are done on both the full sample and the sectors' samples. The empirical techniques employed are the pooled ordinary least squares (OLS), fixed effects (FE), dynamic fixed effects (DFE), and systems generalized methods of moments (sys-GMM) estimators. The study concludes that there are compelling and robust findings that substantiate the fact that the number of transactions, inflation, trade volume and lagged absolute return have a positive statistically significant, and economically meaningful influence on volatility in the Zimbabwe stock market whilst bid-ask spread has a negative impact. Empirical evidence is similarly mixed in relation to our findings. Stoll (2000), and Mensi et al. (2013a), have all reported a positive connection between volatility and liquidity.

Nevertheless, there is a convergence of results with Pastor and Stambaugh (2003) who finds that the empirical correlation between aggregate liquidity and market volatility is negative, whilst Chordia et al. (2003) documented a positive relation between aggregate volatility and liquidity. Additionally, the study concludes that the bid-ask spread has a negative and statistically significant explanatory power for future volatility after controlling for inflation. There exists an indistinguishable difference between the random effects (RE) and fixed effects (FE) results and those obtained using the POLS on the full sample reflecting a cohesion of these findings. Additionally, robustness tests revealed that the bid-ask spread, number of transactions, trade volume, and lagged absolute returns are robust to liquidity for the full sample and respective sectors under consideration. It has also been established after a battery of Hausman (1978) tests of specification that bid-ask spread, number of transactions, trade volume, lagged absolute returns, and stock price volatility are jointly determined. For the control variables, inflation has a positive relation and a relatively high predictive power for stock market volatility in Zimbabwe whilst interest rate reflects a statistically insignificant asymmetric relationship.

The other findings coincide with the hypothesis by Fisher (1930) who stated that stock market price movements should be positively associated with the expected rate of inflation thereby providing a hedge against inflation. This implies that a proportionate increase in inflation can lead to a proportional change in nominal stock market returns which will consequently hedge against inflation. Understanding the relationship between inflation and market risk (volatility) can be beneficial to the investor in selecting the appropriate and most convenient investment strategy. Ideally, an inflationary economy is anticipated to bring down the expected cash inflows from both local and foreign investors; hence those who own some assets are exposed to the potential reduction of the real value of the stock due to inflation. In response to this, the tendency would be to shy away from stock investments as inflation surges. From a policy-making viewpoint, strategic policy means putting in place towards impeding inflation in a country like Zimbabwe, and for that reason, would unquestionably lessen stock market volatility and bolster investor confidence.

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