Dynamic linkage between monetary policy and stock performance in Nigeria: Cointegration and ECM techniques

ABSTRACT

Aims: To explore the dynamic relationship between stock performance and the monetary policy instruments that influence Nigeria's stock market activities.

Study Design: It uses secondary data collected from the Central Bank of Nigeria (CBN) Statistical Bulletin. The annual time series data cover a period of 38 years, from 1981-2018.

Methodology: The Augmented Dickey-Fuller (ADF) unit roots' test technique was used to verify the variables' time series properties while the Johansen procedure was applied to confirm cointegration among variables. The short- and long-run relationships were analyzed after estimating the vector error correction model. Common diagnostic tests were conducted to validate the robustness of the model estimates.

Results: The results of tests of unit roots reveal all included variables as integrated of order one, I(1). The Trace-statistics showed that at least one cointegrating relationship exited among the time series, and the ECM was estimated. The emerging error correction term equation revealed the stock market performance as inversely related to both the credit to the private sector and the lending rate, but positively related to money supply. Each variables was statistically significant ($P<0.01$). Also, the error correction term was well-behaved, being statistically significant ($t=-3.17$; $P<0.01$) and the desired negative sign, implying that previous periods' errors are correctable by adjustments in the subsequent periods, and to attain convergence. The error term had an adjustment speed of 44.19%. Granger-Causality analysis revealed a unidirectional causality relationship between the stock performance and the lending rate, with causality running from lending rate to stock performance, without a boomerang. The implication of the findings are threefold: the subsisting restrictive interest rate policy is unfavourable to long-term investment from the investors' perspective; the existing terms and conditions of the commercial credit packages had proven to be disadvantageous to long-term investment in Nigeria; and money supply as a monetary policy instrument in Nigeria had been used to boost investment and stock market performance. It is recommended that to boost investment and performance of the stock market in Nigeria would require the use of a more investment-friendly commercial lending rate, and relaxation of the stringent terms and conditions attached to the commercial private sector credit and loan packages. These measures would guarantee better access to fund and enhance ease-of-doing-business for investors.

Keywords: Stock market; traded deals' worth, money supply, lending rate, credit to private sector, dynamic interactions; cointegration; ECM; Granger-Causality; Nigeria.

1. INTRODUCTION

1.1 Introductory Comment

Stock markets (SM) play a strategic role in economic advancement worldwide. They achieve this by way of enhancing “capital formation” and “sustainable growth” of the national economies [1]. It is believed that the wide-ranging progress of any national economy hinges on the ability of the stock market to muster savings, and the efficiency with which it allots a larger proportion of these savings to the corporations with capacity to absorb investment-related risks and earn returns on their investments [2]. This view has been upheld that stock markets support the growth and development of the economy through spreading the portfolios, managing change of ownership, guiding against moral hazard, supporting innovation, and safeguarding liquidity of the financial system [3].

As in elsewhere globally, the stock market is a fundamental component of the Nigeria’s financial system (FS), which its significance in the country’s national development cannot be undermined. It is guided by the macroeconomic policies and programmes of the central government that are regularly controlled through the monetary authority, the Central Bank of Nigeria (CBN). “Monetary policy” is a set of macroeconomic instruments that a country’s central bank uses on behalf of its government to enable its attainment of the macroeconomic objectives, like managing inflation, liquidity, consumption and growth. Often, it involves the central bank’s use of “money supply” and “interest rate” in the demand side of the macro economy equation. It serves as a growth catalytic agent by creating and enabling the use of suitable incentives that empower innovative entrepreneurs to drive an all-encompassing growth [4].

Following the awareness of the need to develop the capital market and encourage mobilization of private capital for Nigeria’s economic development, the Nigerian Stock Exchange (NSE) was established in 1960 to supervise dealings in the stock market [5]. Consequently, NSE became a registered corporation “limited by guarantee” [6]. Its ultimate goal is: “to provide investors and businesses a reliable, efficient and an adaptable exchange hub in Africa, and to save and access capital” [7]. NSE is under the control of the “Securities and Exchange Commission” (SEC) of Nigeria. In August 1987, Nigeria commenced the implementation of the financial sector reforms (FSR), which included interest rate deregulation as a key component of its structural adjustment programme or SAP for short [8]. Consequently, the country progressively became an investment destination for overseas’ financial investors [1]. Deregulation under SAP rejuvenated the investors’ interest in the nation’s economy [1]. It also instigated growth in size and increased significance of Nigeria’s stock market in its quest to accomplish its aim of instituting “liquid trading” and determining price of the diverse commercial instruments [9]. In respect of transmission mechanism through the stock market, the monetary policy actions affect stock prices, which themselves are linked to the real economy through their influence on consumption spending, wealth-effect channel, investment spending, and balance sheet channel [4,10]. Securities, debentures, stocks/shares and bonds are among the financial instruments transacted in the stock market. The all share index (ASI), market capitalization, the number of deals/transaction volume, and value of traded shares are among the performance indexes of the SM, under the NSE’s auspices. “Stock market capitalization is the value of all domestic shares listed on the national stock market, while value of shares traded is limited to only those stocks that are traded. The latter may be interpreted as a measure of the liquidity of the stock market” [11].

It is in realization of the enormous benefits of the stock market that this study seeks to explore the relationship between its performance and the monetary policy instruments that directly or indirectly influence its activities. This study uses the value of traded shares or value of deals (VDL) as a performance index of the stock market. It has been argued that direct and instantaneous effect of changes in the monetary policy instruments may be identified using capital market data [4]. Consequently, answers are sought to the following questions: Which monetary policy instruments influence stock markets performance in Nigeria? Is there a long-run relationship between stock market performance and the selected monetary policy variables? How does stock market performance respond to shocks from the monetary policy instruments? Are there causality influences?

1.2 Theoretical Literature: Dividend Discount Model (DDM) of the Monetary Policy and Stock Market

Monetary policy refers to series of action points undertaken by a country through its monetary authority and directed at stabilizing economic activities through regulating conditions around money supply and interest rates. Usually, a country's Central Bank is responsible for providing its currency and prompting its monetary policy. Monetary policy is believed to have a significant implication on short-term interest rates [12]. It is affirmed that the Central Bank uses the monetary policy to regulate the short-term interest rates [13]. This has effect in the rates of returns for investors, as depicted in the "capital asset pricing model" (CAPM) defined as: $ER_i = R_f + \beta_i(ER_m - R_f)$, where ER_i is the expected return on investment, R_f is the risk-free rate, β_i is the beta of the investment, and $(E_m\text{-}R_f)$ is the market risk premium.

The theoretical support for the effects of monetary policy alterations on stock performance is provided by the "dividend discount model" (DDM). Also called the "present value" or "discounted cash flow" model, DDM was propounded by Miller and Modigliani in 1961. It suggests that the current price of a stock is equivalent to the sum of the present value of all future cash flows to equity [14]. Specifically, the stock price (S_t) is the present value of expected future dividends (D_{t+j}). By implication, it foresees that an expansionary monetary policy should increase the future net cash flows or reduce the discount factors at which the cash flows are capitalized.

Given a constant discount rate, R, Ioannidis and Kontonikas [15] gives the stock price equation as follows in equation (1).

$$S_t = E_t\left[\sum_{j=1}^{K}\left(\frac{1}{1+R}\right)^j D_{t+j}\right] + \left[E_t\left(\frac{1}{1+R}\right)^K S_{t+K}\right] \quad (1)$$

where, E_t is the "conditional expectations operator" determined by the information accessible to market members at a particular time, t; R is the "rate of return" used by market members for discounting "future dividends", and K is the investor's stock holding period (time space).

Equation (1) is derived by assuming (for straightforwardness) a case of an investor who faces two alternative investment options over one-period window–he/she takes a decision to either invest in a stock with $E_t[S_{t+1}+D_{t+1}]/S_t$ expected gross yield/return or in a risk-free bond with 1+R perpetual nominal gross yield/return. "Arbitrage opportunities" indicate that a rational investor will be indifferent between the two options if and only if both provide the same expected return that is when $E_t[S_{t+1}+D_{t+1}]/S_t = 1+R$ [15].

The standard transversality condition presupposes that as K becomes extremely large ($K\rightarrow\infty$), the term $E_t[1/(1+R)^K * S_{t+K}]$ in the right hand side of equation (1) approaches zero, and consequently disappears–not any rational stock price squelches (equation 2).

$$\lim_{K\rightarrow\infty} E_t\left[\left(\frac{1}{1+R}\right)^K S_{t+K}\right] = 0 \quad (2)$$

Following this the relationship in equation (1) will be reduced to the standard form of the present value model as depicted in equation (3)

$$S_t = E_t\left[\sum_{j=1}^{K}\left(\frac{1}{1+R}\right)^j D_{t+j}\right] \quad (3)$$

Equation (3) shows the two types of effects that changes in monetary policy often have on stock returns, namely the direct and the indirect effects [15]. It is a widely-held view that “restrictive monetary policy” entails joint use of higher discount rates and lower future cash flow [16].

The direct effect follows changes in the discount rate used by market actors. The rate at which the future cash flows are capitalized often increase with the introduction and use of tight monetary policy. The tighter the monetary policy the higher the discount rate. Higher discount rate often result to decline in stock prices. This argument is built around twofold principal assumptions–first is a direct linkage between the market rates of interest and the discount factors that the market operators use, and second is the ability of the monetary authority to influence market rates of interest [17]. On its part, the indirect effect follows changes in the projected future cash flows. Expectedly, a favorable monetary policy will result to complete increase in the echelons of economic activity, thereby prompting positive reaction in stock price. The key assumption in this respect is that of a direct linkage between monetary policy and the aggregate real economy. It has been argued that inasmuch as monetary policy has real economic effects, monetary conditions should have influence on stock markets considering that stocks are rights on future economic output [18].

1.3 Review of empirical literature

The linkage between macroeconomic policy and stock returns have been widely reserached [19]. Among the macro instruments that have overtime impacted on stock performance is the monetary policy. It is believed that monetary policy movements affect stock prices, which are themselves linked to the real economy through their influence on consumption spending, wealth effect channel, investment spending and balance sheet channel [4; 10]. Researchers seeking to assess the relationship between stock market returns and monetary policy have employed different techniques, and it is believed that there is no exclusivity in the methods through which the determinants of stock performance should be investigated [20]. Studies of the relationships between monetary policy instruments and stock returns have been conducted in different countries and regions worldwide, including the advanced economies (AEs), less advance economies (LAEs) and emerging economies (EEs). The list is endless, and the review in this write-up at best covers only a few of the numerous works, and only meant to provide guide to the direction of future discussions.

Among the works in the AEs is Thorbecke’s work that assessed the monetary policy and stock returns nexus in the United States [17]. The author applied a variety of empirical techniques–including VAR, impulse response function (IRF) and variance decomposition (VD), generalized methods of moment estimation, and non-linear regression estimation models–to monthly data on equity returns, output growth, inflation, and the federal funds rate. The study revealed that monetary policy shocks, measured by orthogonalised innovations in the federal funds rate, have a greater impact on smaller capitalization stocks. This is in line with the hypothesis that monetary policy affects firms’ access to credit, and suggests that expansionary policy stimulates ex-post stock returns in every ramification. Another study examined the impact the monetary policy had on stock returns of thirteen OECD countries from 1972-2002 [15, 21]. The study, which covered the nations of Belgium, Canada, Finland, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, United Kingdom and the United States, involved OLS (with Newey-West heteroskedasticity and serial correlation consistent covariance matrix) estimation of monthly data. It upheld existence of statistically significant negative relationships between monetary policy and both the nominal and the inflation-adjusted stock returns in ten of the thirteen OECD countries. However, the researchers observed relative differences in the strengths of the relationships, which could possibly have resulted from the innate structural differences among the countries [15,21].

Amongst the studies of the LAEs and EEs is an investigation of Nepal’s stock performance vis-à-vis the influence of the Nepal Rastra Bank’s monetary policy factors, using monthly data from mid-August 2000 to mid-July 2014 [20]. The authors found that the response of the Nepal’s stock was positive to both inflation and growth in broad money, but negative to interest rate. This informed their disclosure that handiness of liquidity and the low interest rates drive performance of Nepal’s stock market. In Botswana, Galebotswe and Tlhalefang [11] investigated the connection between monetary policy and stock returns applying VAR technique to quarterly data from the periods 1993-2010. They found a direct relationship between “positive interest rate innovations” and increases in aggregate stock returns. The study indicated that positive interest rate innovations were linked with increases, rather than decreases, in the aggregate stock returns of companies listed on the Botswana Stock Exchange (BSE). Variance decomposition reveals monetary policy shocks as explaining a relatively small proportion of variability in stock returns.

In the Nigerian context, a handful of investigations seeking to evaluate the link between monetary policy and stock returns had also been conducted [4,5,8,12,13]. One such Nigeria-based study applied the techniques Dynamic OLS & Fully modified OLS (DOLS & MFOLS), and error correction mechanism (ECM) to annual data covering the periods 1985-2015 [4]. The study revealed through the ECM that long-run equilibrium relationship existed between stock prices and monetary policy. Further, results of both the DOLS and FMOLS models revealed that the broad money supply, monetary policy rate, credit to the private sector, and exchange rate were among the policy instruments that had significant influence on stock market prices. Result from another study that applied the VAR model alongside IRF and VD analysis on monthly time-series data covering (January) 2003–(June) 2014 suggested that monetary policy variables had no significant impact on the prices of stock in Nigerian equity market [12]. The authors interpreted the finding to mean that the Nigerian equities market was not significantly absorbing the monetary policy impulses, and as such could not be a good transmission channel for the implementation of the monetary policy in Nigeria.

2. METHODOLOGY

2.1 Study Area

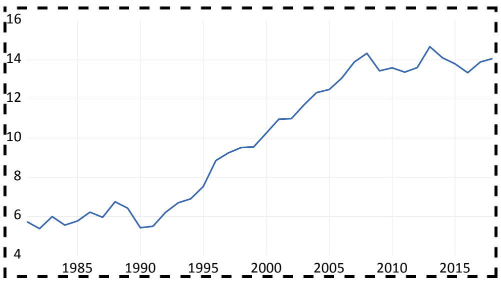
The study is carried out in Nigeria, a densely populated West African nation and member of the Economic Community of West African States (ECOWAS). Nigeria is situated within latitudes 4.67–13.87 degrees north and longitudes 2.82-14.62 degrees east. It has an estimated population some 200 million persons, a land area of 923,768 square kilometers, of which 13,000 square kilometers comprise of water bodies. The countries sharing geographical borders with Nigeria are Cameroon (east), Republic of Benin (west), Chad (northeast), and Niger Republic (north). Nigeria also shares borders with Lake Chad in northeast and the Gulf of Guinea in the southern coast. The nation has seven principal topographical features, comprising the Adamawa Highlands, Jos Plateau, Mambilla Plateau, Niger Delta, Obudu Plateau, River Benue, and River Niger. It has six geopolitical zones, namely the north-central, north-east, north-west, south-east, south-west, and south-south. There are thirty-six states (each having a capital territory), the Federal Capital Territory (FCT) and 774 local government area (LGA) councils that make up the geopolitical zones.

Oil is Nigeria’s principal revenue and foreign exchange earner. The country has a daily crude oil production output of around 1.9 million barrels that contributes over 90% of the revenue per annum. Nigeria stands out as upmost producer of crude oil in Africa and about the sixteenth globally. Although, with respect to contribution to Nigeria’s GDP, the services sector stands out as the chief driver of the economy, providing an estimated over 50%. In the midst of all this, the nation is gifted with enormous natural resources, alongside boundless potential for agriculture and agribusiness value chain activities. Equally, the country comprises of numerous commercial and industrial cities, including Lagos in the southwest, Kano and Sokoto in the northwest, Port Harcourt and Calabar in the south-south, and Aba and Onitsha in the south-east. The Nigeria Stock Exchange (NSE) is located in Lagos (Lat. 6.524^{o} N and 3.379^{o} E). It was established in 1960 as the Lagos Stock Exchange, but the name was changed to the Nigerian Stock Exchange in 1977. As at the mid-2018, the NSE had about 169 listed companies, total market capitalization of over thirteen trillion naira (₦13 trillion) representing about US$ 42.6 billion, which makes it the second largest stock exchange in Africa. All NSE listings are built into its ASI reported to be some 38,243.19 billion basis points as at the end of December 2017 [22].

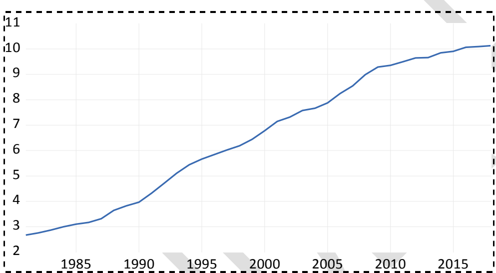
2.2 Study Data

The study used secondary data. They are documented times series of the CBN covering 38 years, from 1981-2018. The data for Nigeria stock market’s value of traded deals, money supply, commercial credit to the private sector operators and maximum lending rate of the commercial credit institutions were collected from the Statistical Bulletin of the CBN.

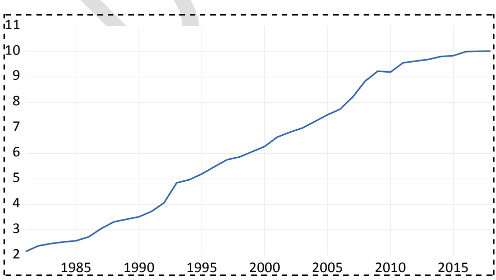
The graphics of the four data series depicting the time trends are presented in Figure 1 (a-d). The estimated time trend equations are $VDL_t=4.1373+0.2965t$ ($R^2=0.919$) for the value of traded shares; $MYS_t=2.0716+0.2308t$ ($R^2=0.989$) for money supply; $PSC_t=1.5023+0.2432t$ ($R^2=0.988$) for credit to the private sector; and $MLR_t=2.7089+0.0171t$ ($R^2=0.313$) for the lending rate. Therefore, each of the variables trends upwards having positive intercepts, although the slopes are steeper for the value of traded deals (VDL_t) than for the credit to the private sector (PSC_t), money supply (MYS), and maximum lending rate (MLR_t) respectively in that order. Also the correlation with time trend is above 90% for VDL_t, PSC_t and MYS_t and below 40% for MLR_t.



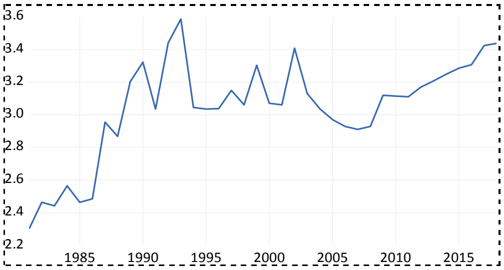
Logarithm of the value of traded deals (VDL)



Logarithm of money supply (MYS)



Logarithm of credit to the private sector (PSC)



Logarithm of the lending rate (MLR)

Figure 1. Graphical trends in the data series

2.3 Methods of Data Analysis

2.3.1 Model specification

In support of this investigation of a dynamic linkage between stock market performance and the monetary policy, this study supposes the following model:

$$Z_i = Z_i(y_i, x_{1i}, \cdots x_{(n-1)i}) \qquad (4)$$

where Z_i is a nx1 vector of variables; y_i is the proxy variable measuring stock market performance, x_{1i}, x_{2i} … $x_{(n-1)i}$ are (n-1) numbers of monetary policy instruments.

In this study, the empirical model is formulated with the aim of exploring the dynamic interface in-between stock market performance, using the value of traded deals as proxy, and selected monetary policy tools. Specifically, this study proposes a four-variable model as follows:

$$Z_t = f(VDL_t, PCS_{1t}, MYS_t, MLR_t) \qquad (5)$$

where Z_t is a 4 x1 vector of variables; VDL_t is the value of traded deals; PSC_t is the private sector credit; MYS_t is the broad money supply; and MLR_t is the maximum lending rate of Nigeria's Deposit Money Banks (DMBs).

2.3.2 Variables in the empirical model

VDL_t is the “value of shares traded” in the stock market. It is used in this study as an index of stock market performance. VDL complements the “market capitalization ratio” and indicates the extent to which “market size” corresponds with transaction activity [23]. It is a measure of the liquidity of the stock market at a given point in time [11]. Market liquidity is a reflection of the certainly with which buyers and seller can buy and sell the market securities. This study appraises the dynamic linkage between the VDL as a performance index and some selected macro monetary policy variables. A precise valuation of the connection amongst stock market performance and macroeconomic rudiments is beneficial to the stock market watchers, the investing public and the policymakers [24]. It is expected, based on literature evidence, that a restrictive monetary policy reduces both the “contemporaneous” and “expected” stock yields while expansive monetary policy prompts rise in both the “contemporaneous” and “expected” stock returns [4].

“PSC” is the “commercial private sector credit.” It is used in this study as a proxy for “financial inclusiveness” of listed firms. The ability of the deepening finance intermediation to enhance economic growth through mobilization of additional investments and invigorating financial resources’ returns to raise productivity has been acknowledged [25]. By boosting investors’ confidence they perceive the market as less risky and contribute to its growth through added investment. This study hypothesizes the relationship between VDL and PSC to be positive.

“MYS” is “broad money supply” portrayed as M2. It is described as currency outside banks plus demand deposits [26]. According to the World Bank Development Indicators of 2017 reported elsewhere, broad money comprises of the entire currency outside the banks, demand deposits excluding those of the central government, the time, savings and foreign currency deposits of resident sectors excluding the central government, the bank and travelers’ checks, and other securities like Certificates of Deposit and Commercial Paper [27]. It is a “financial deepening index” used in this study to capture the “provision of financial services” by the Nigeria’s monetary authority. The effect of money supply on stock market performance can be unpredictable, positive or negative [24,28]. In this study, a positive relationship is hypothesized for MYS and VDL.

“MLR” is the maximum lending rate of the DMBs. With the 2001 adoption of “Universal Banking” scheme in Nigeria, the group of financial institutions, which prior to the scheme had operated independently as “commercial banks” and “merchant banks” came to be jointly called the DMBs. Interest rates are used in strict economic sense to mean the cost of borrowing money [26]. “Lending rate” is the bank rate often directed at meeting the short- and medium-term funding needs of the private sector, and usually discerned in line with the borrowers’ creditworthiness and financing objectives [27]. Interest rate is a restrictive monetary policy, and is expected to have a negative influence on stock performance, hence this study predicts a negative relationship between MLR and VDL.

2.3.3 Testing for stationarity

Exploration of relationships amongst time series data commences with screening of the time series properties of the series through appropriate tests of “stationary.” It is believed that most financial and economic time series data are have non-stationarity features [24], hence, the need to determine from the onset whether or not each included time series has a unit root [29]. The Augmented Dickey-Fuller” (ADF) approach to stationarity screening [30] is applied in this paper. The ADF tests are built around the t-statistics linked to the parameter ‘β’ of the ordinary least square (OLS) regressions estimates of the following set of equations:

$$\Delta z_t = \alpha z_{t-1} + \sum_{i=1}^{k} \beta_i \Delta z_{t-1} + \delta + \gamma t + \varepsilon_t \quad \text{(for levels)} \tag{6}$$

$$\Delta\Delta z_t = \alpha \Delta z_{t-1} + \sum_{i=1}^{k} \beta_i \Delta\Delta z_{t-i} + \delta + \gamma t + \varepsilon_t \quad \text{(for first differences)} \tag{7}$$

where z_t is the time series of interest; $\Delta z_t = (z_{t+1} - z_t)$ is the series' first difference; α, β, γ and δ are unknown parameters estimates, $\mathcal{E}_t$ is an error term, and 'k' is the lag length selected for the ADF test, to guarantee $\mathcal{E}_t$ as an empirical white noise. Lag length "k" is selected bearing in mind that it should be small enough to marmalade the degrees of freedom and large enough to escape autocorrelation in $\mathcal{E}_t$ [31]. The test enables the testing of the null hypothesis (H_0: z_t is non-stationary) against the alternative hypotheses (H_1: z_t is stationary).

The null (H_0) is another way of stating that "z_t has a unit root" or that $\beta = 1$ in the given equations. The decision-taking criterion is to reject H_0 if the absolute value of the t-statistics linked to β exceeds the absolute value of the critical ADF-statistic at 5% level. If this happens, the researcher will reject H_0 and concludes that $\beta \neq 1$ and z_t has no unit root. This means that the series is "stationary" at the level where the rejection is made. Failing to rejecting H_0 and/or concluding that z_t has a unit root at levels would prompt a second step of testing for stationarity at first difference as in equation (7). Similar decision criterion is equally applied.

2.3.4 Testing for cointegration

For this study, the "Johansen cointegration test" technique is used to check the existence or non-existence of a long-run equilibrium linkage between the selected stock performance index and monetary policy variables. Johansen's approach uses the vector autoregressive (VAR) model expressed in the error correction form of equation (8).

$$\Delta z_t = \Omega + \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \Pi z_{t-k} + \zeta_t \tag{8}$$

where Δ connotes first-order difference notation; z_t is (n x 1) vector of the included variables each of which is integrated of order one, I(1); Ω is (n x 1) vector of constants; $\Gamma_i = -\sum_{j=i+1}^{k} A_j$ is (nxn) matrix of coefficients or short-run adjustment among variables; $\Pi = -1 + \sum_{j=i+1}^{k} A_j$ is long-run matrix, also given as $\Pi = \alpha\beta$, where α is (n x r) speed of adjustment, and β is (rxn) cointegrating vectors; k is the number of lags, I is an (n x n) identity matrix; and ξ is (n x 1) Gaussian white-noise error term.

The presence of a cointegrating vector is verified using the "Trace test statistic" and "maximum Eigen-value test statistic" defined as in equation (9) and equation (10) respectively.

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i) \tag{9}$$

$$\lambda_{max} = -T \ln \left(1 - \lambda_{r+1}\right) \quad (10)$$

where T is the number of observations and λ is the Eigen-value.

Equation (9) is the “Trace tests statistics” that verifies the null hypothesis (H_0: there are “at most r cointegrating vectors”) against the alternative hypothesis (H_1: there are “r or more cointegrating relationships”). The decision rule is to reject H_0 at 5% level, if the value of the observed “Trace statistic’ exceeds the 0.05 critical value, otherwise H_0 should not be rejected. On its part, equation (10) is the “Max Eigen-value test statistic” that verifies the null hypothesis (H_0: there are “at most r cointegrating relations”) against the alternative hypothesis (H_1: there are “r+1 cointegrating relations”). The decision rule is to reject H_0 at 5% level if the value of the observed “Max Eigen-value statistic” is greater than the 0.05 critical value, otherwise, fail to reject the H_0.

2.3.5 Error correction model for cointegrated series

2.3.5.1 Long-run cointegrating equation

The general form of the long-run (error correction term) term equation for the stock market performance – involving VDL and PSC, MYS and MLR as employed in this study – is given as:

$$ECT_{t-1} = \ln VDL_{t-1} + \alpha_1 \ln PSC_{(t-1)} + \alpha_2 \ln MYS_{(t-1)} + \alpha_3 \ln MLR_{(t-1)} + \Omega \quad (11)$$

where all variables are as previously defined, ECT is the error correction term, α_i are parameter estimates, and Ω is a constant.

2.3.5.2 Short-run behavioral model

The general form of the short-run behavioural equation involving VDL, PSC, MYS and MLR is given as

$$\Delta \ln VDL_t = \lambda ECT_{t-1} + \sum_{i=1}^{k-1} \beta_i \Delta \ln VDL_{(t-i)} + \sum_{j=1}^{k-1} \varphi_i \Delta \ln PSC_{(t-j)} + \sum_{m=1}^{k-1} \varpi_m \Delta \ln MYS_{(t-m)} + \sum_{g=1}^{k-1} \mu_g \Delta \ln MLR_{(t-g)} + \Omega + \varepsilon_t \quad (12)$$

where ECT is the error correction term and all other variables are as previously defined; Δ is the difference operator; β, φ, ω, μ, and ξ are parameter estimates, Ω is a constant, and ε_t is a random error term.

2.3.5.3 Diagnostic tests

Use of suitable tests are recommended to verify the empirical robustness of the estimated model. Four common tests conducted in this study are tests for serial correlation, heteroskedasticity, normality in distribution, and model stability.

Serial correlation test. The “Breusch-Godfrey serial correlation LM test” is applied. It tests the null hypothesis (H_0) of “no serial correlation” against the alternative hypothesis (H_1) of “presence of serial correlation. Decision rule is to reject (H_0) if the observed F-statistic and Obs*R-squared statistic have associated probability values that are less than 5% level, otherwise fail to reject H_0.

Heteroskedasticity test. The “Breusch-Pagan-Godfrey heteroskedasticity test” is used. It tests the H_0 of “equality of the error variances” against the H_1 of “inequality in variance.” Decision rule is to reject H_0 if the associated probability values of the observed F-statistic and Obs*R-squared statistic are less than 5%, otherwise fail to reject H_0.

Normality of distribution test. The "histogram normality test" for normality in distribution is applied. It tests H_0 that "data are normally distributed" against the H_1 that "data are not normally distributed." Decision criteria is to reject the H_0 if probability of the observed "Jarque-Berra statistic" is less than 5%, otherwise fail to reject the H_0.

Model stability test. The "cumulative sum" (CUSUM) and "cumulative sum of squares" (CUSUM squares) tests are used to test for the stability of the model's recursive residual estimates. Each of the tests evaluates the null hypothesis (H_0) of "model instability" versus the alternative hypothesis (H_1) of "model stability." As a decision rule, H_0 is rejected with the conclusion that the model is stable, if the model estimates (usually represented as a line graph) does not drop outside the 5% significance boundary. But, if it falls outside the 5% significance boundary, the researcher will fail to reject H_0 and conclude that the model is not stable.

Breakpoints test. If the result of either the "CUSUM" or "CUSUM of squares" test leads to the decision that the model is not stable, it may be a warning that one or more "structural breaks" are present in the model. Although this situation does not arise always, but if it does, it requires verification of such breaks and the period(s) of occurrence, through the use of the "Breakpoints test." Once determined, necessary corrective steps are taken to reinstate the model stability, and thereafter re-estimate the model. After re-estimation, it is recommended that all necessary diagnostic tests are carried out once again to ensure that only a well-behaved model is reported.

2.3.6 Variance decomposition (VD)

The VD of the "forecast error" indicates the percentage of the "variance" on a target endogenous variable, which can be attributed to tremors originating from itself against the percentage attributable to tremors from the other endogenous variable(s). It is a reflection of the proportion of the unforeseen disparity in each time series produced from innovations or shocks from itself compared to shocks from other variables. It is an index to measure the relative impact a variable has on other variables. It enables the evaluation of the "economic significance" of the impact as a percentage of the forecast error for a variable, and sums up to one. The "orthogonolisation" or 'VD' technique in the "VAR system" putrefies the projected error variance.

2.3.7 Impulse response function (IRF)

A shock that emanates from a given endogenous variable in a VAR system has the propensity of impacting on both the originating endogenous variable and on any other endogenous variable. The IRF is a reflection of this impact. It trails the influence a unit shock to a single innovation will have on both the current and impending values of the endogenous variables, including the originating variable. It is held that an innovation attached to one endogenous variable affects the originating variable forthrightly, but thereafter extends the influence to other endogenous variables through the dynamic structure of the VAR [32].

2.3.8 Granger-causality test

Suppose Y_t and X_t are two related time series. Y_t, is said to "Granger causes" X_t, if including the past values of Y_t along with other variables (to an equation linking X_t to Y_t,), can strengthen the present values of X_t, that when they are not included [32]. Consider the relationship between X_t and Y_t as depicted in equation (13).

$$X_t = \Omega + \sum_{i=1}^{m} \gamma_i Y_{t-i} + \sum_{j=1}^{m} \psi_j X_{t-j} + e_t \tag{13}$$

where X_t is a function of its own lagged values and the lagged values of Y_t; Ω, γ and ψ are model parameters, m is number of lags, and e_t is an error term.

The F-test is used in determining the proof of causality. It is equivalent to the Wald Test and expressed as:

$$F_{Y_t \rightarrow X_t} = \frac{(SSE_r - SSE_u)/m}{SSE_u/(n-2m-1)} \sim F_{[m,\,(n-2m+1)]}(\alpha) \quad (14)$$

where SSE_r refers to the sum of squared errors with "restricted" coefficients of lagged Y_t;" SSE_u refers to the sum of squared errors of the "unrestricted" form of the equation, α is the critical value; *m* is the number of lags, and *n* is the number of observations.

It is used to test the null hypothesis (H_0), say, that "Y_t does not Granger Cause X_t" against the alternative hypothesis (H_1). The decision criteria is to reject H_0 if $F_{(Yt \rightarrow Xt)} > F_{(m,n-2m+1)}\alpha$ (at α=0.05), otherwise fail to reject H_0. In other words, if $F_{(Yt \rightarrow Xt)} < F_{(m,n-2m+1)}\alpha$ it means that "Y_t does not Granger cause X_t, otherwise Y_t Granger causes X_t. If it is proven that "Y_t Granger causes X_t" and also "X_t Granger causes the Y_t," it means that there is a "feedback relationship" existing between Y_t and X_t.

2.4 Model estimation

All analysis and estimations were done using Microsoft Excel and EViews (Version 11) Standard Edition for Windows Statistical Software. The Software supports the Johansen cointegration and error correction techniques [33].

3. RESULTS AND DISCUSSION

3.1 Descriptive Statistics of the Variables

The descriptive information on the used variables is presented in Table 1. The mean value of traded deals (VDL) is ₦384.68 billion (about US$1.26 billion). The maximum value attained during the study period is ₦2.35 trillion (US$7.68 billion) in 2013 while the minimum value is ₦215 million (US$0.70 million) in 1982. Commercial credit to the private sector (PSC) has a mean value of ₦5.02 trillion (US$16.41 billion) that ranged from minimum of ₦8.57 billion (US$0.03 billion) given out in 1981 to maximum of ₦22.52 trillion (US$73.63 billion) dispensed in 2018. On its part, money supply (MYS) records a mean of ₦5.49 trillion (US$17.97 billion) with minimum and maximum values given as ₦14.47 billion (US$0.05 billion) documented for 1981 and ₦25.08 trillion (US$81.99 billion) recorded for 2016 respectively. The average lending rate (MLR) is 21.87%, but it ranged from a lowest rate of 10% documented for 1981 to highest rate of 36.09% recorded for 1993.

Table 1. Descriptive statistics of variables

Descriptive	VDL (₦' million)[+]	PSC (₦' billion)	MYS (₦' billion)	MLR (%)
Mean	384,677.600	5,020.640	5,496.675	21.875
Median	21,112.550	480.771	753.705	21.444
Maximum	2,350,876.000	22,521.930	25,079.720	36.090
Minimum	215.000	8.570	14.471	10.000
Std. Dev.	578,084.400	7,672.899	8,082.320	6.092
Skewness	1.595	1.274	1.300	-0.036
Kurtosis	5.058	3.022	3.224	2.802
Jarque-Bera	22.815	10.289	10.789	0.070
Probability	0.000011	0.006	0.00454	0.966

Sum	14,617,750.000	190,784.300	208,873.600	831.252
Sum Sq. Dev.	1.24E+13	2.18E+09	2.42E+09	1,373.420
Observations	38	38	38	38

+*Official exchange rate of the local currency (₦) to the United States dollar is ₦305.90/US$1.00*

Positive skewness is observed for VDL, PSC and MYS while MLR is slightly negatively skewed. Also, each of VDL, PSC and MYS is "leptokurtic" with observed Kurtosis greater than 3 in each case. Only MLR is "platykurtic" with Kurtosis less than 3. The observed Jarque-Bera and associated probability values are 22.81 (P<0.01) for VDL, 10.29 (p<0.01) for PSC, 10.79 (p<0.01) for MYS and 0.07 (p=0.97) for MLR. It follows that while the null hypothesis of "normality in distribution" is rejected for VDL, PSC and MYS, the same cannot be rejected for MLR. Thus, apart from the lending rate, none of the other time series is normally distributed.

3.2 Analysis of Stationarity

The results of the ADF-test of unit roots conducted for each time series are reported in Table 2.

Table 2. Unit Roots' test output (1981-2018)

Variable	**ADF-statistic**	**Level**		**First difference**	
		Intercept only	**Trend & intercept**	**Intercept only**	**Trend & intercept**
lnVDL$_i$	t-statistics	-0.4835^{ns}	-1.6485^{ns}	-5.6247***	-5.5513***
	ADF C.V. (1%)	-3.6210	-4.2268	-3.6268	-4.2349
	ADF C.V. (5%)	-2.9434	-3.5366	-2.9458	-3.5403
lnPSC$_i$	t-statistics	-0.6578^{ns}	-1.8530^{ns}	-4.3309***	-4.2988***
	ADF C.V. (1%)	-3.6210	-4.2349	-3.6268	-4.2349
	ADF C.V. (5%)	-2.9434	-3.5403	-2.9458	-3.5403
lnMYS$_i$	t-statistics	-1.1637^{ns}	-1.1233^{ns}	-3.1815**	-3.2623^{ns}
	ADF C.V. (1%)	-3.6268	-4.2349	-3.6268	-4.2349
	ADF C.V. (5%)	-2.9458	-3.5403	-2.9458	-3.5403
lnMLR$_i$	t-statistics	-2.6667^{ns}	-2.9235^{ns}	-7.8171***	-6.1501***
	ADF C.V. (1%)	-3.6210	-4.2268	-3.6268	-4.2436
	ADF C.V. (5%)	-2.9434	-3.5366	-2.9458	-3.5443

****=significant at 1%;* ***=significant at 5%;* **=significant at 10%;* ^{ns}*=not significant.*

At levels, none of the observed t-statistics is significant (both when only intercept is considered and when both intercept and trend are considered). For each variable tested at level, the absolute value of the calculated ADF-statistics is less than the absolute value of the critical ADF-statistics at 5%. This resulted to failure to reject null hypothesis of “non-stationarity” at level for all variables. When testing was conducted at first differences, it is observed that the absolute value of the calculated t-statistics for each variable (and for both “intercept only” and “intercept and trend”) becomes greater than the absolute value of the critical ADF-statistics at 5%. For example, for the VDL at first difference and with intercept only, observed t-statistic is 5.62 while the critical ADF-statistic is 2.92 at 5%, and with intercept and trend, observed t-statistic is 5.55 while the critical ADF-statistic is 3.54 at 5%. For PSC, MYS and MLR, calculated t-statistic at first differences and with intercept only are t=4.33, t=3.18 and t=7.82 each of which is greater than the critical ADF-statistics, which in each case is given as 2.94. Similar outcomes are also recorded for first differences with “intercepts and trends.” Thus, the null hypothesis that each of VDL_i, PSC_i, MYS_i and MLR_i has a unit root” (or is non-stationary) is rejected at first differences, leading to the conclusion that each is a “stationary series” at first different or I(1) series.

3.3 Determining the Optimal Lag Length

Determining the optimal lag length is desirable to avoid possible model misspecification that may arise from use of very few lags or “over parameterization” that may arise from use of too many lags [28]. The test conducted to determine the optimal lengths structure is reported in Table 3.

Table 3. Optimal lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-85.65832	NA	0.002294	5.274019	5.453591	5.335258
1	58.39232	245.7335	1.24e-06	-2.258372	-1.360513*	-1.952176*
2	78.46375	29.51680*	1.02e-06*	-2.497867*	-0.881721	-1.946715
3	93.69583	18.81611	1.19e-06	-2.452696	-0.118262	-1.656587
4	105.5937	11.89785	1.91e-06	-2.211393	0.841328	-1.170328

*** indicates lag order selected by the criterion; Endogenous variables are lnVDL, lnPSC, lnMYS, lnMLR; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.*

Among the values flagged with asterisks in the Table are -2.498 associated with lag order 2 for Akaike information criterion (AIC), -1.361 associated with lag order 1 for Schwarz information criterion (SC) and -1.952 also associated with lag order 1 for Hannan-Quinn information criterion (HQ). Of these, the AIC value of -2.498 is the least of the three values and is linked to lag 2. As a result, lag length of k=2 is the selected optimal lag length and will be used for further analysis of cointegration using VDL_i and MYS_i, MLS_i and PSC_i as endogenous variables.

3.4 Cointegration Analysis

Output of Unrestricted Cointegration Rank Test for “Trace” and “Maximum Eigenvalue” statistics is presented in Table 4.

Table 4. Cointegration test output: Trace-statistic and Max-Eigen value statistic

Hypothesized No. of CE(s)	Eigenvalue	Trace Stat. (λ_{trace})	5% Critical value	Prob.	Max-Eigen Stat. (λ_{max})	5% Critical Value	Prob.
None	0.519409	48.01610**	47.85613	0.0483	25.64588^ns	27.58434	0.0867
At most 1	0.328546	22.37023	29.79707	0.2784	13.94084	21.13162	0.3699

At most 2	0.145231	8.429382	15.49471	0.4207	5.492340	14.26460	0.6788
At most 3	0.080491	2.937042	3.841465	0.0866	2.937042	3.841465	0.0866

****denotes rejection of the hypothesis at the 1% level; **denotes rejection of the hypothesis at the 5% level; Trace test and Max-eigenvalue test indicate at least one cointegrating equation at 5% level; included series are LnVDL, lnPSC, lnMYS and lnMLR.*

The observed Trace-statistic given is 48.016. It is greater than the 5% critical value given as 47.856, leading to rejection of the null hypothesis of “no cointegrating equation” at 1% level. However, the observed Max-eigen statistics is 25.645, which is lower than the 5% critical value of given as 27.584. Because the observed Max-eigen statistic value is lower than the critical value, the study is constrained not to reject the null hypothesis of “no cointegrating equation.” Therefore whereas the Trace test statistics reveals existence of at least one cointegrating relationship, the Max-eigen value test statistics suggests no cointegrating relationship, thereby leading to disagreement between the two indicators. It has been advised that in a case of conflict between the two test statistics, the Trace statistics should be considered more appropriate for use [34] because, unlike the Max-eigen statistic, it reflects the least “eigenvalues,” and apparently stronger and influential compared to the Max-Eigenvalue test statistics [24,35]. Thus, this study proceeds with identifying the long-run (dynamic) relationship between stock market performance and the selected macroeconomic fundamentals on the strength of the findings from the Trace statistics test.

3.5 Johansen Normalization Output

The Johansen normalized and adjustment coefficients based on the observed one cointegrating relationship is presented in Table 5.

Table 5. Normalized and adjustment coefficients

Description	**Variable**	**Dependent variable: lnVDL$_i$ (Log likelihood =81.21899)**		
		Coefficient	**Std. error**	**t-value**
Normalized coefficients	lnVDL	1.0000		
	lnPSC	4.2353***	0.8534	4.9631
	lnMYS	-6.0083***	0.8987	-6.6856
	lnMLR	3.0378***	0.4119	7.3751
Adjustment coefficients	D(LNVDL)	-0.7297**	0.20903	-3.4910
	D(LNPSC)	-0.0264	0.06506	-0.4062
	D(LNMYS)	0.0454	0.04954	0.9159
	D(LNMLR)	0.1602**	0.07652	2.0940

****denotes significance at 1% level; **denotes significance at 5% level*

In expressing and interpreting the long-run cointegrating equation, the signs of the coefficinets are reversed while lnVDL is positioned in the model as a dependent variable with a coefficient of 1. Therefore, from Table 5, the estimated normalized equation becomes:

$$\ln VDL = -4.2353 \ln PSC + 6.0083 \ln MYS - 3.0378 \ln MLR$$

From the result, it can be concluded that in the long-run, money supply (lnMYS) has a significant positive influence (p<0.01) on value of traded deals (lnVDL), on average, ceteris paribus. However, both the credit to the private sector (lnPSC) and lending rate (lnMLR) have significant negative influence (p<0.01) on the value of traded deals (lnVDL), on average, ceteris paribus.

3.6 Analysis of the Error Correction Model

The analysis of the error correction model (ECM) is aimed at appraising the long- and short-run connection between stock market performance and the monetary policy. The ECM is the VAR in first difference by definition, meaning that the lag length earlier acknowledged as 2 using appropriate approach is reduced by one for the estimating of the ECM. Thus, the lag length, k=1, is used for ECM.

The ECM output gives the long-run cointegrating equation and the short-run equation. First, the Johansen's long-term cointegrating (ECT) equation is reported in Table 6.

Table 6. Long-run (error correction) equation for VDL

Variable	Coefficient	Standard error	t-statistic
lnVDL(-1)	1.0000	-	-
lnPSC(-1)	3.1595***	0.7754	4.0746
lnMYS(-1)	-4.9041***	0.8180	-5.995
lnMLR(-1)	3.8815***	0.3923	9.8932
Constant	-9.2551	-	-

****denotes significance at 1% level; **denotes significance at 5% level.*

The output reflected in Table 6 is the error correction term (ECT) equation. It gives the ECT as:

$$ECT_{t-1} = \ln VDL_{t-1} - 9.2551 + \underset{(0.7754)}{3.1595^{***}} \ln PSC_{t-1} - \underset{(0.8180)}{4.9041^{***}} \ln MYS_{t-1} + \underset{(0.3923)}{3.8815^{***}} \ln MLR_{t-1}$$

When expressed in terms of VDL_i, the signs of the parameter estimates of the long-run equation are reversed and they appear as follows

$$\ln VDL_{t-1} = ECT_{t-1} + 9.2551 - \underset{(0.7754)}{3.1595^{***}} \ln PSC_{t-1} + \underset{(0.8180)}{4.9041^{***}} \ln MYS_{t-1} - \underset{(0.3923)}{3.8815^{***}} \ln MLR_{t-1}$$

where the variables are as earlier defined, ECT_{t-1} is the "error correction term" and values in parentheses are standard errors, with (***) and (**) indicating 1% and 5% significant levels respectively.

The long-run equation shows that the stock market performance index (VDL) is inversely related to both the credit to the private sector (PSC) and the lending rate (MLR), but a positively related to money supply (MYS). All the parameter estimates are significant at 1% levels, implying that all variables contribute significantly to the long-term equilibrium. The observed negative sign for lending rate agrees with the a priori expectation of this research. A few related studies that used the all share index as a performance index also established a negative sign for the lending rate [16,36]. Contrarily, the negative sign observed for private sector credit contradicts with the positive relationship postulated by this current study, and also supported that adopted the all share index as a stock performance measure [4]. Also, the positive relationship with money supply agrees with the hypothesized sign, which corroborates results of some previous studies [4,16]. Nevertheless, there are other section of the literature that stipulated an indeterminate sign for money supply [24,28].

3.7 Short-run Representation

The output of the estimated short-run representation of VDL that includes the “error correction term” (ECT_{t-1}) is presented in Table 7.

Table 7. Output of short-run (VAR) model estimation for stock market performance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.029835	0.172629	0.172825	0.8640
D(lnVDL(-1))	0.106842	0.166861	0.640304	0.5268
D(lnPSC(-1))	0.201975	0.758562	0.266261	0.7919
D(lnMYS(-1))	0.546315	1.056046	0.517321	0.6087
D(lnMLR(-1))	0.987378	0.591236	1.670022	0.1053
ECT(-1)	-0.441980	0.139574	-3.166635	0.0035
R-squared	0.284552	Mean dependent variable		0.241545
Adjusted R-squared	0.165310	S.D. dependent variable		0.531434
S.E. of regression	0.485525	Akaike info criterion		1.543840
Sum squared resid	7.072035	Schwarz criterion		1.807760
Log likelihood	-21.78912	Hannan-Quinn criterion		1.635955
F-statistic	2.386351	Durbin-Watson statistic		1.966427
Prob(F-statistic)	0.061670			

Dependent Variable: D(lnVDL)

The model specification is reported in equation (4);

$$\Delta \ln VDL_t = \underset{(0.1726)}{0.0298} + \underset{(0.1669)}{0.1068}\Delta \ln VDL_{t-1} + \underset{(0.7586)}{0.2020}\Delta \ln PSC_{t-1} + \underset{(1.0561)}{0.5463}\Delta \ln MYS_{t-1} + \underset{(0.5912)}{0.9874}\Delta \ln MLR_{t-1}$$

$$-\underset{(0.1396)}{0.4419^{***}} ECT_{t-1}$$

where the variables are as earlier defined, ECT_{t-1} is the "error correction term" and values in parentheses are standard errors, with (***) and (**) indicating 1% and 5% significant levels respectively.

The coefficient of the error correction term is 0-0.442, meaning that it has the desired negative sign. It is also statistically significant at 1% level (t=-3.166). Thus, the adjustment coefficients result signifies that the previous period's deviation from the long-run equilibrium for VDL (the stock market performance index) can be attuned in the present period at an "adjustment speed" of 44.19%. This further signifies that any departure in one direction can be reversed to attain equilibrium. A previous Nigeria-based study reported a 56.58% speed of adjustment [37], while another reported a 41.3% speed of adjustment [38]. There are similar other documented works in this area of research [5,39,40].

3.8 Diagnostic Tests Conducted on the Model of Stock Performance

3.8.1 Test of serial correlation for the VDL model

The result of the error correction residual serial correlation LM Test for the VDL model is displayed in Table 8.

Table 8. Output of error correction residual serial correlation LM Test for VDL

Null hypothesis:	Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
No serial correlation at lags k	1	13.85282	16	0.6097	0.862410	(16, 70.9)	0.6128
	2	7.909149	16	0.9515	0.473536	(16, 70.9)	0.9521
	3	20.88993	16	0.1828	1.362876	(16, 70.9)	0.1859
	4	17.27151	16	0.3682	1.099898	(16, 70.9)	0.3720
No serial correlation at lags 1 to k	1	13.85282	16	0.6097	0.862410	(16, 70.9)	0.6128
	1-2	25.77333	32	0.7735	0.775640	(32, 71.7)	0.7846
	1-3	40.34642	48	0.7758	0.782251	(48, 59.8)	0.8097
	1-4	56.51242	64	0.7356	0.776804	(64, 45.3)	0.8256

**Edgeworth expansion corrected likelihood ratio statistic.*

From the results, both the “LRE*-statistic” and the “Rao F-statistic” reveal that the null hypothesis of “no serial correlation at lag k” cannot be rejected at 5%, with each associated probability exceeding 0.05, for any of the lag levels 1, 2, 3 or 4. Also, the null hypothesis of “no serial correlation at lags 1 to k” cannot be rejected at 5%, with each associated probability exceeding 0.05, for any of the bands. It is concluded that the model is free from serial correlation.

3.8.2 Test of heteroskedasticity for the VDL model

The result of the error correction residual heteroskedasticity test for the VDL model is displayed in Table 9.

Table 9. Output of joint test of error correction residuals heteroskedasticity

Test type	Statistics					
Joint:		Chi-sq	Dof	Prob.		
		104.7134	100	0.3538		
Individual components:	Dependent	R-squared	F(10,25)	Prob.	Chi-sq(10)	Prob.
	res1*res1	0.281461	0.979281	0.4851	10.13259	0.4289
	res2*res2	0.254540	0.853635	0.5850	9.163448	0.5167
	res3*res3	0.423168	1.834015	0.1061	15.23404	0.1238
	res4*res4	0.297278	1.057595	0.4282	10.70201	0.3812
	res2*res1	0.305923	1.101903	0.3982	11.01321	0.3565
	res3*res1	0.355627	1.379741	0.2457	12.80257	0.2349
	res3*res2	0.282165	0.982695	0.4825	10.15795	0.4267
	res4*res1	0.251434	0.839719	0.5966	9.051628	0.5272
	res4*res2	0.441010	1.972349	0.0819	15.87635	0.1032
	res4*res3	0.365115	1.437720	0.2213	13.14413	0.2157

The observed joint “heteroskedasticity” Chi-square statistics is 104.713. It has a probability value of p=0.354 that is greater than 0.05. Consequently, the result means that the null hypothesis of “absence of heteroskedasticity” cannot be rejected at 5% level. The conclusion is that the residual of the error correction model (ECM) is not heteroskedastic portraying the model as a good one.

3.4.3 Test of normality in distribution of residuals

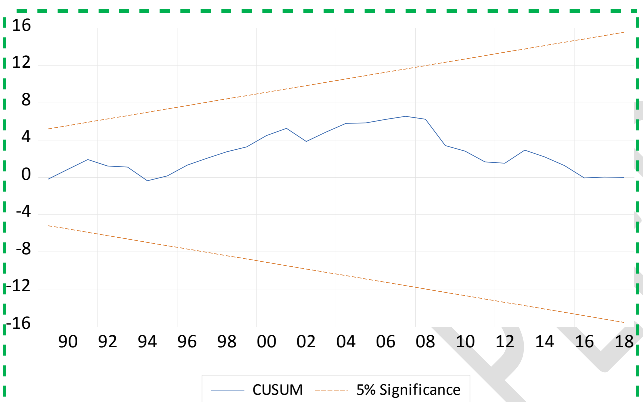
Test of normality of distribution uses the skewness, Kurtosis and Jarque-Bera statistics as displayed in the output in Table 10. It is a test of the null hypothesis that the “residual of the ECM is normally distributed” against it’s the alternative hypothesis of anomaly in distribution of the ECM residual. The test results at each level and for the joint consideration reveal probability values each of which is greater than 0.05. This outcome led to failure to reject the null hypothesis at 5% level for the “skewness,” “Kurtosis,” and “Jarque-Bera.” Apparently, it is concluded that the residuals are normally distributed.

Table 10. Output of error correction model residual normality tests

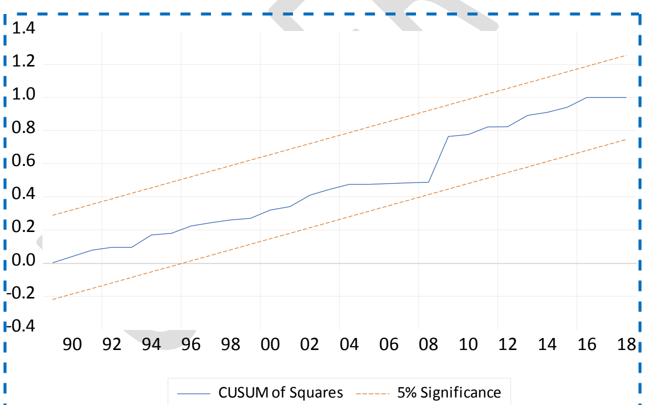
Component	Skewness (n=36)				Kurtosis (n=36)				Jarque-Bera (n=36)		
	Skewness	**χ^2-stat**	**df**	**Prob.**	**Kurtosis**	**χ^2-stat**	**df**	**Prob.**	**JB-stat**	**df**	**Prob**
1	-0.4995	1.4970	1	0.2211	3.1019	0.0156	1	0.9006	1.5126	2	0.4694
2	0.5173	1.6058	1	0.2051	2.6895	0.1446	1	0.7038	1.7504	2	0.4168
3	-0.1916	0.2203	1	0.6388	3.5445	0.4447	1	0.5048	0.6650	2	0.7171
4	0.4977	1.4863	1	0.2228	2.8945	0.0167	1	0.8972	1.5030	2	0.4717
Joint		4.8094	4	0.3074		0.6216	4	0.9606	5.4311	8	0.7107

3.4.4 Test of stability of recursive estimates of the error correction VDL model

The cumulative sum (CUSUM) and cumulative sum of squares (CUSUM of squares) tests are used to diagnose the stability of the error correction model of VDL. The results are shown in Figure 2.



(a) Cumulative sum (CUSUM) test output



(b) Cumulative sum of squares (CUSUM of squares) test output

Figure 2. CUSUM and CUSUM of Squares tests of VDL model stability

The (a) and (b) components of the Figure indicate clear evidence of stability as the plotted “CUSUM” graph and CUSUM of squares graph (in blue). Both graphs are clearly fitted within the 5% significance “corridor” defined by the upper and lower red lines. The implication is that the recursive estimates are significant at 5% level. Elsewhere, the use of the CUSUM test reveals the stability of the "stock trading volume" in Nigeria, irrespective of slender tremors witnessed at certain points in time [38]. The finding warrants that the null hypothesis that "there is no stability" is rejected at 5% levels, leading to conclusion that the estimates are stable.

3.4.5 Granger causality test

The results of pairwise Granger Causality tests for the used variables are displayed in Table 11.

Table 11. Output of Pairwise Granger-Causality Tests

Null Hypothesis:	No. of obs.	F-Statistic	Probability
LNPSC does not Granger Cause LNVDL	34	0.40074	0.8062
LNVDL does not Granger Cause LNPSC		2.67918	0.0550
LNMYS does not Granger Cause LNVDL	34	1.11864	0.3700
LNVDL does not Granger Cause LNMYS		0.19195	0.9403
LNMLR does not Granger Cause LNVDL	34	3.41300	0.0233
LNVDL does not Granger Cause LNMLR		1.42814	0.2539
LNMYS does not Granger Cause LNPSC	34	3.81074	0.0149
LNPSC does not Granger Cause LNMYS		1.19118	0.3390
LNMLR does not Granger Cause LNPSC	34	1.00401	0.4241
LNPSC does not Granger Cause LNMLR		0.81992	0.5247
LNMLR does not Granger Cause LNMYS	34	0.87738	0.4915
LNMYS does not Granger Cause LNMLR		0.92076	0.4675

Among other things, the results reveal that the null hypothesis that lending rate (lnMLR) does not Granger Cause the value of traded transacted deals (lnVDL) is rejected at 5%. This follows from the fact that the observed F-statistics (3.413) has a probability of P=.023 that is less than 0.05. It means that the lending rate Granger Causes value of traded deals. It also implies that the current values of the traded deals can be impacted on by including the past values of the lending rate alongside other variables, rather than by not doing so [32]. However, the null hypothesis that value of traded deals does not Granger Cause the lending rate cannot be rejected (F-statistic=1.428, P=.254). This means that there is a unidirectional causality relationship between the value of transactions and the lending rate, with causality running from lending rate to transaction values, our index of stock market performance. The tests do not reveal any Granger Causality between any of the other included variables, namely credit to the private sector (PSC) and money supply (MYS) and value of transactions.

Another significant causality relationship in the Table is between money supply and credit to the private sector. The null hypothesis that money supply does not Granger Cause credit to the private sector is rejected at 5% (F-statistic=3.811, P=.014), but the corollary that credit to the private sector does not Granger Cause money supply cannot be rejected (F-statistic=1.191, P=.424). The result also reflects a case of unidirectional causality that runs from money supply to credit to the private sector.

3.4.6 Analysis of the variance decomposition function

The comprehensive output of "variance decomposition function" is presented in Appendix I, but the summary of the effects on our target variable (value of traded deals) is shown in Figure 3. Each row of the variance decomposition output reflects the percentage of the forecast error variance accounted for by each of the included variables. In this analysis, 10 periods are chosen indicating the researcher's intention to forecast for 10 years into the future. For the purpose of this analysis, the first two years is considered as the short-run while the last two years (ninth and tenth years) reflect the long-run.

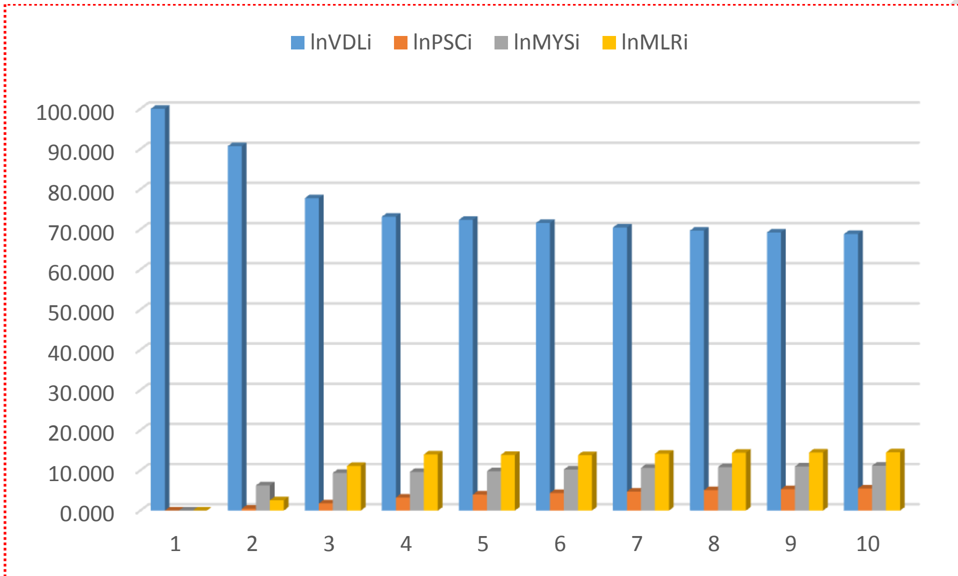


Figure 3. Variance decomposition of effects of variables on VDL

As it can be inferred from the Figure, in the short-run, greater share of the forecast error variance in the value of transacted deals in the Nigeria stock market is explained by the VDL itself. These shares are as high as 100% in the first period and 90.7% in the second period. This means that in the short-run the influence of VDL on itself is "strongly endogenous influence." Also, during the same short-run period the contributions of other variables, namely PSC, MYS and MLR, to forecast error variance in VDL are very weak – from zero percent for each variable at period 1 to 0.4%, 6.25% and 2.65% for PSC, MYS and MLR respectively. This implies that PSC, MYS and MLR are "strongly exogenous" with respect to VDL.

Moving into the future, the influence of VDL on itself dwindles and gets increasingly weaker even as the influences of the other variables (PSC, MYS and MLR) are getting increasingly stronger. From 90.7% in period 2, the contribution of VDL to forecast error variance in itself dropped to 69.22% in period 9 and further to 68.84% in period 10. Contrarily, the shares of contributions to forecast error variance increases from 0.47% in period 2 to 5.51% in period 10 for PSC, from 6.25% in period 2 to 11.15% in period 10 for MYS, and from 2.57% in period 2 to 14.50% in period 10 for MLR. The finding means that in the long-run PSC, MYS and MLR are "robustly endogenous" having strong influences VDL. Also in the long-run, VDL demonstrates "weak endogeneity," having weaker influence on itself. This finding corroborates the outcome of a study in Bangladesh, which through variance decomposition analysis discovered that almost all the variance in the stock performance resulted from shocks from itself in the short-term with the magnitude diminishing over the long-term [24]. The results show further that as movement continues into the future, the relative share of MLR's contribution to the forecast error variance in VDL increases very fast, faster than the relative increase in each of the other two variables. This underscores the futuristic relevance of the lending rate to the VDL model as earlier revealed by the Granger Causality analysis.

3.4.6 Impulse response analysis

A comprehensive output of the variables' individual and accumulated response to Cholesky one standard deviation innovations is displayed in Appendix II. The impulse response function (IRF) graph is presented in Figure 4 as follows.

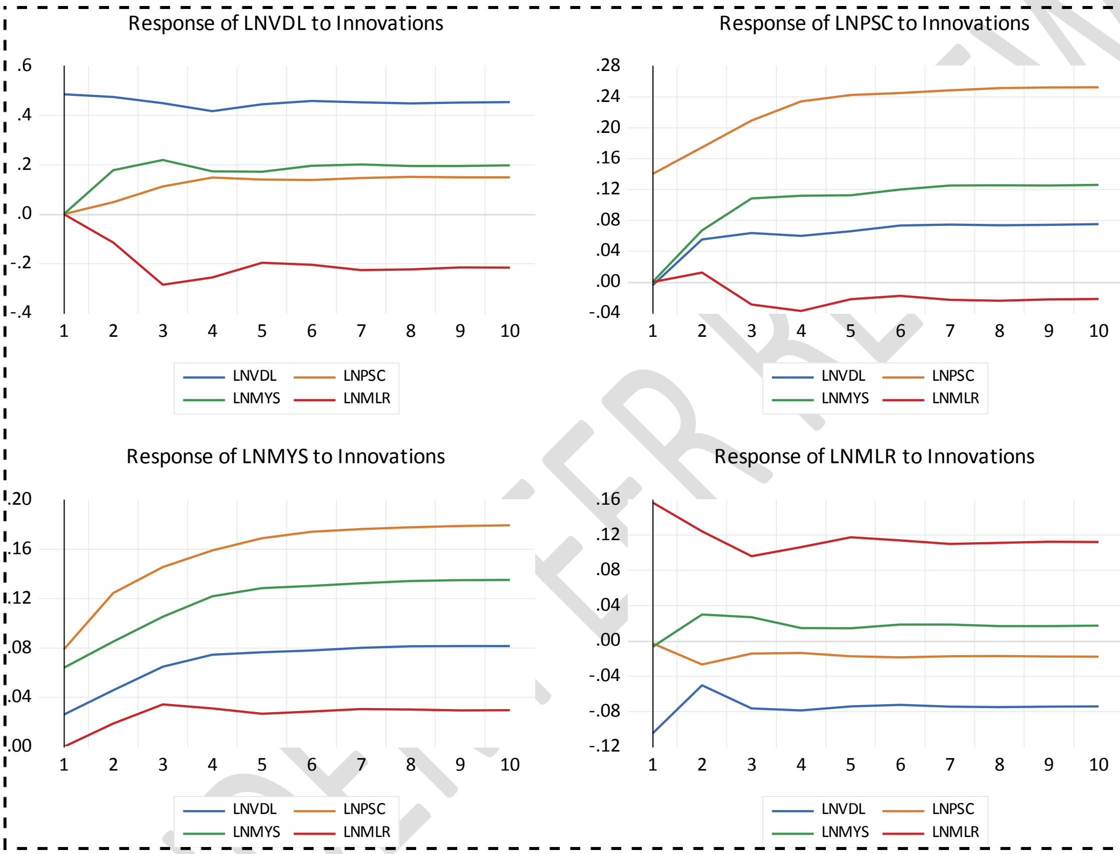


Figure 4. Response of included variables to Cholesky one standard deviation innovations

The main interest is on the target variable (VDL) and its response to one-standard deviation innovations (impulses) from self and the other variables – PSC, MYS and MLR – during the short- and long-run periods. VDL's response to one standard deviation innovation from itself remains positive throughout the 10-year periods considered. In the short-run periods 1 and 2, the response factor to one standard deviation innovation dropped from 0.48 to 0.47. The factor first dropped persistently to 0.42 in period 4, picks up thereafter before closing at 0.45 in period 10. The response of stock market performance indicator (VDL) to private sector credit and money supply starts at zero in the first year, but turns to positive in second period. Thereafter it records marginal increases and to close at 0.15 for PSC and 0.20 for MLR in period 10. Relating to the VDL's response to one standard deviation innovations in MLR, it remains below the 0 point in period 2, remains negative while also exhibiting a decreasing trend moving into the future to close at -0.22 in year period 10. The Figure also presents the response of the other endogenous variables to one standard deviation innovations from themselves and the rest variables included in this study.

4. CONCLUSION

The key findings from this study includes that all four used variables – value of traded shares, commercial credit to the private sector, money supply, and commercial lending rate – are stationary at first difference, I(1). With the Trace-statistics revealing existence of at least one cointegrating relationship among the time series, the long-run ECM was estimated, which resulted to the error correction term producing an expected negative sign with an adjustment speed of 44.19%. Although credit to the private sector, lending rate and money supply are significant contributors to the long-run equilibrium of the stock market performance, the private sector credits and lending rate have negative effects while the influence of money supply is positive. The observed positive relationship between stock performance and money supply is in line with to the a priori expectation of this study. It implies that the provision of financial services by the Nigeria's monetary authority can have a long-term positive impact on the stock market performance. This is understandable because the monetary policy of injecting money into the system helps to boost economic activity and growth in critical sectors. Similarly, the negative observed sign of the lending rate agrees with the hypothesized behavior of the variable, but a similar negative sign observed for private sector credit negates the originally hypothesized positive relationship. Lastly, a unidirectional causality relationship was revealed between the value of transactions and the lending rate, with causality running from lending rate to value of traded deals without a feed-back loop.

The key lessons to be drawn from the above findings from this investigation are: a) that the persisting restrictive interest rate policy are not favourable to long-term investment from the investors' perspective; b) that the terms and conditions of the commercial credit packages is also disadvantageous to long-term investment in Nigeria; and c) that money supply as a monetary policy instrument in Nigeria has been used to boost investment and stock market performance in the country. The above findings from this investigation are of paramount consequences to key stock market players, market watchers, financial analysts, and the investing public who have interest in the Nigeria stock market. It is recommended that use of a more investment friendly commercial lending rate, relaxing of the stringent terms and conditions of the commercial private sector credit and loan packages, will be imperative to boosting investment and performance of the stock market in Nigeria.

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Appendix I. "Variance Decomposition" and forecast the VDL model

Variable	**Period**	**Standard error**	**Variance decomposition (%)**			
			$lnVDL_i$	**$lnPSC_i$**	**$lnMYS_i$**	**$lnMLR_i$**
$lnVDL_i$:	1	0.485525	100.0000	0.000000	0.000000	0.000000
	2	0.713178	90.70583	0.470558	6.253860	2.569749
	3	0.923399	77.75954	1.770544	9.386051	11.08386
	4	1.069691	73.15086	3.241787	9.628333	13.97902
	5	1.195818	72.36581	3.977077	9.775425	13.88169
	6	1.319085	71.57215	4.371163	10.23847	13.81821
	7	1.434596	70.47109	4.739654	10.62594	14.16332
	8	1.539620	69.69089	5.074023	10.83728	14.39781
	9	1.637557	69.22589	5.321865	10.99479	14.45745
	10	1.730843	68.84504	5.507837	11.14630	14.50083
$lnPSC_i$:	1	0.140144	0.092606	99.90739	0.000000	0.000000
	2	0.240538	5.337063	86.59157	7.806062	0.265305
	3	0.344147	6.028338	79.37254	13.76858	0.830544
	4	0.436793	5.618738	78.02807	15.10965	1.243546
	5	0.516751	5.648198	77.75088	15.53296	1.067958
	6	0.589216	5.892862	77.09031	16.10353	0.913298
	7	0.656266	6.037810	76.48930	16.61559	0.857297
	8	0.718069	6.098153	76.14624	16.92655	0.829060
	9	0.775228	6.152780	75.92148	17.13211	0.793633
	10	0.828708	6.209050	75.72129	17.30687	0.762794
$lnMYS_i$:	1	0.104831	6.175211	56.71404	37.11075	0.000000
	2	0.190262	7.685125	60.04337	31.29533	0.976178
	3	0.271775	9.469890	58.13651	30.33006	2.063541
	4	0.347138	10.41237	56.62278	30.90288	2.061968
	5	0.414846	10.68712	56.23127	31.22232	1.859287
	6	0.475720	10.81891	56.16061	31.24830	1.772182
	7	0.531304	10.95276	56.03769	31.26103	1.748514
	8	0.582584	11.05702	55.91146	31.31114	1.720383
	9	0.630160	11.12219	55.83747	31.35112	1.689228
	10	0.674598	11.16890	55.79253	31.37119	1.667382
$lnMLR_i$:	1	0.188973	30.81953	0.020976	0.134086	69.02541
	2	0.235206	24.47567	1.314370	1.696644	72.51332
	3	0.267129	27.18081	1.310238	2.336546	69.17240
	4	0.298865	28.67156	1.253049	2.108830	67.96656
	5	0.330448	28.50457	1.303799	1.916233	68.27540
	6	0.357968	28.38681	1.382605	1.902834	68.32775
	7	0.382663	28.62644	1.418166	1.900143	68.05525
	8	0.406231	28.82323	1.437163	1.860330	67.87928
	9	0.428792	28.88923	1.459806	1.824575	67.82639
	10	0.450110	28.93973	1.481834	1.805339	67.77310

Cholesky Ordering: $lnVDL_i$ $lnPSC_i$ $lnMYS_i$ $lnMLR_i$

Appendix II. Sole and accumulated response of variables to Cholesky one standard deviation innovations

Variable	Period	Response				Accumulated Response			
		lnVDL	lnPSC	lnMYS	lnMLR	lnVDL	lnPSC	lnMYS	lnMLR
lnVDL	1	0.485525	0.000000	0.000000	0.000000	0.485525	0.000000	0.000000	0.000000
	2	0.474991	0.048922	0.178350	-0.114326	0.960516	0.048922	0.178350	-0.114326
	3	0.449086	0.112710	0.219598	-0.285373	1.409602	0.161632	0.397947	-0.399699
	4	0.417122	0.148314	0.173607	-0.255822	1.826724	0.309945	0.571554	-0.655521
	5	0.444745	0.140633	0.172092	-0.196347	2.271469	0.450579	0.743646	-0.851869
	6	0.458832	0.138514	0.195860	-0.204766	2.730301	0.589092	0.939506	-1.056635
	7	0.452766	0.146587	0.201348	-0.225955	3.183067	0.735679	1.140854	-1.282590
	8	0.449034	0.150768	0.195451	-0.223158	3.632101	0.886447	1.336305	-1.505748
	9	0.452087	0.149782	0.194796	-0.215406	4.084188	1.036229	1.531101	-1.721154
	10	0.454001	0.149312	0.197705	-0.216169	4.538189	1.185541	1.728807	-1.937323
lnPSC	1	-0.004265	0.140079	0.000000	0.000000	-0.004265	0.140079	0.000000	0.000000
	2	0.055405	0.174581	0.067205	0.012390	0.051141	0.314660	0.067205	0.012390
	3	0.063654	0.209537	0.108585	-0.028813	0.114795	0.524198	0.175789	-0.016423
	4	0.059834	0.234226	0.111894	-0.037268	0.174629	0.758424	0.287684	-0.053691
	5	0.066050	0.242386	0.112474	-0.021892	0.240679	1.000810	0.400158	-0.075582
	6	0.073322	0.244988	0.120123	-0.017859	0.314000	1.245798	0.520281	-0.093442
	7	0.074467	0.248575	0.125113	-0.022836	0.388468	1.494372	0.645395	-0.116278
	8	0.073754	0.251397	0.125365	-0.024137	0.462221	1.745769	0.770760	-0.140415
	9	0.074386	0.252277	0.125232	-0.022243	0.536608	1.998045	0.895992	-0.162657
	10	0.075261	0.252487	0.126079	-0.021656	0.611869	2.250533	1.022070	-0.184313
lnMYS	1	0.026051	0.078947	0.063862	0.000000	0.026051	0.078947	0.063862	0.000000
	2	0.045862	0.124510	0.085150	0.018798	0.071913	0.203458	0.149012	0.018798
	3	0.064905	0.145620	0.105231	0.034217	0.136818	0.349077	0.254242	0.053015
	4	0.074517	0.159037	0.121808	0.030994	0.211335	0.508114	0.376050	0.084009
	5	0.076452	0.168936	0.128426	0.026740	0.287786	0.677050	0.504476	0.110748
	6	0.078051	0.174139	0.130327	0.028475	0.365838	0.851189	0.634804	0.139224
	7	0.080210	0.176320	0.132390	0.030416	0.446048	1.027509	0.767193	0.169640
	8	0.081302	0.177708	0.134262	0.030054	0.527350	1.205217	0.901456	0.199695
	9	0.081476	0.178789	0.134998	0.029477	0.608826	1.384006	1.036453	0.229172
	10	0.081617	0.179362	0.135163	0.029665	0.690443	1.563368	1.171616	0.258837
lnMLR	1	-0.104909	-0.002737	-0.006920	0.157002	-0.104909	-0.002737	-0.006920	0.157002
	2	-0.050344	-0.026826	0.029845	0.124363	-0.155253	-0.029563	0.022925	0.281365
	3	-0.076520	-0.014416	0.026994	0.096147	-0.231773	-0.043979	0.049920	0.377512
	4	-0.078828	-0.013574	0.014707	0.106526	-0.310600	-0.057554	0.064627	0.484039
	5	-0.074272	-0.017449	0.014451	0.117669	-0.384872	-0.075003	0.079078	0.601708
	6	-0.072452	-0.018654	0.018597	0.114026	-0.457324	-0.093657	0.097675	0.715734
	7	-0.074450	-0.017463	0.018550	0.109992	-0.531775	-0.111120	0.116225	0.825725
	8	-0.075147	-0.017176	0.016958	0.111188	-0.606922	-0.128296	0.133183	0.936913
	9	-0.074508	-0.017674	0.016874	0.112652	-0.681429	-0.145970	0.150057	1.049565
	10	-0.074265	-0.017837	0.017404	0.112252	-0.755694	-0.163807	0.167461	1.161817

Cholesky Ordering: LNVDL LNPSC LNMYS LNMLR