Estimating the Threshold Level of Stock Market Price Volatility on Economic Growth

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Abstract

The threshold level of stock market volatility on economic growth was estimated using quadratic regression model based on annual data of the Nigerian economy from 1985 to 2016. The study found evidence of a threshold effect of stock market volatility on economic growth in Nigeria. The established that the critical point of stock market price volatility which impacts on economic growth for the Nigerian economy is 7.1 percent, beyond this level, stock market price volatility starts exerting cost on growth. The marginal impact of stock market price volatility on growth becomes negative beyond a threshold ratio of about 7.1 percent of GDP. Also, the study revealed that almost all the explanatory variables had signs that were inconsistent with theoretical predictions except capital and trade that had expected signs in line with theoretical expectations. All stakeholders of the Nigerian stock market are, therefore, advised to monitor the stock market price closely such that investment is made close to or equal to 7.1 percent of the GDP to have a positive impact on the economy. Any investment made beyond this threshold point could have an adverse effect on economic growth.

Keywords: Threshold, Stock market volatility, Economic Growth, quadratic regression

Introduction

The stock market has been found to be unpredictable and as such it weakens the smooth running of the economy which impacts negatively on the country's economic performance. According to Onakoya 2013, volatility in the stock market indicates growth suggesting a likely relationship between them. The relationship between stock market price volatility and economic growth has been widely debated in literature. The issue has raised a lot of controversy among scholars as the results are mixed. Some schools of thought are of the view that a significant positive relationship exist between stock market volatility and economic growth (Onakoya, 2013; Babajide et al 2016, etc.) while other schools believe that stock market volatility is not robustly linked with growth (Rahman, 2009; Reinhart and Rogoff, 2008 etc.).While the debate on the relationship is still on going, there are other issues that affect a country's economic growth that needs to be addressed. No matter how small, in order to have appreciable growth and employment, a country needs a little dose of inflation (Tobin (1972) and Vickery (1955) as cited in Papademos (2003). Similarly, fluctuations in stock volatility could impact positively on consumption, investment, and other business cycle variables which will invariably affect economic growth (Schwert, 1989). Therefore, for the purpose of monitoring stock price movement effectively, investors are better off when they are able to know the threshold at which stock price volatility could have negative impact on growth. In developed and developing economies, extant literature have emphasised threshold level of inflation on growth (Pollin and Zhu, 2005; Quartey, 2010 etc.). Empirical studies like Khan and Senhadji (2001) advocated that inflation threshold should be 11-12 percent for developing economies while 1-3 percent should be for developed nations. Inflation threshold established by Kremer et al (2009) for developed countries was 2.5 percent and 17 percent for developed and developing nations respectively. For specific emerging and developing countries, a wide

range of threshold levels were suggested by different authors: 22.2 percent for Ghana (Quartey, 2010); 8percent for Nigeria (Salami and Kelikume, 2010), 14.97 percent for Rwanda (Rutayisire, 2013) etc. However, literature that captures threshold level of stock market volatility which may affect growth in Nigeria is not available. Thus, this study is poised to estimate the threshold level of stock market price volatility on economic growth. The next section reviews the empirical literature followed by methodology and estimation procedure. Section four highlights the results estimated. The conclusions and recommendation are presented in the final section.

Empirical Literature

The focus of this paper is not to determine the threshold of inflation but to utilise the methodology that was adopted in empirical literature to estimate the threshold of stock market volatility and how it may affect growth. Literature on the threshold of stock market volatility which may affect growth is un available as far as we know. The focus of this sub- section is to review literature on the threshold of inflation on growth. For instance, Bawa and Abdullahi (2012) conducted an investigation on threshold level of inflation for Nigeria based on quarterly data from 1981 to 2009. A threshold level of 13 percent was found for the Nigerian economy. Any value lower than this threshold level was found to have an adverse stimulus on growth whereas above the threshold, the extent of negative impact of inflation on growth was higher.

Using Indian quarterly data from Mohanty, Chakraborty, and John (2011) conducted an examination on the presence of threshold effect on economic growth. The authors affirmed that a structural break relationship was found between growth and inflation at 4.0percent and 5.5percent above which inflation hinders growth rate. However, beneath the threshold, inflation is directly related to growth. Therefore it is beneficial if inflation is kept below the threshold. An attempt was made to add to knowledge when Ajide and Lawanson (2012) utilised the simple augmented production function, to estimate the inflation threshold in the Nigerian economy. A threshold value of 9 percent was confirmed to be the acceptable target for inflation in Nigeria. The study could have used country specific inflation threshold to serve as a bench mark for inflation threshold in the country.

Rutayisire (2013) explored the threshold effects of economic growth on inflation. Using a quadratic regression model, the study established a threshold level of 14.97 percent. The granger causality test that was conducted revealed the absence of feedback phenomenon from inflation to growth. This implied that the simultaneity bias does not seriously affect the coefficient of inflation in the regression model. However, the study did not address the channel through which inflation impacts negatively on economic growth. An assessment of the non-linearity in inflation and growth relationship for Brazil, Russia, India, Mexico and China (BRIMC) economies was done by Khadim, Ilyas and Mehmood (2016). The study revealed that the association between economic growth and inflation without square term is positive and significant in the long run. However when a square term of inflation was introduced, the relationship between these two variables became negative and significant. Therefore, the sign switching behaviour of inflation from positive into negative revealed the presence threshold effect from inflation to economic growth in BRIMC economies. The study also revealed that inflation can hamper the growth if it exceeds the threshold level of 8.32 percent. A quarterly data would have been more appropriate for a robust analysis considering the country mix.

Using nonlinear quadratic model, Yabu and Kessy (2015), examined the threshold level of inflation on economic growth among the East African Community (EAC) partner countries. An average threshold value for all the three EAC member states was estimated to be 8.46 percent with a negative and significant effect on growth. However, when countries were considered separately, using the seemingly unrelated regression, the optimal level of inflation for Kenya was 6.77 percent; Tanzanian was 8.80 percent while Uganda was 8.41 percent. Above the optimal level for each country, inflation starts to exert cost on economic growth. The authors however did not address the channels through which inflation caused an adverse influence on growth for each of the countries considered.

The review of empirical literature suggests different threshold values that were identified for inflation however none of the authors conducted an investigation close to finding the threshold at which stock

market price volatility begin to have adverse impact on economic growth. This study seeks to contribute to literature in this regard.

Methodology and Estimation Procedure

This section highlights the methodology that will be adopted in addressing aim of this study as well as the estimation technique to be utilised.

Model Specification

In a bid to achieve the objective of estimating the threshold level of stock market price volatility on economic growth, the study adopts the quadratic regression. According to Gujarati (2004), a quadratic regression is a form of multiple regression model identified under the polynomial range. The quadratic function approach of Pollin and Zhu (2006) and Quartey (2010) has been utilised in empirical growth literature. For instance, Altunc and Aydin (2013) adopted the quadratic function to estimate the optimal size of government and economic growth. The control variables included are: investment, financial development and trade. Labour and capital have been included in the equation as they are important explanatory variables of growth. Therefore, the empirical model that was used to examine the threshold level of stock market volatility that affects growth was modified from an improved Frimpong and Oteng-Abayie (2010), Khan and Senhadji (2001), Beck and Levine (2004), and Adefeso *et al* (2013) is specified in its functional form as follows:

$$GDP = f(SMV, FINDEV, TRD, INV, LAB, KAP) \tag{3}$$

where

GDP: Gross domestic product (measured by annual growth rate of GDP)
SMV: Stock market price volatility (measured by the all share index- Stock returns)
The stock returns (R_t) are obtained by: R_t = Log ASI_t - Log ASI_{t-1} where ASI is the Nigerian all share index, Log is the logarithm.
FINDEV: Financial Development (measured by the ratio of broad money (M2) to GDP)
TRD: Trade (measured by trade as a percentage of GDP)
INV: Investment (measured by gross capital formation as a percentage of GDP)
LAB: Labour (measured by total labour force)
KAP: Capital (measured by gross fixed capital formation)

Data for the variables in equation (3) were sourced from the Central Bank of Nigeria Statistical Bulletin and the World Development Indicators of World Bank. In line with Pollin and Zhu (2006), Quartey (2010) and Rutayisire (2013), the threshold level of stock market volatility equation that was estimated is stated in its quadratic form as:

$$GDP_t = \phi_0 + \phi_1(SMV_t) + \phi_2\left(SMV_t^2\right) + \phi_3\left(FINDEV_t\right) + \phi_4(INV) + \phi_5(TRD + \phi_6(LAB_t) + \phi_7\left(KAP_t\right) + \varepsilon_t \tag{4}$$

ε : error term

ϕ : vector of parameters such that $\phi = \phi_0, \ldots, \phi_7$

other notations are as earlier defined.

The square of the variable of interest (stock market price volatility- SMV) is utilised to capture the threshold level of stock market volatility on economic growth. This is done by giving allowance for variations in slopes as a function of changes in the stock market price volatility. To derive the critical point corresponding to the stock market price volatility, the partial derivative of equation (4) is calculated with respect to stock market price volatility, SMV_t. The derivative yields the following expression that is set equal to zero:

$$\frac{dGDP}{dSMV} = \phi_1 + 2\phi_2 SMV_t = 0 \tag{5}$$

Following Pollin and Zhu (2006), equation (4) was solved for threshold of stock market price volatility (TSMV) which may affect economic growth and it resulted into the formula below:

$$TSMV_t = -\left[\frac{SMV_t}{\left(2 * \left[SMV_t^2\right]\right)}\right] \quad (6)$$

SMV is the coefficient of stock market price volatility, and SMV^2 is the coefficient of stock market price volatility squared.

Estimation Technique

In this section, the quadratic regression model (QRM) was used to estimate the threshold of stock market volatility on economic growth in the Nigerian economy. The QRM is also identified as the non-linear or second degree polynomial regression. The method of finding the equation of the parabola that provides the best fit to a set of data can be regarded as the quadratic regression. A nonlinear model can viewed as any model of the basic form in which the functional part of the model is not linear with reference to the unidentified parameters. The merit of the nonlinear least square regression over other techniques is the broad range of functions that can be fitted. As a way of avoiding spurious result, the unit root properties of the variables were considered in the estimation process. It was established that all the variables under consideration were stationary at first difference I (1). The quadratic regression that was estimated is presented as:

$$\Delta GDP = \phi_0 + \phi_1 \Delta SMV + \phi_2 \Delta SMV^2 + \phi_3 \Delta FINDEV + \phi_4 \Delta INV + \phi_5 \Delta TRD + \phi_6 \Delta KAP + \phi_7 \Delta LAB + \varepsilon_t \quad (7)$$

Where ΔGDP : first difference of annual growth rate of Gross domestic product (growth rate)

ΔSMV : first difference of stock market price volatility (linear form)

ΔSMV^2 : first difference of square of stock market price volatility (stock market returns)

$\Delta FINDEV$: first difference of financial development

ΔTRD : first difference of trade

ΔKAP : first difference of the natural logarithm of capital

ΔINV : first difference of the natural logarithm of investment

ΔLAB : first difference of the natural logarithm of the total labour force

ε_t : Error term

$\phi_1, \phi_2, \phi_3, ..., \phi_7$ coefficient of the variables

Results and Discussion

This section focusses on the time series properties such as the unit root test, co-integration test. The estimated result will also be presented and discussed in details.

Unit Root Test

The estimation procedure began by conducting unit root tests on the variables. It is worthy of note that spurious regression problems characterises data that have unit roots. Thus, it is crucial to check the unit root properties of such variables. According to macroeconomic literature, there are several ways for testing for unit root. However, this study adopted the Philips Perron (PP) test. The unit root test revealed that all the variables were found to be stationary at first difference the PP test. The inference that can be drawn from this result is that a long term relationship could be present between the variables as all of the variables have unit roots and required differencing in order to make them stationary. This calls for co-integration analysis to establish the presence of long term relationship between the variables. (see Table 1)

Table 1: Unit root test @ 5 percent level of significance with intercept and trend

Series	PP (levels)	Order of Integration	Remark	PP (First difference)	Order of Integration	Remark
GDP	-4.605	I(0)	**Stationary**	-24.69	I(1)	**Stationary**
SMV	-4.434	I(0)	**Stationary**	-12.58	I(1)	**Stationary**
FINDEV	-1.028	I(0)	Non-stationary	-6.845	I(1)	**Stationary**
INV	-0.417	I(0)	Non-stationary	-5.264	I(1)	**Stationary**
TRD	-0.134	I(0)	Non-stationary	-13.98	I(1)	**Stationary**
LAB	1.374	I(0)	Non-stationary	-3.894	I(1)	**Stationary**
KAP	1.016	I(0)	Non-stationary	-5.167	I(1)	**Stationary**
Critical Values	-3.562			-3.568		

Source: Author's computation using EViews 9

Co-Integration Test

Having confirmed the unit root properties of the variables, a Johansen co-integration test was carried out to establish the presence or absence of a long run relationship between the variables. The optimal lag length was chosen based on the Schwarz Information criterion (SIC). An optimal lag of one was found to be the best option based on SIC. The study established that trace statistics had one co-integrating equation while the maximum eigenvalue had one co-integrating equations at 5percent level of significance. Therefore, the alternative hypothesis (H_1) of the presence of co-integrating vectors should be accepted. (see Table 2 below)

Table 2: Johansen Co-integration test

TRACE STATISTIC & MAXIMUM EIGENVALUE STATISTIC						
Hypothesized No of CE(s)	Eigenvalue (5%)	Trace Statistic (5%)	0.05 Critical Value	Eigenvalue (5%)	Trace Statistic (5%)	0.05 Critical Value
None *(**)	0.843471	149.3461	125.6154	0.843471	55.63537	46.23142
At most 1	0.734542	93.71077	95.75366	0.734542	39.78901	40.07757
At most 2	0.488274	53.92177	69.81889	0.488274	20.09898	33.87687
At most 3	0.454662	33.82278	47.85613	0.454662	18.19046	27.58434
At most 4	0.263061	15.63232	29.79707	0.263061	9.157496	21.13162
At most 5	0.187733	6.474828	15.49471	0.187733	6.237773	14.2646
At most 6	0.007871	0.237055	3.841466	0.007871	0.237055	3.841466
* denotes rejection of the hypothesis at the 5% for Trace Statistic						
(**) denotes rejection of the hypothesis at the 5% for Max Eigen Statistic						
Both Trace test & Max-eigen indicates 1 cointegrating eqn(s) at the 0.05 level						

Source: Author's computation using EViews 9

Result Presentation and Discussion

The estimated quadratic regression is presented in Table 3. The lagged growth rate was included as an explanatory variable because stock market price volatility is believed to be a dynamic concept (Yartey,2008). More so, when the regression was carried out without the inclusion of the lagged dependent variable, it was only the constant that was significant none of the explanatory variables were significant Also the coefficient of determination performed better with the inclusion of lagged dependent variable in the model. The coefficient of determination R^2 represents the goodness of fit of the model. It can be said to be satisfactory as the quadratic regression model explains 67.5 percent variation in growth. Trade (TRD), Labour (LAB) and lagged GDP were found to be significant at 5 percent level while the remaining variables were statistically insignificant. Though, when the lagged dependent variable was not included in the model, none was significant. As against theoretical expectation and empirical evidence, stock market price volatility had a negative relationship with economic growth.

However, when stock market price volatility was lagged by one period, the relationship remained the same. The same positive relationship was repeated with square of stock market price volatility. Moreover, financial development was found to inversely related to economic growth contrary to theoretical prediction. The negative relationship between investment and growth was also inconsistent with theoretical expectation. Similarly, labour is inversely related with economic growth conflicting theoretical expectation. However, in line with theoretical expectation, capital was found to be directly related to economic growth. Also trade was found to have a negative association with growth which is consistent with theory and the empirical work of Rutayisire (2013). A change of 1 percent in financial development and investment will lead to a reduction in annual growth rate by 0.13 percent and 0.50 percent respectively, while a change of 1 percent in capital will result to an increase in growth rate by 10.5 percent. The observed negative association between financial development and growth is contrary to the empirical work of Babajide et al (2015)

A one percent variation in trade will cause annual growth rate to drop by 22 percent. A change of one percent in capital and labour will make annual growth rate to rise by 10.5 percent and drop by 39.5 percent respectively. It should be noted that the positive effect of stock market price volatility on growth appeared with one period lag, while the contemporaneous impact was negative. The total cumulative effect of stock market price volatility on growth was however negative with a value of 0.962454. Following the estimated result in Table 3 below, the threshold level of stock market price volatility is obtained using the formula obtained in equation(6). The calculation yielded the result below:

$$TSMV = \left(\frac{6.861332}{2\left(0.483547\right)} \right)$$

$$TSMV = \left(\frac{6.861332}{0.967094} \right)$$

$$TSMV = 7.1\%$$

The result reveal that the critical point of stock market price volatility which impacts on economic growth for the Nigerian economy is 7.1 percent, beyond this level stock market price volatility starts exerting cost on growth. The marginal impact of stock market price volatility on growth becomes negative beyond a threshold ratio of about 7.1 percent of GDP. The result also suggests that economic growth peaks when stock market price volatility reaches a threshold level of 7.1 percent corresponding to the growth maximising stock market price volatility. The diagnostic test is presented below the estimated equation table. ARCH effect and serial correlation were both absent in the model. However,

it was found that the residuals are not normally distributed. In spite of this flaw, the estimated model can still be accepted as it does not have serial correlation and ARCH effect

Table 3: Quadratic regression

Dependent Variable: D(GDP)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.519980	2.318047	1.518511	0.1445
D(SMV)	-6.861332	4.493497	-1.526947	0.1424
D(SMV^2)	0.483547	8.564936	0.056457	0.9555
D(FINDEV)	-0.130128	0.245817	-0.529370	0.6024
D(INV)	-0.499330	0.721497	-0.692075	0.4968
D(TRD)	-0.215847	0.086018	-2.509312	0.0208**
D(KAP)	10.54684	8.730189	1.208088	0.2411
D(LAB)	-39.54258	17.22293	-2.295926	0.0326**
GDP(-1)	-0.816876	0.171664	-4.758572	0.0001**
SMV(-1)	-2.181241	5.489083	-0.397378	0.6953
SMV^2(-1)	7.596572	13.45045	0.564782	0.5785
R-squared	0.675240	Adjusted R-squared		0.512859
F-statistic	4.158385	Durbin-Watson stat		1.946280
Prob(F-statistic)	0.003252			

Note: ***, ** and * signifies 1%, 5% and 10% level of significance respectively

Diagnostic Tests

ARCH 1-1 Test: F (1, 28) = 0.230598 [0.6206]

Normality test: 75.10 [0.000000]

Serial correlation: None

Source: Author's computation using EViews 9

Conclusion and Recommendations

This study has estimated the threshold level of stock market volatility which may affect economic growth in Nigeria using a quadratic regression model. It was established that a long term relationship exist among the variables based on the Johansen co-integration test. The estimated threshold level was 7.1 percent which serves as evidence in support of the hypothesis of the presence of threshold effect of stock market volatility on economic growth. Almost all the explanatory variables had signs that were inconsistent with theoretical predictions except capital and trade that had expected signs in line with theoretical expectation. This study is the first attempt to address the threshold effect of stock market price volatility on economic growth in Nigeria as far as authors are aware. It is recommended that all stakeholders of the Nigerian stock market should monitor the stock market price closely such that investment is made close to or equal to 7.1 percent of the GDP to have a positive impact on the economy. Any investment made beyond this threshold point could have an adverse effect on economic growth.

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