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Cointegrating Relationship between Macroeconomic Variables and Stock Market Prices in Nairobi Securities Exchange

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Abstract

The study of stock market prices movements and macroeconomic indicators has been imperative in view of the country's economic growth because the most sensitive segment of any developing economy is its stock market. The buy and sell decision rule are affected by the investor's psychology which exerts influence on the macroeconomic events. The very critical question when it comes to this is that how instantaneous the information is transferred to the investors and market analyst and in return reflects on stock market prices. Therefore, the purpose of this paper was to analyze cointegrating relationship between macroeconomic indicators and the stock market prices in the context of Nairobi Securities Exchange. The paper used longitudinal research design using monthly secondary data for the period 2005 to 2018. The data were sourced from NSE, KNBS and Central Bank of Kenya. Augmented Dickey Fuller test confirmed the presence of unit root at levels for some variables, and all the variables attained stationarity after first difference. The Optimum lag length selected was 3. Johansen cointegration test showed that the variables were cointegrated thus Vector Error Correction Model was used to estimate the parameters. The error correction term was -1.1804 and significant at p-value 0.000 indicating a long-term existence between variables and the stock market prices. Jarque-Bera test showed the residuals followed normal distribution. Inflation and interest rate negatively and significantly affected stock market prices at coefficient -0.8371 (p-value 0.005) and -4.0876 (0.000) respectively. However, Exchange rate and nominal GDP had positive and significant effects on stock prices at 0.0001 (p-value=0.012) and 0.00002 (p-value=0.000) respectively. It was recommended based on the findings that the government should adopt expansionary monetary policy to by regulating interest rate and stabilizing exchange rate to create more money for investors. There is need for the government to encourage activities that increases GDP since it is an important macroeconomic indicator for health economy.

Keywords: Cointegration • Unit root • VECM • Economy

Introduction

Engle and Granger coined the term cointegration that variables are cointegrated if they possess a stochastic trend in the long run. In economic models, the concept of cointegration is commonly associated with economic theories that shows economic relationship between time series variables for instance purchasing power parity implies that there is long term relationship between mon ey income, prices and interest rate and in the Fisher presentation shows that there is long term association between interest rate and the rate of inflation [1].

In financial economics, cointegration relationship ranges from high frequency relation to low frequency. In high frequency levels the concept of cointegration is motivated by arbitrage arguments and the law of one price implies that assets must sell at the same unit price to avoid arbitrage opportunities and in this case, the cointegration between prices of the trading assets. Similarly, the arbitrage arguments of markets imply that there exist a cointegration between current and future market prices. Thus, the cointegrating relationship in these association is defined as the long-term relationship due to the fact the forces in this relationship adjusts the deviation to bring the system into equilibrium long term relationship. Cointegration have been modelled using long spans and low frequencies time series data that is normally measured annually, bi-annually, quarterly or monthly. Two time series X_t and Y_t are said to be cointegrated if either one of them is *I (1)*. That is, if there is a randomness but its linear combination is integrated of order zero denoted as 1(0) according to Herlemont. This implies that these variables X_t and Y_t are not cointegrated and in the long run they become cointegrated and no longer assume their random nature but assume a common path [2].

The security market is a crucial institution for a country's economy. It is the market that deals with the exchange of securities issued publicly by listed firms and the government bonds. It is crucial in the sense that it greatly determines the performance of an economy. For any government, the nature and the state of a stock market is of great concern. Under general equilibrium, it is agreed that the stock market plays a very important role in collecting and efficiently allocating funds.

Stock market through investment fund collections, and maturity transformation and savings mobilization are required to meet two or more basic requirements of supporting industrialization and ensuring that environment is safe and efficient in discharging their functions. Economic reform programs such as privatization, liberalization have not been completed or rather in the process of completion in most emerging economy. In this case, the prevailing knowledge of the relationship between prices of stock and macroeconomic variables for instance consumption, GDP, industrial production investment is predominantly important by the fact that a stable relationship between these variables is most likely to reform postulated economic models.

Literature Review

There is a lot of cynics in regard to the relationship that exist between exchange rate, interest rate, inflation rate and GDP fluctuation variables and the financial performance of a firm in terms of its profitability and security returns. Some studies indicate significant relationships between the variables whereas some indicate insignificant relationship between the variables. According to Chen et al, multi-factor models have been developed as an explanation for the variation in security returns and the extant literature suggests that a wide range of factors explain security returns. The variations have been attributed to such variables as goods

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prices, money supply, real activity, exchange rates, interest rates, political risks, oil prices, trade sector, budget deficits, domestic consumption, unemployment rate, imports and regional stock market indices and real wage. Empirical results regarding the inflationary effect and official exchange rate depreciation in cross-country studies and individual country studies are also conflicting. While investigating the effects of exchange rate, interest rate and GDP fluctuation variables on stock prices in the emerging Sri Lankan stock market using monthly data for the period from September 1991 to December 2002, Menike found that most of the companies reported a higher R^2 justifying higher explanatory power of exchange rate, interest rate, inflation rate and GDP fluctuation variables in explaining stock prices. This was consistent with other emerging market studies where inflation rate and exchange rate reacted negatively in relation to stock prices. Vaz *et al.*, examined the effect of publicly announced changes in official interest rates on the stock returns of the major banks in Australia during the period from 1990 to 2005. The results indicated that Australian Bank stock returns were impacted positively by the announcement of increased in official interest rates. Furthermore, banks experienced net-positive abnormal returns when cash rates are increased, which is consistent with the dividend valuation theory that suggests if income effects dominate, then stock returns need not be negatively impacted. Olweny and Omondi sought to find out the impact of macroeconomic factors on the performance of the stock market. The results showed that Foreign exchange rate, interest rate, and inflation rate, affect stock return volatility [3-7].

Methodology

Cointegration

Purchasing power parity implies cointegration between the nominal exchange rate and foreign and domestic prices. Covered interest rate parity implies cointegration between forwarding and spot exchange rates. As a result, cointegration is modeled using long spans of low-frequency time series data measured monthly, quarterly or annually.

Let denote an $Y_t = (y_{1t},...,y_{nt})'$ vector of $I(1)$ time series. Y_t Is cointergrated if there exists an n × 1 vector $\beta = (\beta_1,...\beta_n)'$ such that $\beta' Y_t = \beta_1 y_{1t} + ... + \beta_n y_{nt} \sim I(0)$.

In words, the nonstationary time series Y_t in are cointegrated if there is a linear combination of them that is stationary or $I(0)$. If some elements of β are equal to zero, then only the subset of the time series in Y_t with non-zero coefficients are cointegrated. The linear combination $\beta' Y_t$ is often motivated by economic theory and referred to as a long-run equilibrium relationship. The intuition is that $I(1)$ time series with a long-run equilibrium relationship cannot drift too far apart from the equilibrium because economic forces will act to restore the equilibrium relationship. In this study, the Johansen test for cointegration was employed.

Johansen test for cointegration: Johansen Multivariate Co-Integration technique was used to estimate Co-Integration to find out if variances of the model are Co-Integrated. The model estimated as follows;

$$\Delta Y_t = \alpha\beta Y_{t-1} + \sum_{i=1}^{P} \phi_i^x \Delta Y_{t-i} + \delta_0 + \varepsilon_t \quad (1)$$

Where; ΔY_t is the Dependent variable; α is the degree of convergence (or rate of) long-term relationship β' is the co-efficient for the long-term relationship and ϕ_i^x is the vector of n by n and will show the short-term relationship.

Model specification

The study employed a Vector Autoregressive (VAR), model. To estimate and provide empirical evidence on the nature of the causal relationship between stock market prices and changes in macroeconomic variables. The VAR model provides a systematic way to capture rich dynamics between the variables under the study.

The Vector Autoregressive (VAR) model: A VAR is a model, in which *K* variables are specified as linear functions of *p* of their own lags, *p* lags of the other K-1 variable, and possibly additional exogenous variables. Algebraically, a *p*-order VAR model, written VAR (p), with exogenous variables X_t is given by;

$$y_t = \nu + A_1 y_{t-1} + \ldots + A_p y_{t-p} + B_0 X_t + B_1 X_{t-1} + \ldots + B_s X_{t-s} + \mu_t, t\dot{o}\ \{-\infty,\infty\}, \quad (2)$$

Where $y_t = (y_{1t},...y_{kt})'$ Is a $K \times 1$ random vector; A_1 through are $K \times K$ matrices of parameters, X_t Is an $M \times 1$ vector of exogenous variables, B_0 through B_s are $K \times M$ matrices of coefficients, ν is a $K \times 1$ vector of parameters and μ_t is assumed to be white noise, $E(\mu_t) = 0$, $E\left(\mu_t \mu_t^{'}\right) = \sum E(\mu_t \mu_s^{'}) = 0$ For $t \neq s$.

Vector error correction model: A vector error-correction model (VECM) is a type of VAR that is used with variables that are cointegrated. Although first-differencing variables that are integrated of order one makes them stationary, fitting a VAR to such first-differenced variables results in misspecification error if the variables are cointegrated.

Consider a VAR with *p* lags

$$y_t = \nu + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + \varepsilon_t \quad (3)$$

Where y_t a $K \times 1$ vector of variables, ν, a $K \times 1$ vector of parameters, A_1, ... A_p is $K \times K$ matrices of parameters and ε_t is a $K \times 1$ vector of disturbances. ε_t have a mean 0, covariance matrix $\sum$ and *iid* normal over time. Any *VAR*(*p*) can be rewritten as a VECM.

Equation 3 can be written in VECM form as

$$\ddot{A} y_t = \nu + Đ y_{t-1} + \sum_{i=1}^{p-1} \tilde{A}_i \ddot{A} y_{t-i} + \varepsilon_t \ 4$$

Where $\Pi = \sum_{(j=1)}^{(j=p)} A_j - I_k \Gamma_i$ and $\Gamma_i = -\sum_{j=i+1}^{j=p} A_j$

Engle and Granger show that if the variable y_t are $I(1)$ the matrix in equation 3 has a rank of $0 \leq r < K$ where r is the number of linearly independent cointegrating vectors. If the variables co integrate, $0 \leq r < K$ and equation 4 shows that a VAR in first difference is miss specified becomes it omits the lagged levels term Πy_{t-1} [1].

Results and Discussion

Unit root tests

The unit root test adopted was ADF test. The null hypothesis is; the series have unit root against alternative hypothesis that the series are stationary. The results in Table 1 indicate Stock market prices, Exchange rate and GDP had unit roots at levels. Whereas inflation and interest rates were stationary, or we can say that they are integrated of order zero denoted as *I (0)*. The order at which a variable is said to be stationary is the number of differencing times a variable takes to attain its stationarity. According to Green, differencing an already stationary variable makes it more stationary though you will lose degrees of freedom. All the variables became stationary upon first difference. The critical reference value for this study was 5 %. All absolute Mackinnon Z(t) values less that absolute critical values of 5% confirms the presence of unit roots and the values greater than this critical value confirms stationarity.

Determination of optimum lag

The Table 2 reports the estimation of lag length of various criteria used lag length. To tests for the number of for cointegration ranks or fit cointegrating in the VECM model lag length must be specified. Tsay and Paulsen, Nielsen showed that several methods can be used to select lag length for a VAR model with *I (1)* variables. From the output on Table 2 the maximum number of lags selected was three. Log likelihood ratio (LR), Final prediction error (FPE) method, Akaike information criterion (AIC) showed that the maximum applicable in this multivariate model was three. Schwarz's Bayesian information criterion (SBIC) and Hannan and Quinn

Table 1. Augmented Dicker Fuller Test at Levels and at First Difference.

At Levels						
Variables	**Z(t)**	**Prob>t**	**Critical values**			**Conclusion**
			1%	5%	10%	
SMP	-2.092	0.24477	-3.488	-2.866	-2.576	Presence of unit root
INF	-4.836	0	-3.488	-2.886	-2.576	No unit root (*I(0)*)
EXR	-1.495	0.5362	-3.488	-2.886	-2.576	Presence of unit root
INR	-3.289	0.0154	-3.488	-2.886	-2.576	No unit root(*I(0)*)
GDP	-0.493	0.8935	-3.488	-2.886	-2.576	Presence of unit root
At First Difference						
DSMP	-13.116	0	-3.488	-2.886	-2.576	*I(1)*
DINF	-12.042	0	-3.488	-2.886	-2.576	*I(1)*
DEXR	-13.461	0	-3.488	-2.886	-2.576	*I(1)*
DINR	-13.076	0	-3.488	-2.886	-2.576	*I(1)*
DGDP	-11.172	0	-3.488	-2.886	-2.576	*I(1)*

* I(1) represents the variables that are stationary at first difference.

Table 2. Determination of Optimum Lag length.

Lag	LL	LR	DF	P	FPE	AIC	HQIC	SBIC
0	-3843.87				2.20E+14	47.2254	47.264*	47.3203*
1	-3821.92	43.917	25	0.011	2.30E+14	47.2628	47.4939	47.8322
2	-3803.22	37.382	25	0.053	2.50E+14	47.3402	47.764	48.3841
3	-3744.64	117.16*	25	0	1.7e+14*	46.9281*	47.5446	48.4465
4	-3729.66	29.968	25	0.225	1.90E+14	47.051	47.8601	49.0439

Source: Authors' Compilation, 2019.

information criterion (HQIC) showed that maximum lag-order was at zero (as indicated by *) [8-10].

It is important to determine the appropriate lag length in estimating the VAR model. Lutkepohl postulates that that overfitting that is selecting a higher order lag increases the mean square variance of residuals. On the other hand, small lag order generates autocorrelation problem. In this study lag order was selected because majority of the criteria predicted maximum lag order at order three [11,12].

Johansen cointegration test

Having established the stationarity and confirmed that the univariate time series are integrated of order one *I (1)*, cointegration tests was essential. In this study, Johansen test was chosen because it is applicable where we have multivariate relationships as opposed to Engle-Granger technique that applies to bivariate relationships. Johansen's technique also has advantages over other cointegration methods because it does not suffer from a normalization problem and is robust to departures from normality. It also supports other superior properties in relation to other technique (Table 3) [13,14].

Cointegration tests technique is a common and important phenomenon in econometrics as it enables the researcher to estimate either VAR of VEC models. When its detected that there is cointegration between variables in question, Vector Error Correction Model is estimated. Johansen cointegration test procedure involve use of two test statistics, first, trace statistics and second, maximum eigen value statistics. The results from the analysis showed that the trace statistic is greater than critical value at 5% percent level of significance (86.83 > 69.819, p-value=0.0012) confirming that there is one cointegrating equation. Maximum eigen value likewise indicates there is one significant cointegrating equation at 5 percent level (maximum eigen value was 41.504, which is greater than 33.877 critical value) as shown in Table 3 and it was concluded that there was cointegration among the variables which implies a long term association among the variables.

Rehman *et al.* investigated the commonalities of equity market fundamentals and returns co-movements in the ten Asian emerging and

Table 3. Johansen Cointegration Test.

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized	**Trace**	**0.05**		
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None*	0.2248	86.8304	69.8189	0.0012
At most 1	0.1176	45.3267	47.8561	0.0848
At most 2	0.0682	4.9256	29.7971	0.1641
At most 3	0.0570	13.4044	15.4947	0.1008
At most 4	0.0233	3.8470	3.8415	0.0498
Trace test indicates 1 cointegrating eqn (s) at the 0.05 level.				
*Rejection of the hypothesis at the 0.05 level.				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized	**Max-Eigen**	**0.05**		
No. of CE(s)	**Eigen value**	**Statistic**	**Critical Value**	**Prob.****
None *	0.2248	41.50370	33.8768	0.0051
At most 1	0.1176	20.4011	27.5843	0.3140
At most 2	0.0682	11.5212	21.1316	0.5953
At most 3	0.0569	9.5573	14.2646	0.2427
At most 4	0.0233	3.8470	3.8415	0.0498
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level.				
* denotes rejection of the hypothesis at the 0.05 level.				
**MacKinnon-Haug- Michelis (1999) p-values.				
Source: Authors' Compilation, 2019.				

Source: Authors' Compilation, 2019.

frontier equity markets. The study used the equity market in Pakistan a local nation whereby bilateral co-movement of the rest of markets were examined. The study also used the traditional literature on finance theories. The research used panel cointegration method and data from 2000 to 2014. The study findings revealed that there is a long run association amongst bilateral equity market co-movement and its determinants [15].

Chopra, studied the macroeconomic analysis of capital good industry performance in India. The study used monthly time series data spanning

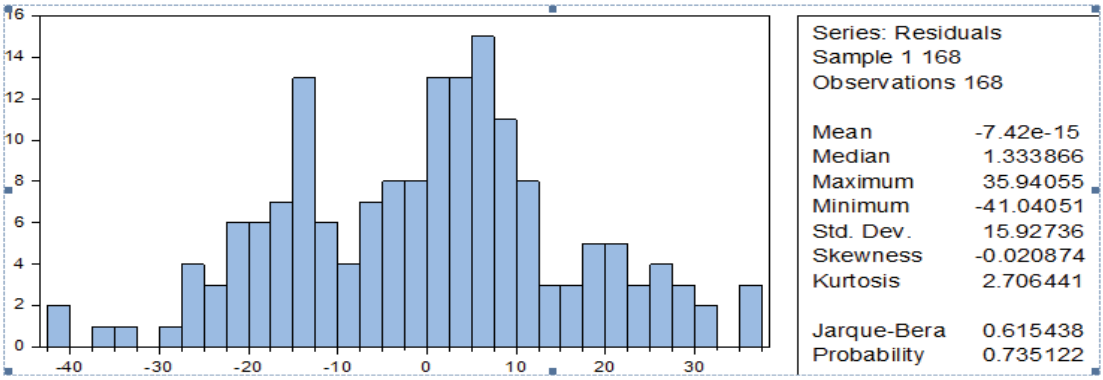

Figure 1. Normality Test.

Table 4. Vector Error Correction Regression Results.

				No. of Obs=165
				R-sq=0.2878
	Coef.	**Std. Err.**	**Z**	**p>|z|**
D_dsmp				
_ce1	-1.1804	0.1234	-9.56	0
Dsmp				
LD.	0.2195	0.1111	1.98	0.048
L2D.	0.299533	0.0846	3.54	0
Dinf				
CLD.	-0.83713	0.300426	-2.79	0.005
L2D.	-0.50297	0.2869	-1.76	0.079
Dexr				
LD.	0.0001	4.54E-06	2.51	0.012
L2D.	-0.0882	0.275638	-0.32	0.749
Dinr				
LD.	-4.0876	0.8161	-5.01	0
L2D.	1.8627	0.7962	2.34	0.019
Dgdp				
LD.	0.00002	4.71E-06	4.47	0
L2D.	0.4431	0.2864	1.55	0.122
_cons	-0.0015	0.9006	0	0.999

Note: D represents difference, LD-Lagged difference, ce1-cointegrating equation.

from 1999 to 2017. In order to check for stationarity of the data, the study conducted Augmented Dickey fuller and Philip Perron test. To check for a long run relationship between the study variables, Toda and Yamamoto and Johansen Cointegration test was employed. The study findings revealed that exchange rate alone had a unidirectional relationship by means of closing index value. The cointegration results as per Johansen test revealed that 4 of the variables under the study were cointegrated. Eventually, the study concluded that US dollar and Indian Rupee exchange rate should be stabilized in order to spur the growth of Capital Good Industry [16].

Vector error correction estimates

As from the results of Johansen cointegration discussed earlier, there was a co-integrating relationship detected among variables, it implied that there was an error correction that gradually corrects the endogenous variables to a long run relationship through series of partial short run adjustments. Therefore, it required application of Vector Error Correction Model (VECM) which is an appropriate in order to evaluate the short run properties of the co integrated series (Greene, 2008). The VECM results in Table 4 showed a negative error term (-1.1804) and significant (p-value=0.000) coefficient in cointegrating equation (_ce1) indicating that any form of short-term fluctuations between stock market prices, inflation, exchange rate, interest rate and GDP gave a stable and a long run relationship. The magnitude of cointegrating term (-1.1804) coefficient represents the speed of adjustment with which the variables converges over time [8,13,14,17,18].

Diagnostic tests

The following tests were undertaken to understand the assumptions of the OLS in the time series variables. There tests were; Normality using Jarque-Bera test, Breusch-Pagan-Godfrey Lagrange test for heteroskedasticity, Durbin-Watson test for serial correlation and finally testing for stability of the model (VECM) used.

Normality test

Jarque-Bera test was used to test for normality of residuals of the estimated VECM model. The null hypothesis states that the residuals of variables are normally distributed while the alternative hypothesis states that the residual are not normally distributed. From the results presented in the Figure 1, the value for Jarque-Bera was 0.6154 and the probability of 0.7351. Since the probability is greater than 5 percent significance level, the null hypothesis failed to reject the null hypothesis and it was concluded that residuals were normally distributed.

Conclusions

The present empirical findings that is helpful in policy recommendation that will be helpful in improving. It was concluded from the vector error correction estimates that showed that the lagged difference value of inflation had a negative relationship with stock market prices in Nairobi stock exchange. The findings concurred with the findings of Chandra who found out a negative relationship between stock market prices and inflation rate. However, the results contradicted the findings of Gultekin who found a positive link between inflation and common stocks in the United Kingdom. Owusu and Kuwornu, Bhattarai and Joshi and Issahaku *et al.*, Elly and Oriwo also found a positive and relationship between stock market prices and inflation prices while the findings of Khan and Yousuf showed no significant relation between inflation and stock market prices and this suggests that inflation is a determinant of stock market prices in Kenya. The negative relationship is in tandem with theory that a rise in inflation causes in stock market prices.

Findings

Exchange rate had a positive relationship with stock market prices which implies that an increase in exchange rate increases stock market price in NSE. It disagreed with the findings of Kirui *et al.*,. The findings of Olweny and Omondi, Suriani *et al.*, were inconclusive in that it found no significant relationship between exchange rate and stock market prices. This positive and significant relationship between exchange rate and stock market prices shows that an appreciation of exchange rate enhances performance of NSE. Increased participation of foreign investors in the stock markets will increase the prices of share and therefor this implies increased returns in the stock market [7,19-26].

From the vector error correction model results interest rates attested a negative relationship with stock market prices. The value of the coefficient

of interest rate was negative association suggests that when interest rates is increased by commercial banks the investors reduces investment in financial markets and this consequently reduces the performance of stock markets in NSE. These findings are consistent with earlier studies by Perera, Ado and Sunzuoye. These findings also corroborate with the studies of Amarasinghe who found out a negative relationship with between interest rates and stock market prices. However, the results contradict those by Otieno who found a positive relationship between stock market prices and interest rates [27-30].

GDP was found to positively affect stock market prices in NSE. These findings disagree with earlier findings of Kyangavo who found out a negative but insignificant relationship between GDP and stock market prices. Kirui *et al.,* found an insignificant relationship between stock market prices and GDP [31,32].

Recommendation

Based on the findings, the study recommends that government and Central Bank of Kenya should monitor macroeconomic environment since unregulated macroeconomic environment destabilizes the performance of the stock prices in Kenya. The CBK can achieve this through collaboration with the Capital Markets Authority. It is recommended that interest rate should be reduced to encourage investment in the stock market. Reduction of interest in the stock market will propel investment in the stock markets which will also reduce inflation.

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