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Assessing the Stability of Money Multipliers: Evidence from Keny

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Abstract: *This paper investigated the stability of money multiplier using Kenyan data for the period 1983-2015.This paper used Maki(2012) tests for cointegration allowing for unknown number of structural breaks and the Dynamic Ordinary Square method to estimate long run parameters. The findings of this paper shows that in the short run money supply function is unstable , however in the long run money supply function is stable. Another finding of this paper is that there is a one to one positive relationship between money supply and high powered money in Kenya. The implication is that money supply is an effective monetary policy target variable, hence can be used by Central Bank of Kenya in implementing its monetary policy in order to achieve the macroeconomic goals.*
Keywords*: Stability,Money multiplier, cointegration with structural breaks, DOLS Stability,Kenya*

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I. Introduction

The issue of long run relationship between money stock and monetary base and stability of money multiplier has been the centre of monetary policy in both developed and developing countries.. Due to a lot of growth and development of financial innovations, international financial globalization,this area has gained a lot of attention to academicians and policy makers. Kenya financial sector has gained a lot in development and experiencedgrowth of financial innovations. The country has experienced severalpolitical elections in the past 20 years, has experienced violence due to political election results of 2007 and many macroeconomic reforms and climatic changes which have the possibility of affecting long run relationship among variables within the economy.

In Kenya monetary policy aims at achieving and maintaining price stability in the economy (Central Bank of Kenya, annual report 2015). In the financial year 2014/2015, the government aimed at achieving a 5 percent target in inflation.The Kenyan government aims to meet this objective by setting the growth of money supply and reserve money consistent with the targeted inflation rate and economic growth. For the central bank to achieve its monetary policy objectives such as price stability by targeting money supply and reserve money targets it needs stable money multiplier,otherwise it is very difficult to achieve the objectives((Feige & Parkin, 1971). The concept of stability of money multiplier has attracted a lot of empirical research.

A stable money multiplier is necessary to achieve monetary policy objectives.Stability of money multiplier is also necessary for accurate monetary policy prediction. This is because for a certain money supply measure to be an effective monetary target variable, there must be a stable long run relationship between high powered money and money supply. Determining the existence of long run relationship between money stock and monetary base is very crucial in monetary policy in Kenya, given that money supply is used as a target variable monetary policy process. More also, in one of the basic theories of money supply it is assumed that money supply is determined by money multiplier and high powered money, with the major assumptions that money multiplier is stable and high powered money is controllable by central bank.

In Kenya, there are very few studies that have been done to investigate the stability of money multiplier. Mwega(1990) aimed at finding out whether money stock and credit are controlled by the monetary authority in Kenya. Using broader money (M3) as the dependent variable, this study found that money multiplier is unstable.Nyamongo and Ndirangu (2013) investigated the effect of financial innovations in the banking sector, among the results obtained found that money multiplier is unstable.The study revealed that money multiplier has a significant upward trend and grew by 0.01 percent on average.Motivated by the mixed results and the fact that, Kenya has experienced upward growth in the financial innovations, increased remittances, political unrests, climaticchanges, international financial globalization, high international oil prices, and implementation of economic reforms,this study investigated the stability of money multiplier using Maki(2012) cointegration approach which allows for unknown number of structural breaks.This approach is very different from those used by Mwega (1990) and Nyamongo and Ndirangu (2013) and most of the studies done on this topic elsewhere in the world.

Over the world several studies have been done on this area, however there is no consensus on the findings. Tule & Ajilore(2016), using Nigerian data investigated the stability of money multiplier.One of the key findings of this study is that a broad money and high powered money are cointegrated in Nigeria.Rusuhuzwa(2015) investigated the stability of money multiplier in Rwanda. The study used the usual Engle-Granger test for existence of cointegration and the Gregory-Hansen (1996) method. The study found that in Rwanda the money multiplier is stable and that the long run relationship between money stock and high powered money holds over some period of time and shifted to a new relationship after when the break occurred in the year 2010. Adam and Kessy (2011) carried out a study on the stability and predictability of money multiplier for East African countries using Tanzania data. Thestudy foundthat the money multiplier for broad money (M2) is stable over the long run but unstable in the short run.Khan (2002), examined the stability of money multiplier in Pakistan and the results suggests that for Pakistan the money multiplier is not stable for the entire period of study (1972-2009).Similarly Sahinbeyoglu(1995), found that money multiplier for Turkey is non-stationary using unit root tests. The same results for Turkish economy were found by Saatcioglu and Korap (2006). Odior (2013) using the portfolio approach and method of generalized method of moments, investigated the determinants of money supply in Nigeria. The study found that broad money supply and monetary base are cointegrated and money multiplier is unstable. Gangadhar (2000) , by using the Gregory- Hansen (1996) for cointegration analysis that allows for a single structural break ,found that there is a stable long run relationship between money supply and base money

This paper contributes the following: current information on the status of stability of money multiplier in Kenya using latest data 1983-2015, adds value on methodology as we have used Maki(2012) cointegration method to investigate long-run relationship between money stock and monetary base while adjusting for possible structural breaks. So far there is hardly any study in Kenya which has used this approach.

2. Money multiplier Model

The money multiplier model is a basic model in macroeconomics, money and banking and monetary theory disciplines which argues that money supply in any economy is determined by the product of money multiplier and high powered money. The monetary authorities can be able to predict the stock of money in the economy my controlling monetary base and also predict the behaviors of the banks and non bank public.
In a basic approach, Money supply (M^s) is defined as the sum of cash held by non bank private sector denoted by C and the deposits (D) held by the banking system represented by equation 1:

$$M^s = C + D. \qquad 1$$

The next model is the high powered money(H) which is expressed as the sum net liabilities or reserves of the Central bank of Kenya (CBK) held by either the non-bank private sector or by commercial banks expressed as follows:

$$H = C + TR = C + RR + ER \qquad 2$$

Where H,represents high powered money (base money), TR represents total reserves which is divided into two :Required reserves(RR) and excess reserves(ER).The required reserves are set by the central bank while ER are the reserves held by commercial above the required reserves.
Dividing Equation 1 by equation 2 gives the following:

$$\frac{M^S}{H} = \frac{C + D}{C + RR + ER} \qquad 3$$

Dividing the numerator and denominator of the right hand side of equation 3 by D and multiplying both sides be H we get:

$$M^s = (\frac{c_r + 1}{c_r + rr + er})H \qquad 4$$

Cr, rr, er represents currency –deposit ratio(C/D), required reserve –deposit ratio(RR/D) and excess reserve –deposit ratio(ER/D).

In equation 4 , the term in brackets represents the money multiplier (m). Equation 4, gives the determinants of money stock in the economy using the narrow definition of money.

$$M^s = mH \qquad 5$$

From equation 5, money stock is the product of money multiplier and monetary base(high powered money)

$$m = \frac{c_r + 1}{c_r + rr + er} \qquad 6$$

$$m = \frac{M^S}{H} \qquad 7$$

The ratio of money stock to high powered money gives the estimates of money multiplier as expressed in equation 7.
In logarithmic form equation 5, can be expressed as:

$$LnM^s = \alpha + \beta LnH + u. \qquad 8$$

Where α is the logarithm of m and u is the error term.

For the monetary authority to be able to predict money stock, the money multiplier has to be stable. This means that m has to be stationary and, LnMs and LnH have to be stationary or be cointegrated if the series are non-stationary but with same order of integration. The parameter α also has to be equal to zero and ß to be equal to one (Rusuhuzwa, 2015., Sahinbeyoglu 1995…..

The aim of this paper was to investigate the stability of money multiplier in Kenya using annual data for the period 1983-2015. Unlike previous studies in Kenya this paper used cointegartion method of Maki(2012) which allow for unknown number of structural breaks.

Most of the studies in this area have investigated stability of money multiplier by use of the residual based Engle-Granger (1987) method and the Johansen and Juselius (1988) method. These methods have been widely used to investigate cointegration between money supply and high powered money. It is here assumed that if money multiplier is stable, then money supply aggregate and base money must have a long-run relationship which is investigated though cointegration analysis.

II. Methodology

The money multipler model used in this paper is expressed as:

$$LnM = \alpha + \beta LnH + u \qquad 9.$$

Two definition of money were used in this paper:broad money-M2 and broader money-M3 where both acted as dependent variables separately. M2 is the broad measure of money which is the sum of the currency outside the banking sector and all private and other public holdings of demand savings and time deposits (C). Broader money (M3) in Kenya is defines as M2 plus residents foreign currency deposits with the local commercial banks.(CBK, Annual report 2015).
Before investigating the existence of co-integration in the two variables, we carried out unit root analysis using both Augmented Dickey Fuller test (ADF) and the Phillips-Perron (PP) tests to test for stationarity of the time series of the variables and identify the order of integration.The advantage of the Phillips-Perron test over ADF is that the test is more applicable when there are structural breaks in the series.

3.1 Cointegration Test

A number of studies in a two variable relationship including the investigation of long-run relationship between money supply and monetary have used the two step Engle and Granger (1987)procedures. To apply this approach equation 9, is estimated through Ordinary Least Squares (OLS) and the estimated values of the residuals are obtained. The residual series are then tested for stationarity. If found stationary at levels , the null hypothesis of no cointegration is rejected and it is then concluded that there is cointegration between money supply and monetary base.

Structural relationships among variables may not be time invariant.To find out whether this is the case the parameters of the model have to be investigated whether they are stable. If the parameters are stable , there must be stable long-run relationship between variables for example between money supply and high powered money The cointegration test using Engle-Granger approach, assumes there are no structural breaks in the long-run relationship between money supply and high powered money.Due to economic crises, financial crises, major financial reforms,major changes in the financial sector, political regimes theequilibrium relationship between money supply and monetary base may change, and this may affect the reliability of the Engle- Granger cointegration test results. Many studies confirm that if the structural breaks are ignored the Engle-Granger gives spurious cointegration results (Leybourne and Newbold, 2003., Kellard 2006.). Other studies have found that ignoring structural breaks reduces the power of the cointegration test methods (Campos et al, 1966., Gregory et al, 1996). Gregory and Hansen (1996), actually argue that the Engle-Granger method assumes that the cointegrating vector is time invariant against the alternative hypothesis; hence they have low power in detecting a change in policy regime which may lead to a one time shift in the parameter vector.Gregory and Hansen(1996) improved the Engle-Granger approach by allowing for a single structural break in the long-run relationship among the variables. However there can be more than one structural breaks in the long-run relationship this makes the Gregory and Hansen (1996) to be mis-specified.Taking into account of these limitations and the fact that Kenya has gone through several structural changes in the sample period including the post election violence of the year 2007, several financial reforms, several financial innovations, the global financial crises , the study used Maki(2012) method to test for cointegartion between money supply and monetary base.Maki(2012) assumes several unknown structural breaks. Another advantage of Maki (2012) methodology is that it is computationally easy as compared to other methods. Maki(2012) proposed four different models depending whether the changes in the economy affect the intercept, the slope or the trend. These models consider multiple structural breaks. The models are represented in equations 10 to 13.

$$Y_t = \alpha + \sum_{i=1}^{m} \alpha_i D_{it} + \beta` X_t + u_t \ldots\ldots 10$$

$$Y_t = \alpha + \sum_{i=1}^{m} \alpha_i D_{it} + \beta` X + \sum_{i=1}^{m} \beta_i` X_t D_{it} + u_t \ldots\ldots 11$$

$$Y_t = \alpha + \sum_{i=1}^{m} \alpha_i D_{it} + \theta t + \beta` X + \sum_{i=1}^{m} \beta_i` X_t D_{it} + u_t \ldots\ldots 12$$

$$Y_t = \alpha + \sum_{i=1}^{m} \alpha_i D_{it} + \theta t + \sum_{i=1}^{m} \theta_i t D_{it} + \beta` X_t + \sum_{i=1}^{m} \beta`_i X_t D_{it} + u_t \ldots\ldots 13$$

Where α,β, and θ represent changes in the level, slope and trend coefficients, respectfully. Di is a dummy taking the value of 1 if t>TBi(i=1,…,m) and 0 otherwise where m is the number of breaks and TB is the period when the break occurred.

Model 10, is the level shift where the structural change affect only the intercept while the second model 11 which is called the regime model, the changes affect both the intercept and the slope. In the third model 12, the trend variable is added to the model .The last model 13, assumes breaks in the intercept, trend and slope terms.

To test the null hypothesis of no co-integration against the alternative hypothesis of co-integration with i number of breaks is implemented by agrid search procedure. Maki(2012) argues that to find the periods when breaks occurred, first the maximum number of breaks are set m. All the years are possible breaks. Each model is estimated through the OLS method and the RSS are obtained. The first break is obtained by minimizing the RSS over the estimations. To obtain the second break point, the first breakpoint is incorporated in the equation and estimations are done, the minimum RSS will provide the second break point. The process will continue until all the break points are obtained.

The critical values for testing forco integration between the time series variables with structural breaks are obtained through Monte Carlo Simulation Maki(2012.

This paper used time series data for the period 1983 to 2015. These data was obtained from various sources including: the Kenya economic survey, The Central bank of Kenya annual reports andStatistical bulletins, and the IFS website. To measure money stock we used M2 and the broad measure M3 as the dependent variables. The independent variable was high powered money .All variables were expressed in logarithmic form.

III. Empirical Results

4.1.Unit Root test results

Before investigating long run relationship between money supply and monetary base, it is the practice in time series econometrics to investigate the unit root properties of the variables in the model .The importance of this is to avoid spurious regression and to identify the order of integration of the time series .The paper used both the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP)methods. The results are reported in Table 1.The results show that the null hypothesis of unit root cannot be rejected for all variables .This suggest that the variables are I(1) ,the variables are stationary at their first differences. The level test contained the constant and trend while the first difference contained only the constant. Differencing of the series removes the trend from the series (Singh and Pandey, 2009)

Table 1: Results for Unit root Tests

Variable	ADF	PP

	Level	First difference	Level	First difference
M2	-2.53	-3.40**	-2.00	-3.58**
M3	-3.15	-3.14**	-2.15	-4.63***
Base	-1.69	-2.56	-2.180	--4.13***

***, **,* indicate significant at 1%, 5% and 10% respectively (stationary at first differences)

After the unit root test we proceeded to test for existence of cointegration using Maki(2012) method represented by equations 10 to 13. The results are presented in the next section.

4.2.Co-integration Test Results

Cointegration is only possible if the variables money stock and monetary base are integrated of order one thus I(1).In this study all the variables were found to be I(1), thus integrated of order one. With these results then , analysed cointegration using models 10 to 13 so has to examine the longrun relationship between money supply and base money in Kenya. The results are presented in Table 2.

Table 2: Cointegration Test Results with unknown number of structural breaks, dependent variable M2, independent variable base money

	tau -statistics	Break dates	Maki(2012) Critical values		
Models			1%	5%	10%
1: Level shift	-7.057***	1993, 1995, 2001, 2006 2009,	-5.959	-5.426	-5.131
2:Regime Shift	-6.144***	1993, 1998,2009	-5.833	-5.373	-5.106
3:Regime shift with trend	-7.697***	1995,2001,2009	-6.251	-5.703	-5.402
4:Level, trend and regime shift	-7.731**	1995,2004,2009	-7.82	-6.524	-6.267

Critical values are taken from Maki (2012) , Table 1 page 2013. ***, ** represent significant at 1% and 5% levels, respectively.

Table3:Cointegration Test Results with unknown number of structural breaks, dependent variable M3, independent variable base money

	tau –statistics	Break dates	Maki(2012) Critical values		
Models			1%	5%	10%
1: Level shift	-6.487***	1993, 1996, 2001, 2006 2009,	-5.959	-5.426	-5.131
2:Regime Shift	-6.542***	1998,2006, 2009	-5.833	-5.373	-5.106
3:Regime shift with trend	-5.823**	2001,2006,2009	-6.251	-5.703	-5.402
4:Level, trend and regime shift	-5.743	2001, 2007	-6.620	-6.100	-5.845

Critical values are taken from Maki(2012) , Table 1 page 2013. ***, ** represent significant at 1% and 5% levels, respectively.

According to the results presented in Table2, all the absolute values ofthe tau-statistics exceed the absolute values of the Maki(2012) critical values at all level except for model 4 which is significant at 5% level. This means that the null hypotheses of no cointegration between M2 and base money is rejected at 1% for models 1 to 3, and for model 4 at 5% level. This provides evidence of existence of long run relationship between broad money and monetary base in Kenya

The result in table 3, shows that the t-values of model 1 and model 2 are statistically significant at 1% level while the t value of model 3, is statistically significant at 5% level. Results for model 4 was, found to be statistically insignificant. The results for model 1 to 3 suggest that the null hypothesis of no cointegration between M3 and high powered money is rejected. Therefore, there is evidence for long-run relationship between M3 and base money under multiple structural breaks. From the results for cointegration analysis for both broad money and broader money and high powered money,there is therefore, evidence that there is long run relationship between money supply and monetary base in Kenya under unknown structural breaks.

The results in Tables 2 and 3, provide very important information which can help in monetary policy making. The results suggest that there is long-run relation between money supply and base money under structural breaks. The structural breaks that may have affected money supply in Kenya happened in the years 1993, 1995, 1998,2001,2004,2006 and 2009.These break dates are meaningful to Kenya. These years are consistence to the events in Kenyan economy.In 1993, there was complete liberation of the exchange rates. Kenya experienced a lot of drought during the year 1993 which led to significant reduction in agricultural production the major exchange earner of Kenyan economy. In the year 1995, the economy was experiencing the impact of structural adjustment programs which impacted positively on economic growth. Economy grew by 4.9 per cent in the year 1995 as compared to 3.4 per cent in the year 1994.Several factors in the year 1998 contributed to the decline of GDP growth from 2.4 percent in 1997 to 1.8 per cent in 1998.This include: El Nino rains, Nairobi terrorists attack, labour unrest in education and crisis in the banking sector.In the year 2001 the economy grew by a positive figure of 1.2 per cent from a previous negative growth of 0.2 per cent.In the year 2006 the country experienced high inflation rate of 14.5 per cent from 10.3 in the previous year due to increases of international oil prices. The major oil imported to Kenya registered a price increase of 9.1 percent in December 2006.The period2007 to 2009 and even beyond the county was still experiencing the effects of post-elections violence of the year 2007.

With evidence of existence of cointegration between money supply and monetary base, we next estimated the Error Correction Model to examine the short run dynamics of the variables. The results of the error correction models are presented in equation 14 and 15.

$$\Delta M2 = 0.1 + 0.37\Delta base - 0.08 e_{(m2)-1} \qquad 14$$

$$(4.8) \quad (1.5) \qquad (-1.9)$$

$$\Delta M3 = 0.03 + 0.62\Delta base - 0.17 e_{(m3)-1} \qquad 15$$

$$(2.0) \quad (3.6) \qquad (-1.7)$$

The ECM results for M2 as a dependent variable represented in equation 14, shows that all the coefficients have the correct signs of the coefficients. The short-run response of M2 changes to monetary base is positive (0.37). However this elasticity is statistically insignificant. The error correction term shows that 8% of the fluctuations in broad money M2 are corrected each period.

The ECM results for M3 as a dependent variable are presented in equation 15.In the short run the high powered money has the expected positive sign. The coefficient of monetary base is statistically significant at 1%. The high powered money elasticity to changes in money supply is 0.62.The error correction term shows that 17% of the discrepancy between actual and the equilibrium value of broader money (M3) are corrected each year.

The stability test for the estimated Error Correction Models shown by the plots of CUSUM and CUSUM SQ in figures 1, 2 ,3 and 4 for both broad money supply and broader money supply, provides evidence that money supply function is unstable in the short run. The broad money supply in the short run shows instability from 1999 to 2007, while for broader money function in the short run there is evidence of instability from the period 1999 to 2013.

Figure 1: CUSUM plot for short run M2 function

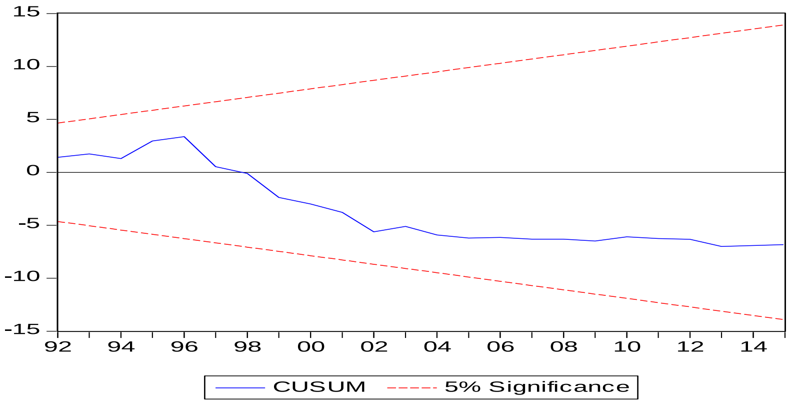


Figure 2 : CUSUM SQ plot for short run M2 function

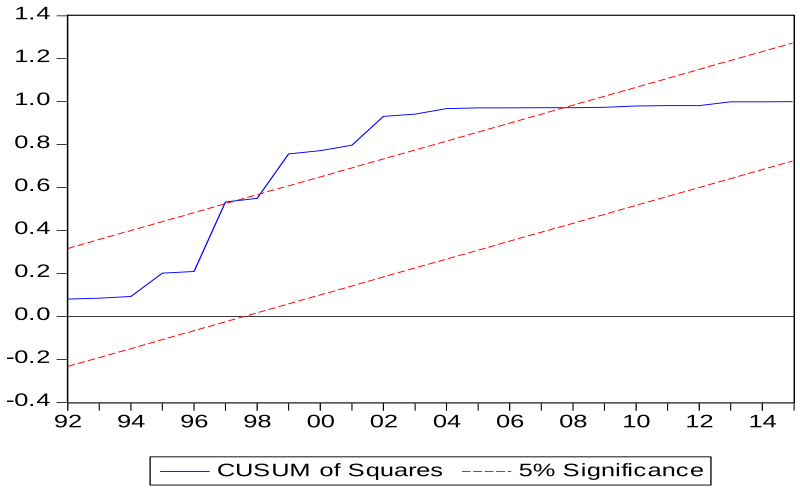
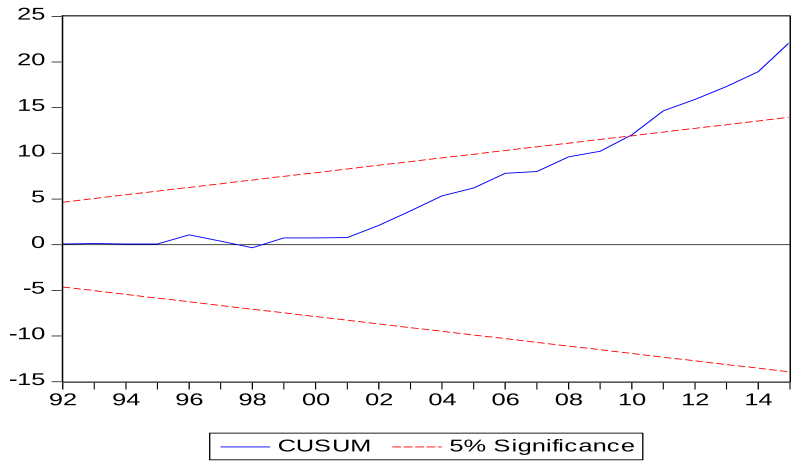
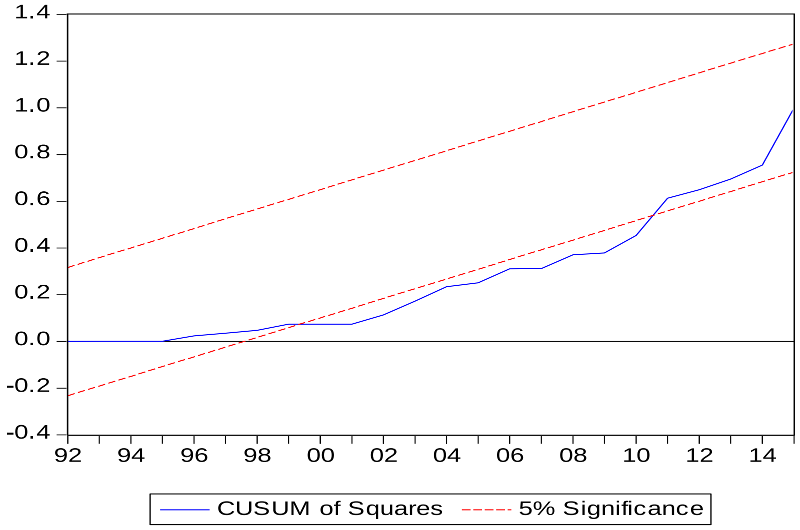


Figure 3: CUSUM plot for short run M3 function



M3Figure 4: CUSUM SQ plot for short run M3 function



4.3.Estimation of Long Run Parameters

Where the variables are not cointegrated the usual Ordinary least squares method is used to estimate the model. However in the case where the variables are non-stationary but cointegrated, the model can be estimated by the Dynamic Ordinary Least Square (DOLS) method or the Fully Modified Ordinary Least Square(FMOLS) method.

Incase OLS is used in a model with variables which are non-stationary but cointegrated, OLS provides biased and inconsistent estimated parameters. Stock and Watson (1993), argue that lags and leads should be added to the first differences of the explanatory variables to correct the bias and to solve the endogeneity problem in OLS estimator. This leads to the DOLS method. As a method of estimation, it estimates long run equilibrium relationships that involve cointegrated variables (Masih and Masih, 1996). Stock and Watson (1993), argue that the DOLS provides strong and consisted estimated parameters despite the endogeneity and autocorrelation of the explanatory variables.The DOLS is a robust method that can be applied to small samples irrespective of the order of integration of variables (whether they are I(0), I(1) or mutually co-integrated), but the dependent variable needs to be I(1). Following Stock and Watson (1993), DOLS model for this paper was expressed as:

$$M_t = \varphi_0 + \varphi_1 t + \varphi_2 Base_t + \sum_{i=-q}^{p} \beta_i \Delta Base_{t-i} + e_t \qquad 16$$

Where p is lag length q leads , M measure of money stock, Base represents high powered money, t time while e is the error term, respectively.

The following Table4, provides the long run estimated coefficients for the above model when the dependent variable is M2.The lags and leads were estimated by Schwarz Information Criterion (SIC).

Table4: Long run parameter estimates of the DOLS, dependent variable M2

Variable	coefficient	t- statistics	R^2=0.99 F=206 p(0.00) D.W=2.2 JB= 0.706 p(0.7)
C	-3.12	-0.7	
Trend	0.02	0.49	
Base	1.3***	3.2	
D(base(-1)	0.9	1.44	
D(Base(-2)	0.24	0.44	
D(Base(1)	-0.79	-1.35	
D(base(2)	-0.69	-1.6	
Dummy1993	0.34***	3.2	
Dummy1995	0.31***	2.7	
Dummy2006	-0.32	-1.6	

*** indicate significant at 1%.

The results show that there is a positive significant effect of high powered money on stock of money in Kenya. The relationship is elastic . With a one percent increase of high powered money stock increases by 1.3 percent. The independent variables explain 99% of the changes in the dependent variable. The structural events that occurred in 1993 and 1995 have a positive significant effects on broad money supply in Kenya in the sample period of study. The structural events in 1993 and 1995 each significantly shifted money supply upwards by about 0.3% in this period of study.

To test for the stability of the estimated money supply models we used CUSUM and CUSUM of squares of Brown *et al*. (1975). The plots are represented in figures 1 and 2.If the recursive residual of the estimated money supply model is located outside the boundaries of the critical lines, then the estimated model is unstable in the period of study.To test for stability of money supply is very important since money supply is one of the monetary policy targets used by the CBK. If it is stable, then money supply is an appropriate monetary policy target, if it is unstable then the CBK should use a different target in implementing its monetary policy.After estimating the long run parameters using the DOLS, in this paper we used the CUSUM and CUSUM of squares to test for stability of broad money supply function. Theplots in figure 5, and 6, show that the estimated broad money supply function is stable in the sample period.

Figure 5: plots of CUSUM for M2 as the dependent variable

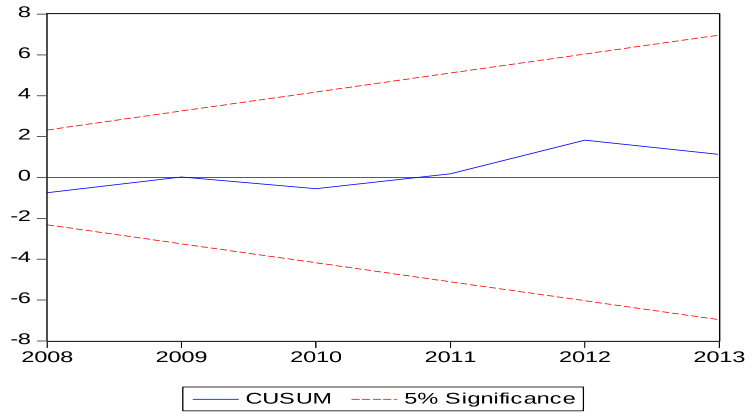


Figure 6: Plot of CUSUM SQ for M2 as the dependent variable

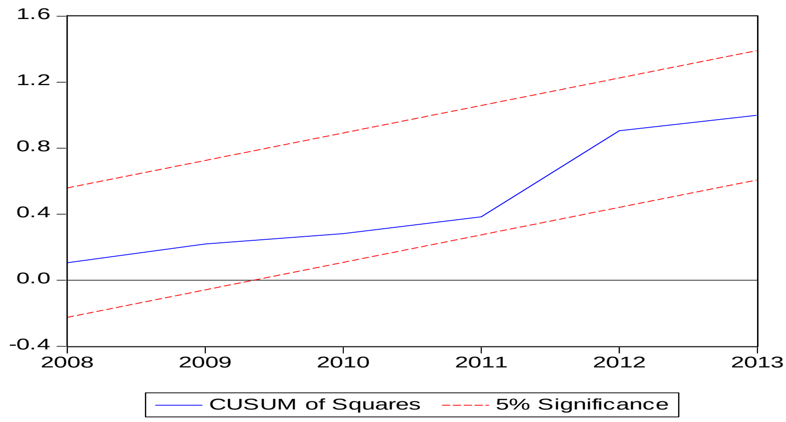


Table 5:Long term parameters with M3 as the dependent variable

Variable	coefficient	T ratio	
C	1.3	0.59	R^2=0.99 D.W=2.0 F=1135 p(0.00) Normality JB=1.079 p(0.58)
Trend	-0.02**	-2.3	
Base	1.0***	5.03	
D(base)	-0.44**	-2.2	
D(base(-1)	-0.46**	-2.4	
D(base(-2)	0.36	1.6	
D(base(1)	0.82***	4.9	
D(base(2)	0.56***	3.78	
Dummy1993	-0.04	-1.4	
Dummy2001	0.09***	3.2	
Dummy2006	0.14*	2.0	
Dummy2009	0.22***	3.5	

***, ** significant at 1%, 5% respectively.

The results in the above table providepositive significant effect of high powered money on broader money supply (M3) in the long run.If high powered money increases by one percent money supply increases by 1percent. This coefficient fulfils the restriction on the coefficients stated earlier. This shows there is a one to one relationship between money supply and high powered money in Kenya.The structural events that occurred in 2001, 2006 and 2009 all impacted positively to changes in money supply in Kenya in the study period. All these effects were found to be statistically significant. The estimated model provides very good fit into the data as shown by the value of R squared (99%). It shows that 99% of the changes in the dependent variable are explained by all the included explanatory variables.

To test for the stability of the estimated money supply model we used the CUSUM and CUSUM of squares which are shown with the following plots figure 7 and 8. The plots show that the estimated money supply model for M2 as the dependent is stable in the sample period.There is therefore, evidence of stability of broad money supply function in the long run run in Kenya. Adam & Kessy (2011) and Tule & Ajilore (2016) found similar findings of existence of long run relationship between broad money and monetary base..However the level shift that occurred in 1993 and in 1995 significantly affected the broad money supply function. The events of 1993, 1995 significantly increased broad money supply by 0.3 % and 0.3 % respectively.

Figure 7 : plots of CUSUM and CUSUM of Squares when M3 is the dependent variable

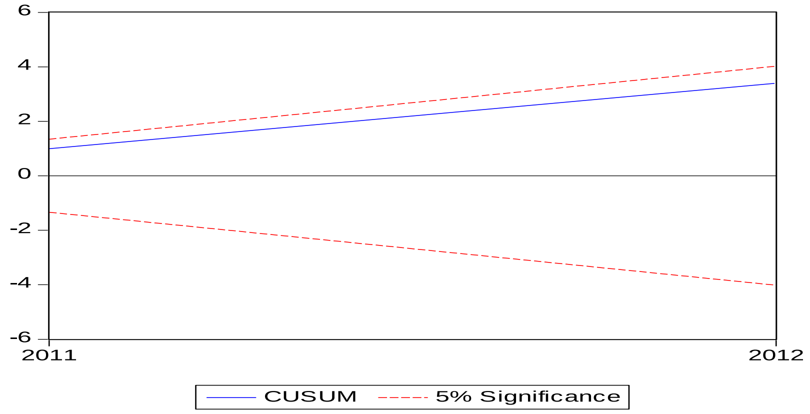
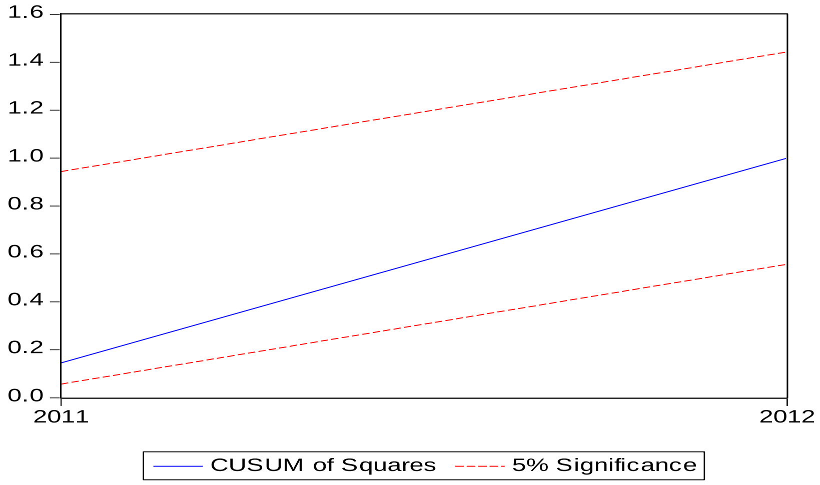


Figure 8: CUSUM SQ when M3 is the dependent variable



The CUSUM and CUSUM of squares of the estimated model for broader money supply shown in figure 8, shows that broader money supply function is stable in the long run. However there were structural breaks that occurred in 2001, 2006 and 2009 that significantly increased supply of money. The structural breaks of 2001, 2006 and 2009 significantly increased broader money supply in Kenya by 0.09%, 0.14% and 0.22% respectively in the period 1988-2015.

From both the CUSUM and CUSUM of squares plots for both functions of M2 and M3, we conclude that money supply is the appropriate monetary policy target in Kenya.

IV. Conclusions

This paper investigated the stability of money multiplier in Kenya using time series data for the period 1988 to 2015. The stability was investigated through cointegration analysis for the variables money supply and high powered money using Maki(2012) approach. The Maki(2012) approach identified the years 1993,1995, 1998, 2001, 2004, 2006 and 2009 as possible structural breaks between 1988 to 2015.

The results from the study show that there is a long run relationship between money supply and high powered money considering structural breaks in Kenya data series.The dummy variables for the years 1993, 1995, 2001 ,2006 and 2009 had significant impact on money stock in Kenya in the period of study. These events include the impact of structural adjustment programs implemented in Kenya, the impact of international oil prices and finally the impact of domestic post election violence of the year 2007.

The results from the ECM, shows that in the short run there is a positive relationship between high powered money and money stock. The response of money stock to changes in monetary base was more significant for broader money (M3). CUSUM and CUSUM SQ shows money supply function in the short run it is unstable in kenya in the sample period.

The long run estimated coefficient suggests a one to one relationship between high powered money and money supply in Kenya. This suggests that if monetary authorities increase high powered by 100%, it is expected to lead to the same percentage increase in money supply.

The CUSUM and CUSUM SQ tests shows that the long run estimated money supply models inKenya in the sample period of 1988 to 2015 are stable. The plots provide evidence of a stable money supply function in Kenya. Money supply is an appropriate monetary policy target in Kenya.

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