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DIVISIA MONETARY AGGREGATES AND DEMAND FOR MONEY IN KENYA

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Abstract:

In this study, Divisia monetary aggregates are constructed and compared to corresponding traditional monetary aggregates, namely M1, M2, M3 and M3XT, for Kenya. The differences between traditional and constructed Divisia monetary aggregates suggest that the different subcomponents of monetary assets are not highly substitutable as assumed for traditional simple sum aggregates. Cointegration analysis of the underlying long-run relationships based on demand for money reveals that the constructed Divisia indices perform as equally well as traditional measures. However, the Divisia monetary aggregates provide additional useful information to enable understanding of changes in stocks of financial assets as economic conditions change. This information includes user costs and expenditure shares for the different monetary aggregates. While Divisia monetary aggregates may have an edge over traditional aggregates, there is a need for further research on their usefulness through the use of different policy criteria.

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INTRODUCTION

In designing monetary policy, many countries assign greater weight to the role of the stock of money in the economy. However, during the last three decades, measurement of aggregate money has become a subject of extensive research and policy debate. The standard monetary aggregates (such as M1, M2 and M3 money), published by central banks and used for monetary policy purposes have come under criticism that they suffer from aggregation bias and do not effectively capture changes in the financial sector. It is in this regard that Divisia monetary aggregates—also referred to as monetary services indices (MSI)—have attracted interest, and thus are presented as an alternative or complement to simple sum monetary aggregates (Barnett, 1980; Barnett, Offenbacher and Spindt, 1984; Barnett, Fisher, and Serletis, 1992). A Divisia monetary index measure of money is based on an alternative method of aggregation where different weights are attached to monetary (sub)components, reflecting the flow of monetary services (Barnett,1982).The simple sum monetary aggregates treat all (sub)components of money as being the same in their "moneyness." The components, including currency, demand deposits, and savings and time deposits are given equal weights rather than unequal ones that reflect the monetary aggregates' usefulness in making transactions or flow of monetary services. Simple sum aggregates have thus been criticized for failing to account for substitution among components of money.

The purpose of this paper is to construct Divisia monetary aggregates for Kenya and compare them with standard simple sum monetary aggregates. The paper also attempts to assess the usefulness of Divisia aggregates for monetary policy purposes by examining their importance in the demand function for money. This study is of interest to Kenya because the Central Bank of Kenya (CBK) has largely relied on targeting monetary aggregates in the conduct of monetary policy. In addition, various financial sector reforms and innovations have taken place that might not be adequately captured by the simple sum aggregates. The CBK has sought to enhance the effectiveness of monetary policy by changing the policy framework, but Divisia monetary aggregates have not been tried as an alternative or complement to the simple sum aggregates. In the 1990s, M2 (currency in circulation plus demand deposits) money was the intermediate monetary policy target. However, following financial deregulation and further opening up of the economy, the relationship between M2 and nominal gross domestic product (GDP) was found to be unstable. By the end of 1998, the Central Bank of Kenya had shifted to M3 (M2 plus foreign currency deposits) as the policy target (Rotich, Kathanje and Isaya, 2007). In October 2011, the Central Bank of Kenya adopted a new monetary policy framework that gives more prominence to its policy rate—the Central Bank Rate (CBR) (IMF, 2013). We expect that publishing Divisia monetary aggregates for Kenya will encourage policy debate and research on their importance.

In the 1980s and 1990s, Kenya undertook various financial sector reforms under structural adjustment programs supported by the International Monetary Fund (IMF) and the World Bank. Key reforms included deregulation and liberalization of interest rates and the capital account, and a shift to a floating exchange rate. In recent years, the financial sector has experienced various innovations and developments that may have impacted monetary aggregates. These include financial innovations such as automated teller machines (ATMs), credit and debit cards, mobile banking and mobile money services. The composition of monetary assets has also changed significantly. For instance, currency outside banks as a percentage of M3 declined from about 12 percent at the end of 1995 to about 8 percent by the end of 2011. The share of foreign currency deposits in M3 doubled from about 6 percent in 1995 to about 12 percent at the beginning of 2002 and increased further to 16 percent towards the end of 2011. The importance of non-bank financial institutions (NBFIs) has also been declining. In early 1990s, NBFIs accounted for about 24 percent of total quasi-money, and by early 2012 the share stood at only 2 percent. We expect that Divisia monetary aggregates will capture these changes through their different weighting as opposed to the simple sum aggregates based on equal weights.

The technique of cointegration developed by Johansen and Juselius (1990) is used to analyze and compare the underlying long-run relationships between the constructed Divisia money index, simple sum aggregates, output, and interest rates, through the estimation of a money demand function. The rest of this paper is organized as follows. In Section 2 we provide an overview of the empirical literature on usefulness of Divisia monetary aggregates. Section 3 discusses how Divisia monetary aggregates are constructed, and compare them to simple sum aggregates. In Section 4, we assess the underlying long-run relationships through cointegration analysis. Section 5 provides an interpretation of the results and conclusion.

2. OVERVIEW OF LITERATURE

Most empirical studies on Divisia monetary aggregates have been undertaken on developed and East Asian economies. The studies suggest that Divisia money performs better than simple sum aggregates. The tests that have been used in the literature include a long-run underlying money demand function through cointegration tests, stable money demand function, information content tests, David-Mackinonj tests, forecasting performance tests, and dispersion dependence tests (Archarya and Kamaiah, 2001). Using forecasting performance criterion, Kok-Shyong, Puah and Habibullah (2007) conclude that Divisia M1 provides better forecasts of future inflationary movements in Malaysia. Serletis and King (1993) use cointegration analysis to assess the usefulness of Divisia monetary aggregates for Canada. Their findings suggest that Divisia money has the potential to forecast nominal GDP better than the simple sum aggregates. In the U.S., Barnett, Offenbacher and Spindt (1984) test the relative importance of Divisia money against standard tests such as causality, stability of demand for money function and forecasting. They conclude, based on all test results, that no single measure dominates. Overall, the results are in favor of Divisia. Wesche (1996) investigates the importance of Divisia indices in the euro area through cointegration analysis and concludes that the demand for a Divisia monetary aggregate for five European countries performs relatively well. Reimers and Hans-Eggert (2002), in analyzing Divisia aggregates for the euro area, also find evidence that Divisia provides information on future movements of the Harmonized Index of Consumer Prices (HICP). Celik and Uzun (2009), through panel cointegration data analysis for the period 1980:1 and 1993:3, establish that Divisia monetary aggregates have a robust link to GDP and interest rates in a money demand function for the United States, United Kingdom, euro area and Japan. Schunk (2001) investigates forecasting performance of Divisia monetary aggregates relative to simple sum monetary aggregates using quarterly data between 1960 and 1997 for the U.S. The forecasting results were found to be more accurate when a Divisia aggregate is included.

Puah and Hiew (2010) analyze the usefulness of Divisia monetary aggregates in formulating monetary policy in Indonesia, using quarterly data from 1981-2005. They use a demand function to compare the relative performance of simple-sum M1 and M2 and Divisia M1 and M2. The results indicate that Divisia models perform better than simple sum aggregates, especially with regard to stability. These results corroborate those reported by Serletis and Robb (1986). In Japan, findings by Ishida (1984) suggest that there is high level of substitutability between components of simple sum aggregates, thus implying that simple sum and weighted sum are plausible for Japan. However, Ishida (1984) reports that regression models of Divisia aggregates are more stable and superior to simple sum aggregates. Acharya and Kamaiah (2001) report mixed results for India based on different tests for performance. However, overall, the measures based on Divisia are confirmed to be superior. In a recent study in India, Ramachandran, Rajib and Binod (2010) use a vector error correction model (VECM), to report that Divisia monetary aggregates help predict inflation rates better than simple sum aggregates.

While the overall empirical evidence appears to suggest that Divisia aggregates perform better based on the different criteria discussed above, some studies suggest that this might not be the case for developing countries. In a study on Nigeria, Gebregiorgis and Handa (2005), using quarterly data over the period 1970:1 to 2000:4, obtain results that suggest that simple sum aggregates perform better than Divisia measures of money. They attribute these findings to the underdeveloped nature of financial systems in Nigeria. In Pakistan, Tariq and Mathews (1997), using cointegration analysis of a three variable vector autoregression (VAR)—namely, output, money and opportunity cost—conclude that simple sum and Divisia measures perform uniformly. Consequently, these findings suggest the need to undertake more studies for developing countries.

Some central banks are publishing Divisia monetary aggregates alongside simple sum monetary aggregates. For instance, Divisia monetary aggregates produced by the Bank of England, National Bank of Poland, Bank of Israel and the St. Louis Federal Reserve Bank are available to the public through each respective bank's website.

3. CONSTRUCTION OF DIVISIA MONETARY AGGREGATES

The traditional measures of aggregate money supply add together the different components (such as currency, demand deposits, savings and time deposits, and foreign currency deposits) into one aggregate without using weights for each component. Thus, the measure of aggregate money supply (M) is a linear aggregation of the components without weighting. If the components of aggregate money are m_i where $i = 1,2,3 \ldots N$, then the traditional simple sum aggregate money supply is given by:

$$M = \sum_{i=1}^{N} m_1 \quad (1)$$

This measure has the advantage of simplicity. However, it does not distinguish the "moneyness" of the different aggregates (IMF, 2008; Barnett, 1980). This approach assumes that different monetary assets are perfect substitutes carrying identical risks and returns (Gebregiorgis and Handa, 2005).

The Divisia approach to monetary aggregation aims to capture the total flow of monetary services in a given economy by weighting each money stock asset based on its contribution to the aggregate flow of monetary services. This approach has strong theoretical foundations based on statistical index number theory and microeconomic demand models (Barnett, 1980; Anderson, Jones and Nesmith, 1997a). The aggregation technique takes into account substitution effects as relative prices between assets change. Asset prices may change due to monetary policy actions that alter interest rates and the amount of money in circulation. Economic reforms and changes such as financial reforms, liberalization and innovations also tend to change the composition of monetary aggregates that consequently alter the relative importance of any aggregate as a medium of exchange in an economy (Puah and Hiew, 2010; Barnett 1980). The Divisia aggregates are based on user-cost estimated expenditure shares, which help capture changes in the importance of monetary assets due to changing economic conditions. Simple sum aggregates have thus come under the criticism that they do not sufficiently capture changes in the flow of monetary services. Consequently, Divisia monetary aggregates (also referred to as monetary services indices (MSI), or Törnqvist-Theil monetary indices) are receiving increased attention in the literature as alternatives or complements to the traditional measures of money.

Following Anderson, Jones and Nesmith (1997b), the nominal Divisia monetary index (DMI) is derived as a chained Törnqvist-Theil quantity index. The DMI is defined as:

$$\mathrm{DMI}_t = DMI_{t-1} \prod_{i=0}^{n} \left(\frac{M_{it}}{M_{it-1}} \right)^{0.5(W_{it}+W_{it-1})} \quad (2)$$

where W_{it} is the expenditure share of monetary asset i at time t, and M_{it} represents the nominal monetary asset i at time t. Likewise, the real Divisia monetary index (DMIreal) is constructed as:

$$\mathrm{DMIreal}_t = \mathrm{DMIreal}_{t-1} \prod_{i=0}^{n} \left(\frac{Mreal_{it}}{Mreal_{it-1}} \right)^{0.5(W_{it}+W_{it-1})} \quad (3)$$

where $Mreal_{it}$ represents real monetary asset i at time t and is calculated as M_{it}/P_{it} where P_{it} is the cost of living index at time t.

The expenditure share, W_{it}, is defined as:

$$W_{it} = \frac{\pi_{it} M_{it}}{\sum_{j=1}^{n} \pi_{it} M_{jt}} \quad (4)$$

The denominator in Equation 4, $\sum_{j=1}^{n} \pi_{it} M_{jt}$, represents total expenditure on monetary assets, and π_{it} is the user cost of money for asset i at time t. It can be expressed either as the summation of the product of the nominal user costs, π_{it}^{n}, and the respective real assets, RM_{jt} or the sum of product of real user costs, π_{it}^{r}, and nominal assets, NM_{jt}, as below:

$$\Sigma_{j=1}^{n} \pi_{it} M_{jt} = \Sigma_{j=1}^{n} \pi_{it}^{n} RM_{jt} = \Sigma_{j=1}^{n} \pi_{it} NM_{jt} \tag{5}$$

Note that $\pi_{it}^{n} = P_t * \pi_{it}^{r}$, where P represents the cost of living at time t.

The nominal user cost of money is the price of transaction service of each monetary asset and is defined as:

$$\pi_{it}^{n} = \frac{P_t(R_t - r_{it})}{(1+R_t)} \tag{6}$$

where R_t is the benchmark rate at time t, r_{it} is asset i's own rate of return at time t, and P_t is the price index. The benchmark rate is the highest rate of return over the class of monetary assets. The class of assets used for Kenya include government paper (91, 182 and 364-day Treasury bill rates), repo, savings rates and deposit rates. Therefore, the benchmark rate is expressed as:

$R_{it} = max\{r_{it}(\text{deposit rates, 91-, 182- and 364-day T-bill rates), repo, savings rates)}\}+c$

where c is a constant set at 0.001. Its inclusion ensures that the rate of return on any monetary asset is below the benchmark rate (Anderson, Jones and Nesmith, 1997b).

The data sources are Central Bank of Kenya, International Monetary Fund's International Financial Statistics and the Kenya National Bureau of Statistics (KNBS). The monetary components include notes and coins, demand deposits, time and savings deposits, foreign currency deposits and stock of Treasury bills. Quarterly data from 1995:4 to 2011:3 are used in this study. This is a period characterized by a liberalized financial system and, thus, one would expect the analysis of the importance of Divisia indices to be relevant.

For Kenya, M0 comprises currency in circulation less cash in tills of banks, while M1 includes M0 and demand deposits. M2 comprises M1 plus savings deposits (SD), time deposits (TD) and deposits in non-bank financial institutions (NBFIs). There is also a variant measure of M2 that excludes deposits by NBFIs (OM2). M3 comprises M2 plus foreign currency deposits. The broadest category that is considered is M3XT, which is simply M3 plus Treasury bills holdings.

In constructing the Divisia Monetary Services index, we start by calculating the user cost of each monetary asset. The corresponding own rates of return are also required to calculate the user cost (see Equation 6). Currency outside banks is considered pure money and, therefore, the return paid on currency is taken as zero, in the computation of the user cost. For demand deposits, they do not carry explicit rates of returns. However, there are non-price implicit returns such as reduced cost of banking services (e.g., free check books and bankers' checks, overdraft facilities, and free debit cards). Therefore, to calculate the own-rate of return on demand deposits, the implicit rate of return is derived following Klein (1974) as:

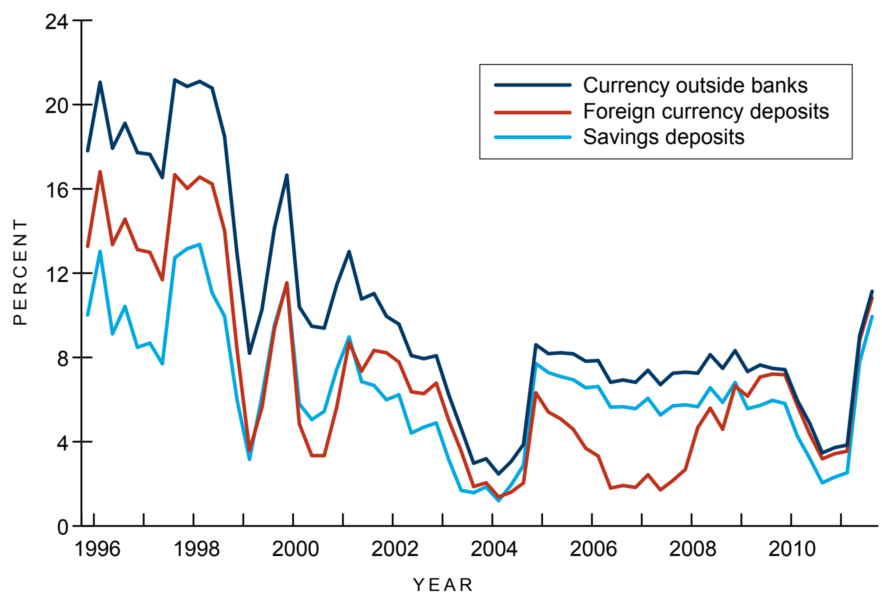
$$R_{Dp} = (1-CRR)R_{alt} \tag{7}$$

where R_{Dp} is the implicit rate of return on demand deposits, CRR is the maximum cash reserve ratio, and R_{alt} is the rate of return on an alternative asset, in this case the rate for the 91-day Treasury bills. However, Starz (1979) argues that the implicit rate of return on demand deposits is below the fully competitive rate by Klein (1974) by between 0.34 and 0.58 times. We use Starz (1979) modified return by multiplying the measure obtained from Equation 6 by 0.58. As a result, the implicit rate of return on demand deposits is consistent with the rate on other deposits but is lower. For instance, over the period 1995:12 to 1999:12, the implicit rate of return is estimated as 5.9 percent, compared to 9.3 percent, 14.4 percent and 20.6 percent for savings deposits, time deposits and 91-day Treasury bill rate, respectively. The own-rate of return for savings, time deposits and treasury bills holdings are explicit. Therefore, we use the savings, deposit and Treasury bills rate, respectively. As for the foreign currency deposits of residents, the own-rate of return is the London Interbank Offered Rate (LIBOR).

The user cost is an important component in the construction of Divisia monetary services index. It approximates the value of a monetary asset's service flow per shilling of the asset held. The income that is foregone by holding a given monetary asset rather than an asset that yields a higher return (benchmark rate) is proportional to its own or rental rate. Currency outside banks and demand deposits do not earn explicit returns and, therefore, have the highest user cost. As expected, currency outside banks had the highest average real-user cost over the period of study (Figure 1).

The trends in the user cost of holding foreign currency deposits reflect movements in domestic interests relative to the LIBOR, especially reflecting the interest rate differential between domestic rates and the LIBOR. For instance, the user cost for foreign currency deposits is lowest in both 2004 and 2006, corresponding to periods when the differential has been at its lowest. Overall, during the period 1995 to 2010, there has been a general reduction in the user costs for the different money assets. However, the trends show troughs during periods, when rates on government paper have fallen below commercial bank deposit rates. It might appear that when the monetary authorities

Figure 1: Trends in selected real user costs



have attempted to reduce interest rates drastically, the episodes have been rather short-lived, for instance in 2003/04 and immediately after 2008. The general rise in user costs towards the end of the study period captures the change in monetary policy stance from expansionary to restrictive.

The user cost combined with the stock of monetary assets provides the expenditure weights for the monetary services index. The expenditure shares are summarized in Table 1. The data reveals that between 1995 and 2011, there have been substantial changes in the relative importance of the different components of money. Within M1, the increasing importance of demand deposits relative to currency outside banks can be observed. With financial development and innovations have come instruments and products such as ATMs, checking accounts, and credit and debit card systems. As these new products, including mobile phone money transfer and improved payment systems, gain wider acceptance, demand for hard cash is expected to be reduced. In 2005, Kenya introduced the Kenya Electronic Payments Settlement System (KEPSS), which is a real-time gross settlement system meant to modernize payment systems in line with international standards.

The expenditure shares also reveal the declining importance of NBFIs. The importance of NBFIs is noted in the inclusion of the deposits in M2. The expenditure share for NBFIs declined from an average of 7 percent over the period 1995:4 and 1999:4 to 1 percent by 2011:3. Between 1995 and 2007, 22 NBFIs transformed to commercial banks by meeting the relevant prudential requirements. The expenditure share shows that foreign currency deposits have been growing in importance. The weight for foreign currency deposits increased from about 8 percent between 1995:4 to 1999:4 and to 18 percent by 2011:3. This trend largely reflects the growing importance of foreign currency deposits. Foreign currency deposits as a percentage of M2 increased from about 6 percent at the end of 1995 to about 20 percent during the third quarter of 2011. In conclusion, it can be noted that the construction of Divisia money enables us to track changes in the composition of broad monetary aggregates due to developments in the financial system.

The expenditure shares also indicate that, as monetary assets are broadened, the incremental expenditure shares decrease. Thus, beyond M2, excluding NBFIs, the incremental or marginal expenditure share declines. Consequently, the difference between Divisia

Table 1: Key expenditure shares for monetary assets (period average %), 1995:4-2011:3

Monetary Component	M0	Demand Deposits	Savings Deposits	NBFIs Deposits	Foreign Currency Deposits
1995:4-1999:4	18	22	26	7	8
2000:1-2004:4	17	27	20	3	12
2005:1-2009:4	15	33	16	2	13
2010:1-2011:3	12	36	12	1	18

M3 and Divisia M3XT is very small. The average expenditure weight over the period of study for M0 is 14 percent, M1 is 38 percent, M2 excluding NBFIs is 70 percent, and M2 including NBFIs is 87 percent. In this regard, as the definition of money is broadened beyond M2, excluding deposits by NBFIs, the incremental weighting starts to decline.

A Comparison of Divisia and Simple-Sum Aggregates

The Divisia and simple sum aggregates have been normalized to equal 100 at the beginning period, 1995:4, so as to facilitate comparison. The basic descriptive statistics based on the standard deviation indicate that simple sum aggregates fluctuate more around the mean. The standard deviation of simple sum M1 (SSM1), simple sum M2 including NBFIs (SSM2), simple sum M2 excluding NBFIs (OM2) and simple sum M3 (SSM3) are 227.7, 133.7, 162.9 and 148.7, respectively, compared to 49.7,93.6, 102.4 and 131.5 for corresponding Divisia measures of aggregate money.

The degree of substitutability among the components of M1 appears to be relatively low compared to M2 and M3. There is a large difference in the degree of moneyness between the components of M1, namely, currency and demand deposits. This difference might suggest that preference for cash-relative demand deposits is strong among the Kenya public. The simple sum measures of money give currency and demand deposits equal weight. This is reflected in the relatively large difference between simple sum and Divisia measures. The share of currency outside banks in M1 has declined gradually from an average of about 35 percent at the beginning of the study period to about 20 percent by 2011. The level of substitutability appears to increase in relation to the components of M2 and M3 as reflected in the reduced difference between Divisia and simple sum measures of aggregate money supply. It would appear that the impact of different weighting diminishes as you aggregate from M1 to M3XT (Figures 2 to 6).

Figure 2: Divisia M1 and simple sum M1, 1995:4-2011:3

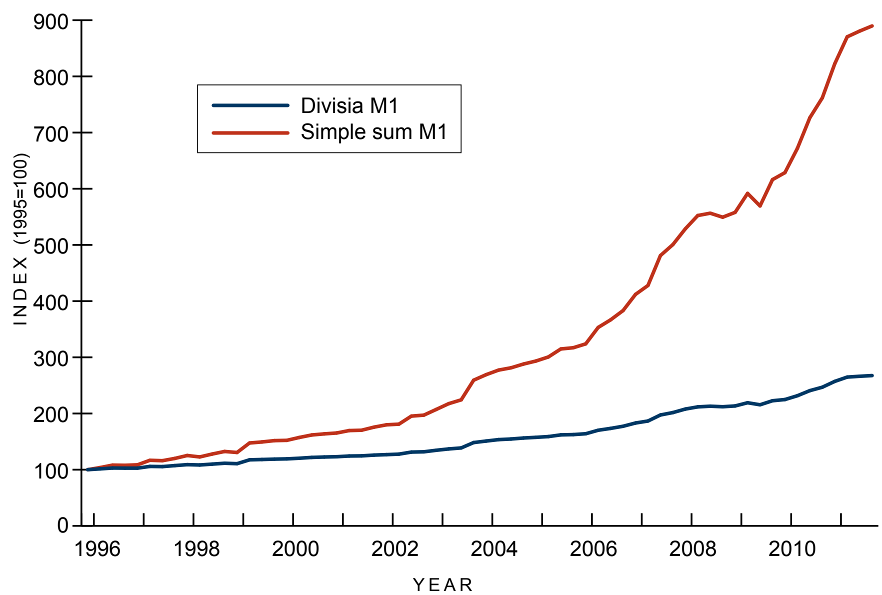


Figure 3: Divisia M2 and simple sum M2 (excluding NBFIs), 1995:4-2011:3

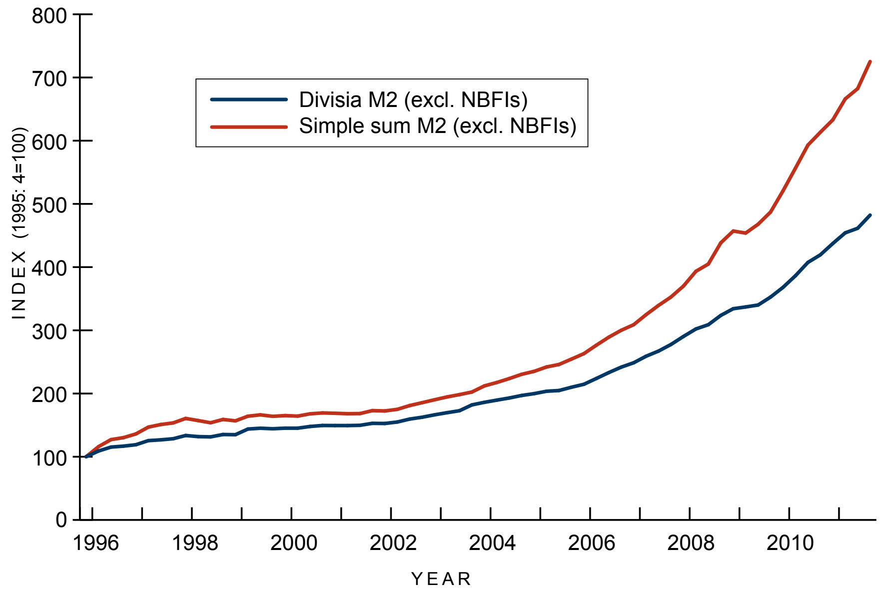


Figure 4: Divisia M2 and simple sum M2 (including NBFIs), 1995:4-2011:3

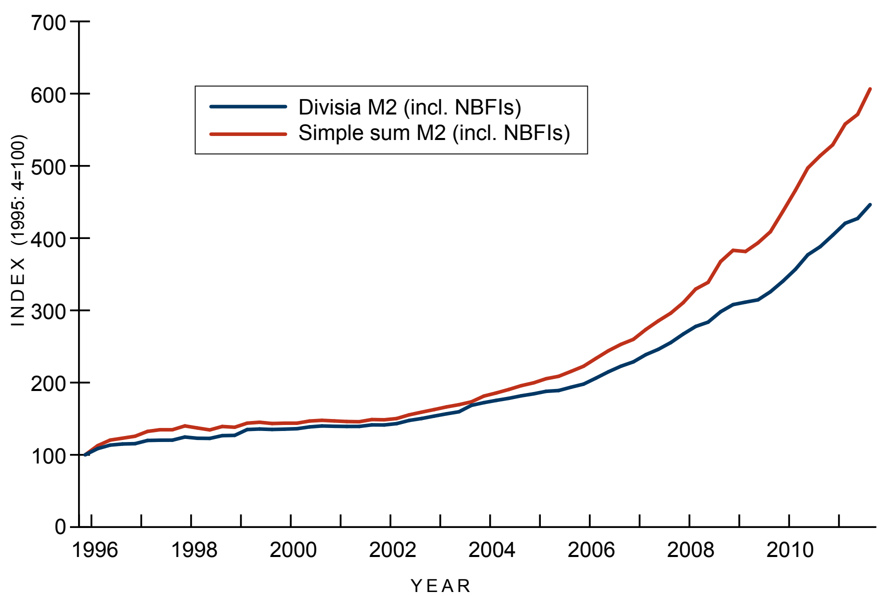


Figure 5: Divisia M3 and simple sum M3, 1995:4-2011:3

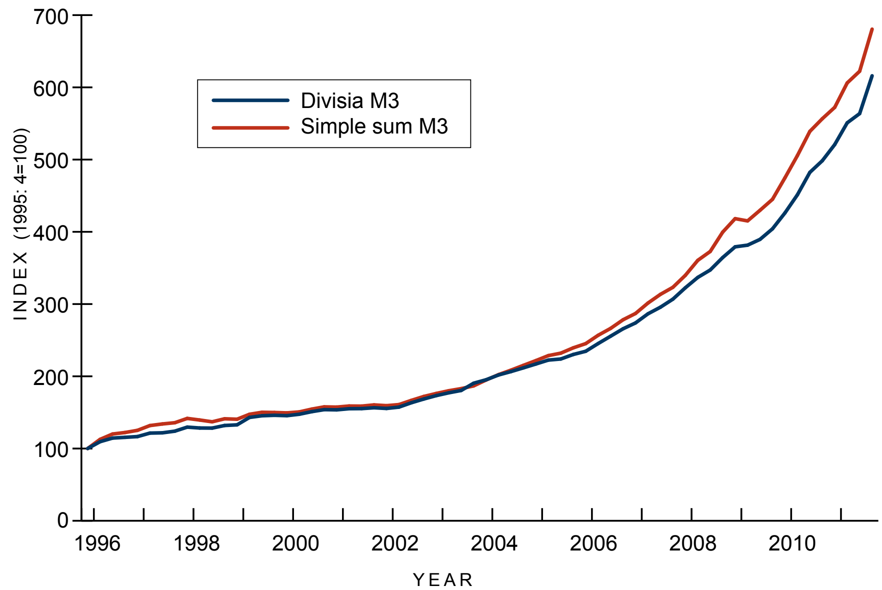
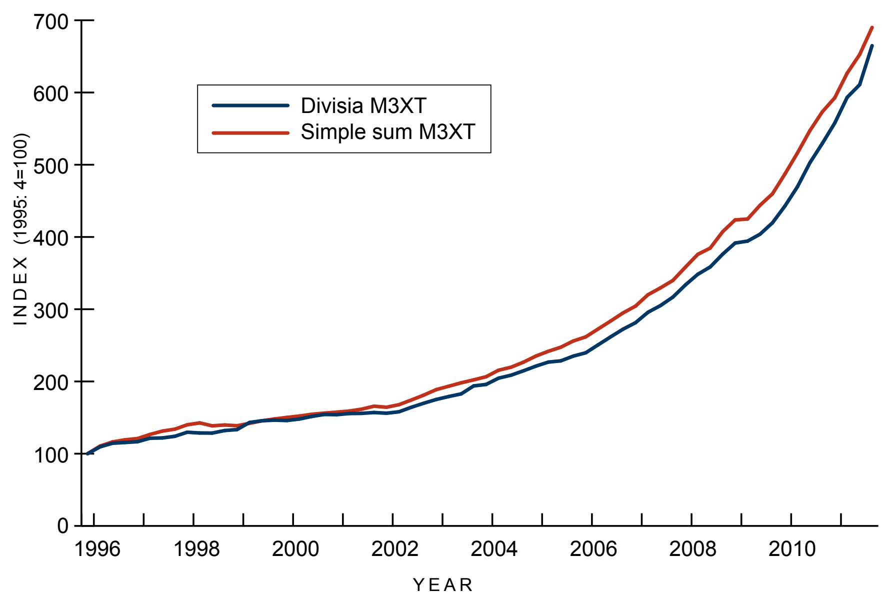


Figure 6: Divisia M3XT and simple sum M3XT, 1995:4-2011:3



An analysis of the developments in income velocities for simple sum and Divisia measures of aggregate money for Kenya indicates close correlations. However, an inspection of the trends (Figures 7 through Figure 11) suggests that there was a change in 2004. The income velocity of money refers to the ratio of nominal GDP to money supply. The income velocity is a useful concept for policy, since if it is stable and known, the central bank can easily predict the nominal GDP given the stock of money. In addition, the inverse of income velocity especially with regard to M2, that is M2/GDP, is commonly used in the literature as a proxy for financial deepening. For emerging and developing economies, this ratio is expected to increase as the financial depth increases in the sense of increased resources for financial intermediation (Loayza and Romain, 2006). Figures 7 through 11 show the income velocity for simple sum monetary aggregates and the corresponding Divisia aggregates. The income velocity is calculated as the ratio of the index of real GDP (1995:4=100) and the real measure of money. Kenya does not produce quarterly GDP in nominal terms, thus velocity, v, is calculated as $\frac{GDP}{M/P}$. Where GDP is real GDP and $\mathrm{M/P}$ is a measure of real money.

While the income velocity for simple sum aggregates indicates that there has been steady growth in financial depth, the same cannot be said of Divisia monetary aggregates (Figures 7 through 11) except for M3 and M3XT. The graphs also indicate that there was a shift in the income velocity of money with regard to M2, starting from the period after 2004. The declining income velocity for M3 and M3XT might largely be explained by the rapid growth in foreign currency deposits.

Figure 7: Income velocity for Divisia M1 and simple sum M1, 1995:4-2011:3

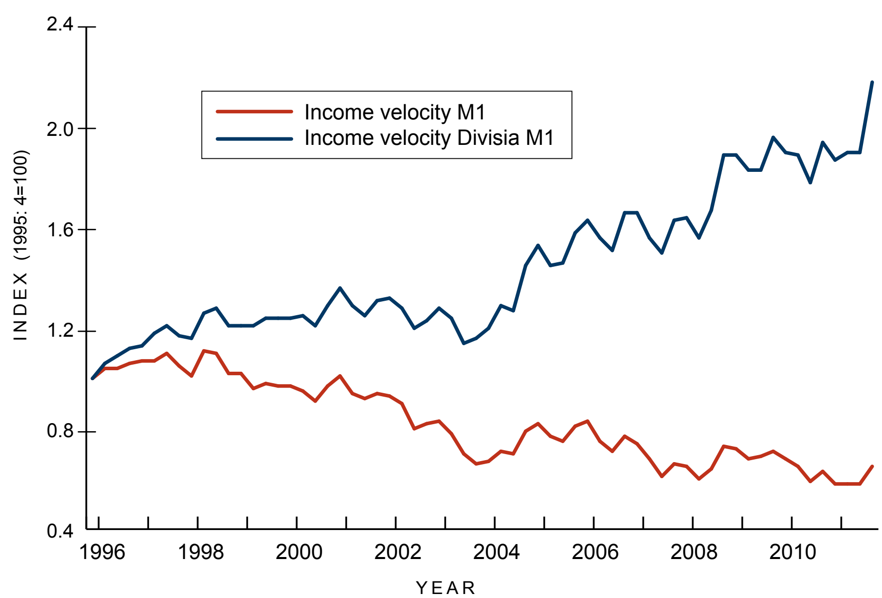


Figure 8: Income velocity of Divisia M2 excluding NBFIs and simple sum M2 excluding NBFIs, 1995:4-2011:3

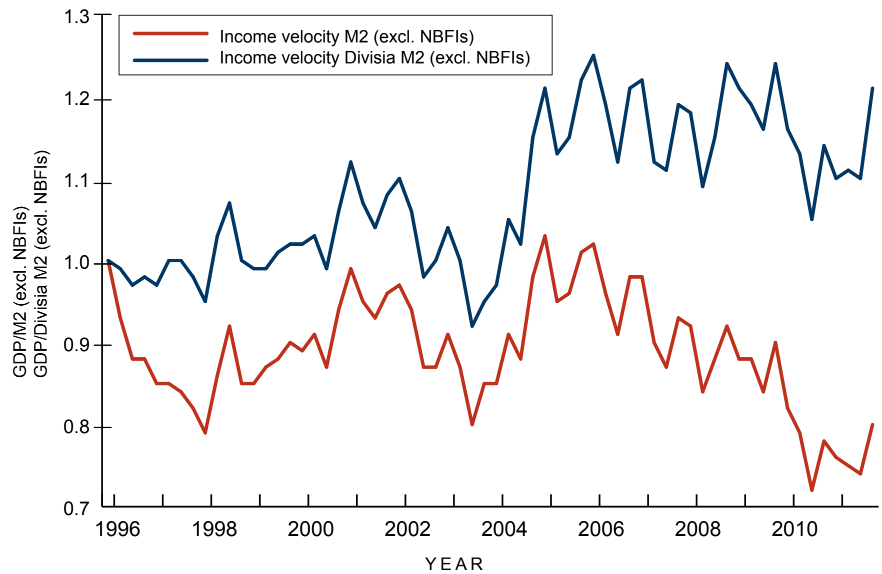


Figure 9: Income velocity Divisia M2 and simple sum M2 (including NBFIs), 1995:4-2011:3

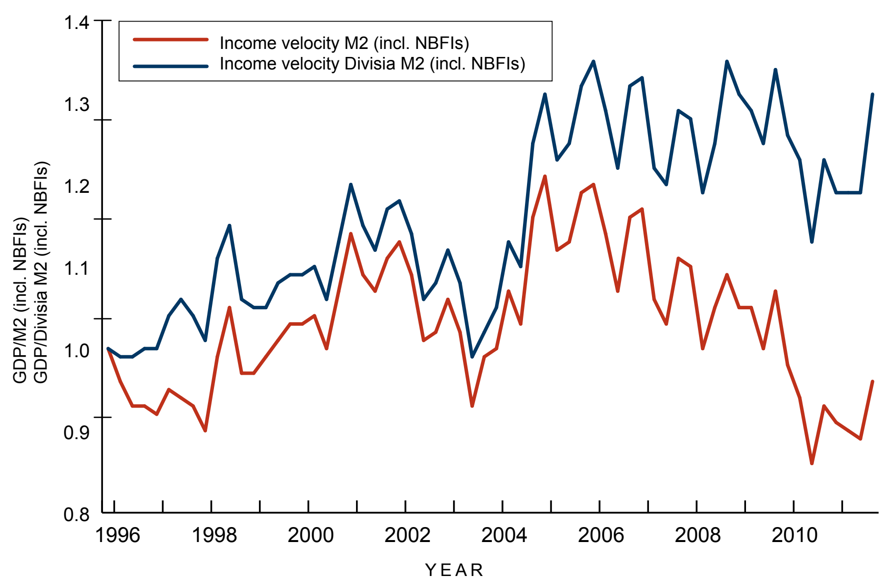


Figure 10: Income velocity Divisia M3 (DM3VEL) and simple sum M3 (M3VEL), 1995:4-2011:3

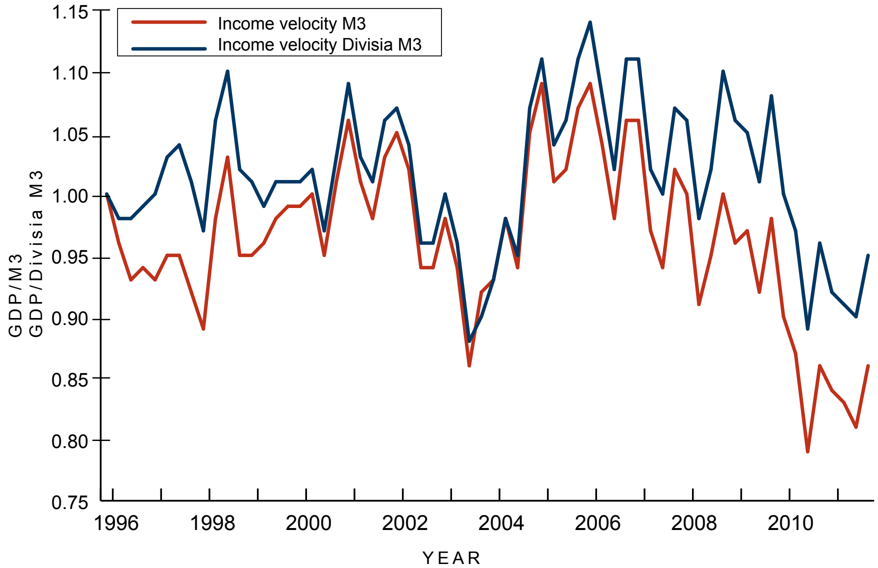
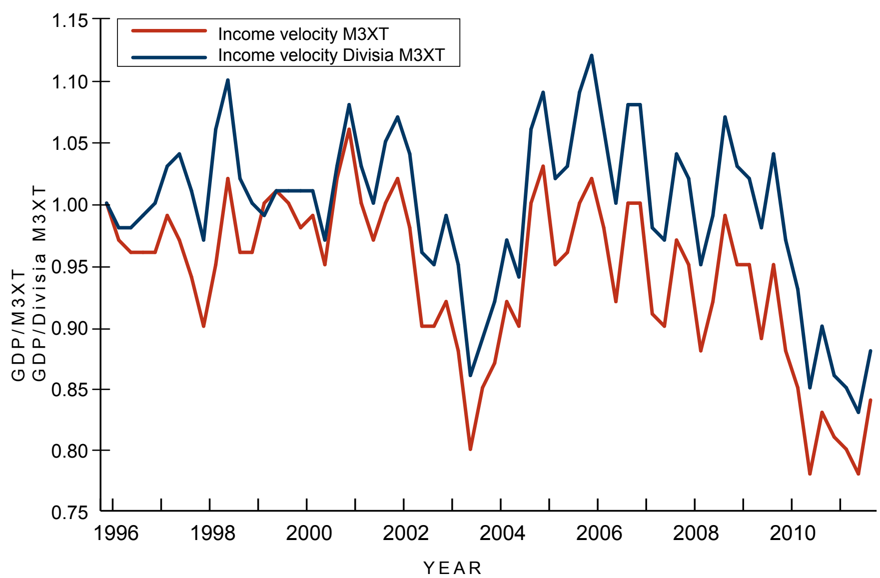


Figure 11: Income velocity Divisia M3 (M3XTVEL) and simple sum M3XT (M3XTVEL), 1995:4-2011:3



We further analyze the relative performance of the Divisia and simple sum aggregates by assessing the existence of plausible long-run relationships between the monetary aggregates, and output and interest rate. In the following section, the relationship between the monetary aggregates, national income and interest rates is thus examined through cointegration analyses.

4. ANALYSIS OF DEMAND FUNCTION FOR DIVISIA AND SIMPLE SUM MONEY

In this section, we analyse demand functions for Divisia and simple sum money aggregates. We estimate a general money demand function in the form:

$$M_t = F(SV,C)_t \quad (8)$$

where M_t is a measure of money in real terms, SV is the scale variable in the money demand function representing a measure for economic activity, and C stands for variables that represent the opportunity cost of holding money. Sriram (2000), in a survey of studies on demand for money in industrial and developing countries, notes that in the literature the opportunity cost variables constitute those that represent own-rate and/or return on alternative assets, both domestic and foreign. The variables include exchange rate, expected inflation, foreign interests, interest rates on deposits, and yields on government paper. The scale variables on the other hand include measured income such as GDP, expenditure and wealth variables.

We estimate a general money demand function in the form:

$$\ln M_t = \alpha_0 + \alpha_1 \ln GDP_t + \alpha_2 \ln tb91_t + \alpha_3 \ln \Delta P_t + u_t \quad (9)$$

where M_t refers to real money balances, GDP is real gross domestic product, ΔP_t is inflation based on the consumer price index (CPI) at the beginning of the quarter and represents expected inflation. The 91-day Treasury bill rate, $tb91$, is our opportunity cost variable. According to Sichei and Kamau (2012), studies on money demand in Kenya have confirmed the significance of GDP and $tb91$ in the money demand functions for Kenya.

In this regard, the above specification leads us to a standard error correction model (ECM) in the form:

$$\Delta \ln M_t = \alpha_0 + \sum_{j=1}^{p-1} \alpha_{1j} \Delta \ln M_{t-j} + \sum_{j=0}^{p-1} \alpha_{2j} \Delta \ln GDP_{t-j} + \sum_{j=0}^{p-1} \alpha_{3j} \Delta \ln tb91_{t-j} + \sum_{j=0}^{p-1} \alpha_{2j} \Delta \ln(\Delta P_{t-j}) + \lambda u_{t-1} + \varepsilon_t \quad (10)$$

where $u_{t-1} = \ln M_{t-1} - \alpha_0 - \alpha_1 \ln GDP_t - \alpha_2 \ln tb91_t - \alpha_3 \ln \Delta P_t$ is the error-correction term, and λ measures the adjustment to the equilibrium errors. The advantage of the ECM is that it allows separate reaction speeds to the different determinants of money demand. It combines both the short-run and long-run effects. The error correction portion in the model enables us to capture the information in the long-run equilibrium. We employ the Johansen cointegration method to establish the existence of cointegrating vectors and examine the underlying long-run relationships.

The first step in conducting cointegration tests is to determine, for each variable, its order of integration. The variables M_t, GDP_t, $tb91_t$, ΔP_t have to be cointegrated for a long-run relationship to exist. We use the traditional tests for unit roots, namely Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests. In addition, we use an alternative test, the Kwiatowski, Philips, Schmidt and Shin (KPSS) (1992) test for the order of integration. Unlike the ADF and PP tests, the KPSS tests for stationarity as the null hypothesis and the existence of a unit root as the alternative. The KPSS test is useful due to the low power of unit roots (Verbeek, 2008). Results for ADF and PP tests are presented in Table 2 below. The results from KPSS tests suggest that most of the variables are trend stationary (Annex Table 1).

Table 2: Unit root tests for log levels

	ADF Test (Log Levels)		Phillips-Perron Test Statistic (Log Levels)	
Variables	Intercept	Intercept & Trend	Intercept	Intercept & Trend
Divisia M3XT	1.06	-1.91	1.00	-1.07
Divisia M3	0.81	-2.18	0.72	-1.43
Divisia M2 (incl. NBFIs)	-0.54	-2.79	-0.23	-2.09
Divisia M2 (excl. NBFIs)	-0.55	-2.82	-0.64	-2.31
Divisia M1	-3.67	-3.70	-2.82	-2.82
Simple sum M3XT	0.68	-1.33	0.68	-1.56
Simple sum M3	0.85	-0.91	0.88	-0.91
Simple sum M2 (incl. NBFIs)	0.69	-0.86	0.56	-0.98
Simple sum M2 (excl. NBFIs)	-0.04	-1.19	-0.18	-1.47
Simple sum M1	-0.31	-3.63	-0.12	-3.15
Inflation		-3.82	-4.12	-2.60
GDP	1.24	-2.09	-0.55	-4.49
User cost	-2.79	3.01	-2.04	-2.20
T-bill rate	-2.75	-2.97	-2.21	-2.29
Critical values				
1%	-3.54	-4.11	-3.54	-4.11
5%	-2.91	-3.48	-2.91	-3.48
10%	-2.59	-3.17	-2.59	-3.17

Table 3: Unit root tests for log first differences

	ADF Test (Log First Differences)		Phillips-Perron Test Statistic (Log First Differences)	
Variables	Intercept	Intercept & Trend	Intercept	Intercept & Trend
Divisia M3XT	-6.16	-6.51	-6.16	-6.45
Divisia M3	-6.45	-6.70	-6.48	-6.64
Divisia M2 (incl. NBFIs)	-6.21	-6.31	-6.17	-6.25
Divisia M2 (excl. NBFIs)	-6.35	-6.36	-6.30	-6.29
Divisia M1	-5.18	-5.13	4.94	-4.87
Simple sum M3XT	-6.47	-6.67	-6.49	-6.65
Simple sum M3	-7.29	-7.64	7.29	-7.87
Simple sum M2 (incl. NBFIs)	-6.92	-7.26	-6.92	-7.29
Simple sum M2 (excl. NBFIs)	-7.11	-7.21	-7.12	-7.21
Simple sum M1	-6.08	-6.04	-6.09	-6.04
Inflation	-5.81	-5.81	-5.26	-5.31
GDP	-3.82	-4.28	-12.70	-13.32
User cost	-5.74	-5.89	-5.48	-5.65
T-Bill rate	-5.86	-5.90	-5.64	-5.65
Critical values				
1%	-3.54	-4.11	-3.54	-4.11
5%	2.91	-3.48	-2.91	-3.48
10%	-2.59	-3.17	-2.59	-3.17

All the variables (including the constructed monetary aggregates) proved to be I(1), except the rate of inflation, which appears to stationary I(0). The variable is therefore not included in the cointegrating relationship in the analysis based on Equation 10 above. Thus, the empirical analysis is based on:

$$\Delta \ln M_t = \alpha_0 + \sum_{j=1}^{p-1} \alpha_{1j} \Delta \ln M_{t-j} + \sum_{j=0}^{p-1} \alpha_{2j} \Delta \ln GDP_{t-j} + \sum_{j=0}^{p-1} \alpha_{3j} \Delta \ln tb91_{t-j} + \sum_{j=0} \alpha_{5j} \ln \Delta P_{t-j} + \lambda u_{t-1} + \varepsilon_t \quad (11)$$

where $u_{t-1} = \ln M_{t-1} - \alpha_0 - \alpha_1 \ln GDP_t - \alpha_2 \ln tb91_t$.

The trace and maximum Eigen value tests for cointegration indicate that there is one co-integrating vector for each of the models for the constructed Divisia monetary aggregates and simple sum aggregates (Annex Table 3) for cointegration between money, GDP and the T-bill rate. The maximum lag length p is determined through residual serial correlation Lagrangian Multiplier tests, ensuring that there are no autocorrelation problems with the residuals. The appropriate lag length is p=5. We therefore estimate a vector error correction model (VECM) for the system, with the inclusion of one error correction term for each equation. The normalized co-integrated vector for each monetary aggregate is given below. Fifteen co-integrating vectors are reported in Table 4. Equations 3, 6, 9, 12 and 15 use the user cost as the relevant opportunity cost variable for Divisia monetary aggregates (Barnett, 1980; Dahalan, Sharm and Sylwester, 2005).

Table 4: Estimates of cointegrating vectors

	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6	Equation 7	Equation 8
	Divisia M3XT	M3XT	Divisia M3XT	Divisia M3	M3	Divisia M3	Divisia M2 (incl. NBFIs)	M2 (incl. NBFIs)
GDP	1.55	1.50	1.99	1.354	1.735	1.68	.913	1.81
T-bill rate	-0.15	-0.14		-0.129	-0.111		-0.088	-0.10
Intercept	-14.36	-13.72	-19.18	-11.93	-16.704	-15.39	-6.611	-17.719
User cost			-0.17			-0.147		

	Equation 9	Equation 10	Equation 11	Equation 12	Equation 13	Equation 14	Equation 15
	Divisia M2 (incl. NBFIs)	M2 (excl. NBFIs)	Divisia M2 (excl. NBFIs)	Divisia M2 (excl. NBFIs)	Divisia M1	M1	Divisia M1
GDP	1.099	1.701	0.878	1.068	0.200	1.93	0.746
T-bill rate		-0.091	-0.087		-0.211	-0.231	
Intercept	-8.52	-16.234	6.087	-8.054	-2.365	-18.713	-3.29
User cost	-0.102			-0.102			-0.273

The results obtained from the estimations are consistent with economic theory. In our demand function, the scale variable is represented by real GDP. It is positively related to the demand for money in all the models that have been estimated for the constructed Divisia aggregates and for the simple sum aggregates. As expected, the opportunity cost variable (represented by the 91-day Treasury bill rate and user cost for Divisia aggregates in Equations 3, 6, 9, 12 and 15) are inversely related to the demand for money. Previous studies on demand for money using traditional measures have found different estimates of income elasticity. Ndele (1991) found an income elasticity of 1.9 for M3, and Sichei and Kamau (2012) report an income elasticity of 1.98 and 1.5 for M2 and M3, respectively. Killick and Mwega (1990) found an income elasticity of 0.78 for M2. In this study, income elasticity based on Divisia monetary aggregates is lower, while the interest rate elasticities are marginally higher except for Divisia M1.

As a next step, we explore whether short-run movements in the modeled variables affect the long run demand for money based on the simple sum and Divisia measures. We do these by examining the adjustment coefficients associated with error correction terms. The 3×1 matrix and the associated standard errors for selected ECMs are reported in Table 5.

The results presented in Table 5 indicate that the short-run behavior of money demand for the constructed Divisia measures as well as the traditional simple sum aggregates are affected by the long-run demand for money. In addition, it appears that short-run changes in GDP are affected by the long-run demand for simple sum M3.

Table 5: Matrix of adjustment coefficients

Equation	DIV M3XT: u_{t-1}	M3XT u_{t-1}	DIV M3XT u_{t-1}	DIVM3 u_{t-1}	M3 u_{t-1}	DIVM3 u_{t-1}	DIVM2 incl. NBFIs u_{t-1}	SSM2 incl. NBFIs u_{t-1}	DIVM2 incl. NBFIs u_{t-1}	SSM1: u_{t-1}	DIVM1 u_{t-1}
Δm_t	-0.305* (0.056)	-0.410* (0.06)	0.33* (0.06)	-0.361* (0.06)	-0.31* (0.05)	0.43* (0.075)	-0.43* (0.058)	-0.281* (0.044)	-0.589* (0.070	-0.134* (0.039)	-0.253* (0.116)
Δgdp	-0.113 (0.08)	-.200* (0.107)	-0.012 (0.09)	-0.137 (0.09)	-0.11 (0.08)	-0.029 (0.11)	-0.153 (0.108)	-0.107 (0.072)	-0.085 (0.136)	-0.071 (0.052)	-0.067 (0.079)
$\Delta tb91$	-0.17 (1.07)	-1.73 (1.34)		-0.723 (1.19)	-1.10 (1.00)		-0.857 (1.35)	-1.25 (0.86)		-0.522 (0.74)	
$\Delta usercost$			-0.19 (0.84)			-0.72 (1.02)			-0.69 (1.25)		-1.270 (1.06)

** indicates significant at the 5% level*

5. CONCLUSION AND POLICY IMPLICATIONS

The purpose of this paper was to construct Divisia monetary aggregates and compare them with simple sum aggregates. The constructed Divisia monetary aggregates for M1, M2, M3 and M3XT are different from their counterparts, especially for M1 and M2. These findings suggest that currency and bank deposits are imperfect substitutes. The demand for money analysis suggests that Divisia aggregates perform equally as well as traditional monetary aggregates. In this regard, Divisia monetary aggregates can be useful to complement traditional monetary aggregates. However, there is need for more work to establish the optimal levels of aggregation and the usefulness for monetary policy.

REFERENCES

Acharya D. and Kamaiah B. (2001),"Simple Sum vs Divisia Monetary Aggregates: An Empirical", *Economic and Political Weekly*, Vol. 36, No. 4, Money, Banking & Finance (27 January-2 February, 2001).

Anderson, R. G., Jones, B. E. and Nesmith T. D. (1997a), Monetary Aggregation Theory and Statistical Index Numbers, Federal Reserve Bank of St. Louis Review.

Anderson, R. G., Jones, B. E., and Nesmith, T. D. (1997b), Building New Monetary Services Indexes: Concepts, Data, and Methods, Federal Reserve Bank of St. Louis Review.

Barnett, W. A. (1982) "The Optimal Level of Monetary Aggregation". *Journal of Money, Credit, and Banking* 14, no. 4: 687-710.

Barnett, W. A., Fisher, D., and Serletis, A. (1992), "Consumer Theory and the Demand for Money". *Journal of Economic Literature*, 30, 2086-2119.

Barnett, W. A., Offenbacher, E. K. and Spindt, P. A.(1984), "The New Divisia Monetary Aggregates," *Journal of Political Economy*, Vol. 92(6), pp: 1049–85

Barnett, W. A. (1980),"Economic Monetary Aggregates: An Application of Aggregation and Index Number Theory," *Journal of Econometrics* 14 (1980), pp: 11-48.

Celik, S. and Uzun, S. (2009),"Comparison of Simple Sum and Divisia Monetary Aggregates Using Panel Data Analysis", *International Journal of Social Sciences and Humanity Studies* Vol 1, No 1, 2009

Dahalan, J., Sharm, S. and Sylwester, K. (2005), "Divisia Monetary Aggregates and Money Demand for Money in Malaysia", *Journal of Asian Economics*, Elsevier, Vol. 15(6), pp: 1137-1153.

Durevall, D. and Ndung'u S. (1999), A Dynamic Model of Inflation for Kenya, 1974-1996, IMF Working Papers WP/99/97.

Fase, M. M. G. and Winder, C.C.A. (1994), "Money Demand within EMU: An Analysis with the Divisia Measure," *De Nederlandsche Bank Quarterly Bulletin*, September, pp25-55.

Gebregiorgis B.S. and Handa, J. (2005), "Monetary Aggregation for a Developing Economy: A Case Study of Nigeria", *Journal of Developing Areas*, Vol. 38 (2).

Haroon, S., Zakir, H. and Masood Sarwar A.(2011), "*Money Demand Functions for Pakistan (Divisia Approach)*", *Pakistan Economic and Social Review* (2011): pp: 1-20.

International Monetary Fund - IMF(2008), *Monetary and Financial Statistics Compilation Guide*. Washington DC: International Monetary Fund.

International Monetary Fund - IMF (2013), Regional Economic Outlook. Sub-Saharan Africa Building Momentum in a Multi-Speed World, Washington, D.C.: International Monetary Fund

Ishida, Kazuhiko(1984): Divisia Monetary Aggregates and Demand for Money: A Japanese Case. Bank Japan Monetary and Economic Studies 49-80.

Klein, B. (1974). "Competitive interest payments on bank deposits and the long-run demand for money". *The American Economic Review*, 64(6), 931–949. Jha, R. and Longjam I. S. (1999), "Will the Right Monetary Aggregate for India Please Stand Up?" *Economic and Political Weekly*, Vol. 34, pp: 631-630.

Johansen, Søren and Juselius, Katarina (1990). "Maximum Likelihood Estimation and Inferences on Cointegration—with Applications to the Demand for Money," *Oxford Bulletin of Economics and Statistics*, 52, 169–210

Killick, T. and Mwega, F. M. (1990), Monetary Policy in Kenya, 1967-1988. Working Paper No.39. London: Overseas Development Institute.

Kok-Shyong Lim, Chin-Hong Puah and Habibullah, M. S(2007), Predictive Powers of Divisia Monetary Aggregates and Simple Sum Money on Inflation, FEB Working Paper Series No. 0704 (August 2007), Faculty of Economics and Business (UNIMAS).

Kwiatowski, D., Phillips, P. C. B., Schmidt, P. and Shin, Y. (1992), "Testing Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure are We that Economic Time Series Have a Unit Root?",*Journal of Econometrics*, 54, p:159-178.

Loayza V. and Romain R. (2006), "Financial Development, Financial Fragility, and Growth". *Journal of Money, Credit and Banking*, Vol. 38, No. 4 (June 2006), pp: 1051-1076.

VerbeekMarno(2008), *A Guide to Modern Econometrics*, 3rd Edition, London: John Wiley and Sons.

Ndele, S. M. (1991), The Effects of Non-Bank Financial Intermediaries on the Demand for Money in Kenya, AERC Research Paper No.5. Nairobi: African Economic Research Consortium.

Ngugi, R. W. and Kabubo J. W. (1998), Financial Sector Reforms and Interest Rate Liberalization: The Kenyan Experience, AERC Research Paper No. 72. Nairobi: African Economic Research Consortium.

Puah Chin-Hong and Hiew, Lee-Chea (2010),"*Financial Liberalization, Weighted Monetary Aggregates and Money Demand in Indonesia*".*Labuan Bulletin of International Business and Finance*, Vol. 8, December 2010, pp : 76-93.

Ramachandran, M., Das Rajib and Bhoi Binod B. (2010), The Divisia Indices as Leading Indicator of Inflation, Department of Economic Analysis and Policy, Reserve Bank of India, Mumbai, Study No. 36, 2010.

Reimers, Hans-Eggert (2002), Analysing Divisia Aggregates for the Euro Area, Discussion Paper Series 1, Volkswirtschaftliches Forschungszentrum der Deutschen Bundesbank, No. 2002,13, http://hdl.handle.net/10419/19570.

Rotich H., Kathanje M. and Maana Isaya (2007), A Monetary Policy Reaction Function for Kenya. Paper Presented During the 13th Annual African Econometric Society Conference in Pretoria, South Africa, 9th to 11th July 2008.

Schunk, D.L. (2001). "The relative forecasting performance of the Divisia and simple sum monetary Aggregates". *Journal of Money, Credit and Banking*, 33, 272-283.

Serletis, A. and King M.(1993). "The Role of Money in Canada". *Journal of Macroeconomics* 15 (1): 91–107.

Serletis, A. and Robb, A. L. (1986), "Divisia Aggregation and Substitutability among Monetary Assets". *Journal of Money, Credit, and Banking, 28*, pp: 430-446.

Sichei M. and Kamau A. (2012), "Demand for Money: Implications for the Conduct of Monetary Policy in Kenya", *International Journal of Economic and Finance*, Vol. 4 No. 8.

Sriram Subramanian S, (2000). "A Survey of Recent Empirical Money Demand Studies", *IMF Staff Papers*, Vol. 47, No. 3 (2000), pp. 334-365

Starz, R. (1979). "Implicit interest on demand deposits". *Journal of Monetary Economics*, 515–534.

Tariq, S. Muhammad and Matthews, K. (1997), "The Demand for Simple-sum and Divisia Monetary Aggregates for Pakistan: A Cointegration Approach". *The Pakistan Development Review*, Vol. 36, No. 3, Autumn 1997, pp: 275-291.

Wesche, K. (1996), Aggregating Money Demand in Europe with a Index: Projektbereich B., Discussion Paper No. B-392.

ANNEX

Table 1: Kwiatkowski-Phillips, Schmidt and Shin (KPSS)-levels

	Intercept	Intercept & Trend
Divisia M3XT	0.96	0.21
Divisia M3	0.96	0.20
DivisiaM2 (incl. NBFIs)	0.82	0.19
Divisia M2 (excl. NBFIs)	0.89	0.16
Divisia M1	0.14	0.08
Simple sum M3XT	0.97	0.19
Simple sum M3	0.93	0.23
Simple sum M2 (incl. NBFIs)	0.83	0.23
Simple sum M2 (excl. NBFIs)	0.91	0.22
Simple sum M1	1.00	0.08
Inflation	0.18	0.07
GDP	0.99	0.25
User cost	0.31	0.17
T-Bill rate	0.64	0.15
Critical values		
1%	0.74	0.22
5%	0.46	0.15
10%	0.35	0.12

Table 2: Kwiatkowski-Phillips, Schmidt and Shin (KPSS) – log first differences

	Intercept	Intercept & Trend
Divisia M3XT	0.26	0.04
Divisia M3	0.23	0.04
Divisia M2 (incl. NBFIs)	0.14	0.03
Divisia M2 (excl. NBFIs)	0.08	0.04
Divisia M1	0.08	0.08
Simple sum M3XT	0.17	0.05
Simple sum M3	0.25	0.06
Simple sum M2 (incl. NBFIs)	0.26	0.07
Simple Sum M2 (excl. NBFIs)	0.14	0.10
Simple sum M1	0.07	0.05
Inflation	0.10	0.05
GDP	0.11	0.10
User cost	0.18	0.06
T-bill rate	0.09	0.04
Critical values		
1%	0.74	0.22
5%	0.46	0.15
10%	0.35	0.12

Table 3: Selected Johansen cointegration test results

Null Hypothesis	Alternative Hypothesis	Test Statistic (p=5) (M3XT, GDP, tb91)		5% Critical value	
		λ_{trace}-	λ_{max}	λ_{trace}-	λ_{max}
H_0: r=o	H_1: r≥1	61.19	53.98	29.79	21.13
H_0: r≤1	H_1: r≥2	7.21	5.58	15.49	14.26
Test Statistic(p=5) (Divisia M3XT, GDP, tb91)					
		λ_{trace}-	λ_{max}	λ_{trace}-	λ_{max}
H_0: r=o	H_1: r≥1	51.59	40.58	29.79	21.13
H_0: r≤1	H_1: r≥2	11.02	6.33	15.49	14.26
Test Statistic (p=5) (Divisia M3, GDP, tb91)					
		λ_{trace}-	λ_{max}	λ_{trace}-	λ_{max}
H_0: r=o	H_1: r≥1	56.34	45.55	29.79	21.13
H_0: r≤1	H_1: r≥2	10.79	7.13	15.49	14.26
Test Statistic (p=5) (M3, GDP, tb91)					
		λ_{trace}-	λ_{max}	λ_{trace}-	λ_{max}
H_0: r=o	H_1: r≥1	52.76	40.86	29.79	21.13
H_0: r≤1	H_1: r≥2	11.9	8.31	15.49	14.26
Test Statistic (p=5) (Divisia M2 incl. NBFIs, tb91, GDP)					
		λ_{trace}-	λ_{max}	λ_{trace}-	λ_{max}
H_0: r=o	H_1: r≥1	73.65	64.25	47.86	29.79
H_0: r≤1	H_1: r≥2	9.39	6.6	29.79	15.49
Test Statistic (p=5) (M1, tb91, GDP)					
		λ_{trace}-	λ_{max}	λ_{trace}-	λ_{max}
H_0: r=o	H_1: r≥1	83.59	57.38	47.86	27.58
H_0: r≤1	H_1: r≥2	26.21	17.41	29.79	21.13
Test Statistic (p=5) (Divisia M1, GDP, tb91)					
		λ_{trace}-	λ_{max}	λ_{trace}-	λ_{max}
H_0: r=o	H_1: r≥1	52.08	30.93	47.86	27.58
H_0: r≤o	H_1: r≥2	21.14	12.50	29.79	21.13

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