Money Based Indicators of Price Stability in Jamaica

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Abstract

The main objective of this paper is to compare the performance of the standard 'simple-sum' monetary aggregates (SSMA) with their corresponding Divisia monetary aggregate (DMA) in order to provide money-based leading indicators of inflation in Jamaica. The Bank of Jamaica (BOJ) is exploring transitioning to a formal inflation targeting monetary policy regime; hence the need to explore alternative leading indicators which would complement current indicators. The potential advantage of a DMA is that its weights can vary over time in response to factors such as a shift in the yield curve, which will alter the opportunity cost of holding money. Despite its theoretical superiority, DMAs do not always outperform its SSMA counterpart empirically as is evidenced in this paper. However, the DMA proves to be a useful indicator of impending inflationary pressures and may be explored as a viable monetary policy indicator.

Key words: inflation, divisia monetary aggregates, simple-sum monetary aggregates, band pass filter, correlation, cointegration and granger causality test.

JEL Classifications: C10, C12, E31, E32, E51, E52

[1] The views expressed in this paper are those of the author and in no way represent an official position of the Bank of Jamaica.

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1.0 Introduction

The long-run association between money growth and inflation has long been an area of interest in macroeconomics as it is argued that inflation is ultimately a monetary phenomenon. The quantity theory of money pioneered by European economists in the fifteenth century states that increasing the amount of money in the economy will eventually lead to an equal percentage rise in the prices of products and services. This co-movement between money growth and inflation has been found to exist across different countries and has proven to be of increased significance in providing important and timely warning signals about the risks to price stability in the economy. This theory was further popularized by Friedman (1963) who opined that variations in the money supply largely influenced changes in output and the price level in the short and long run, respectively. He argued that inflation is a monetary phenomenon; hence the growth rate of money supply should be a central intermediate target of monetary policy.

This relationship has gained further prominence in recent time given the European Central Bank's (ECB) two-pillar framework for the assessment of future price developments and risks to price stability. This two-pillar framework encompasses an assessment of future inflation trends based on analysis of the real economy as well as developments in monetary indicators. The ECB's policy framework implies that developments in the price level over the medium to long-term are monetary phenomena. Importantly, money in the hands of the public may prove to be a useful indicator for future price movements and may ultimately provide information for the conduct of monetary policy. In fact, research has consistently presented evidence to suggest that there is a stable relationship between inflation and money growth in the Euro Area and that money growth serves as a useful indicator in predicting future price movements, according to Assenmacher-Wesche & Gerlach (2006).

The leading indicator properties of money are largely based on the historical relationship between money growth and inflation. Papademos & Stark (2012) stated that money plays an important role in economic analysis and its role depends on several factors. In this regard, "the most important and relevant to the objective of price stability is the forward-looking information contained in current monetary developments about future inflation trends." They therefore suggest a decomposition of monetary aggregates (MAs) into components of varying persistence, in order to disentangle different frequency components. This is supported by empirical and theoretical considerations which identify the low-frequency component as the component that best embodies the relationship between medium to long-term price developments. Notwithstanding, all components are known to carry information that can provide valuable insights for policy assessment.

The analysis of the properties of monetary indicators in Jamaica has so far focused on simple-sum aggregates (see for example Whyte (2011)), whereas to date there has been no study on the properties of a DMA in Jamaica. This paper endeavours to fill this gap by computing a Divisia index for the broader MAs in order to evaluate the properties of these indicators. The study therefore highlights the importance of incorporating the use of monetary indicators in assessing future inflation trends in Jamaica and also introduces the use of the DMA as an improvement to policy makers' information set in monetary policy decision-making.

The usefulness of the DMA relative to the standard SSMA, as a leading indicator of inflation is therefore examined. The SSMA has been criticized for attaching the same weight to all components of the MA, despite the difference in the monetary and store-of-value services provided by these components. According to Binner, Fielding, & Mullineux (1999), the weights assigned to DMAs can vary over time in response to shifts in the yield curve and to financial assets. This modifies the opportunity costs of holding monetary assets and therefore provides a better indicator of money demand.

This study utilizes the approach of Neumann & Greiber (2004) in assessing the usefulness of different monetary indicators under an inflation targeting regime. In this paper, the band pass filter is utilized to extract the low frequency component of each MA.[2] This frequency analysis eliminates short-run fluctuations in money growth generated by money demand shocks and allows for the flexibility of choosing the appropriate cycle period, to decompose each MA into a particular frequency component. The cross correlation between each MA and Jamaica's CPI is then examined in order to identify a money-based leading indicator of inflation.

The remainder of this paper is structured as follows. In Section (2) the theoretical and empirical background is examined. Section (3) presents the data and methodology, while Section (4) compares Jamaica's SSMAs and DMAs. Section (5) presents the results and Section (6) concludes. In the Appendix, additional empirical results are presented.

2.0 Theoretical and Empirical Background

The argument for the existence of a relationship between money growth and inflation has been advanced by several authors. This association has gained increased popularity since the ECB assumed responsibility for monetary policy in the Euro Area as well as the onset of the global financial crisis in 2008. The inclusion of money growth in the inflation analysis adds to the information available for policy makers and is seen as a way to predict inflation trends over longer time horizons. Neumann & Greiber (2004) studied the importance of money for inflation in the Euro Area and found that there is a close link between inflation and core money growth.[3] In fact, they posit that in the long-run, there exists a one-to-one relationship, while higher frequency money growth has a nil impact on price movements. They argue that a frequency domain below eight years is insignificant for inflation and identify the short and long-term link between money and inflation in the Euro Area by exploring different frequency ranges of money growth to identify the appropriate domain which best explains the long-run relationship. Neumann & Greiber (2004) note that the use of frequency adjustable filters instead of

[2] The full sample asymmetric filter by Christiano and Fitzgerald was utilized given that asymmetric band pass filters are necessary to extract the desired frequency band towards the end of the dataset, without the addition of forecasts.
[3] Core money growth is defined as the "long-lasting, low frequency component of nominal money growth in excess of real money demand."

cointegration techniques makes clearer the fluctuations in money growth which are relevant for the explanation of inflation.

Gerlach (2004), in his study argues that filtered inflation and adjusted money growth exhibit a stronger correlation than a growth series for money that is unadjusted. Gerlach (2004) concluded that there is a tight relationship between money growth and inflation in the Euro Area and argues that the two-pillar approach taken by the ECB is warranted, given that "the relationship between money growth and inflation arises from the existence of a money demand relationship irrespective of the monetary policy strategy followed by the central bank."

This relationship is supported by Amisano & Fagan (2010), who state that the long-term relationship between money growth and inflation has been typically evident through the use of "smoothed measures based either on moving averages or frequency domain techniques." In their study which utilizes data from the euro area, Germany, the UK, US and Canada, it was found that a smooth measure of broad money growth had important leading indicator properties for risks to price stability. However, as inflation becomes low and stable, the predictive power of this methodology may be compromised, as is evident in the Euro Area, for example. They argue that in a low inflation regime, the correlation between money growth and inflation may be found to have limited value. However, it is not advised that money be disregarded as a leading indicator of inflation by central banks. Jaeger (2003) in his study on the link between inflation and nominal money growth, using frequency domain analysis, further highlights that this relationship is stronger at the lower frequencies but not as evident for frequencies associated with business cycle fluctuations. He argues that a much stronger coherence at the lower, relative to the business cycle frequencies, suggests that the long run link between inflation and nominal money growth is quite strong.

There are several filtering tools that are often utilized in macroeconomic and financial research to separate the behavior of a time series into trend versus cyclical components. Time series data often follow a trend which reflects long-term social and economic development. Therefore, these filtering tools remove fluctuations associated with certain frequencies in the short, medium or long-run. These trends evolve gradually and may be disrupted by deviations that occur as a result of cyclical fluctuations. Christiano & Fitzgerald (2003), highlight that different frequency components serve as important inputs into macroeconomic stabilization policy given that an observed change in a particular variable may reflect a shift in trend or merely a "transitory blip". They note that the use of the band pass filter via spectral analysis allows a linear transformation of data that eliminates unwanted components of the data, leaving only the components of data within a specified band of frequencies that are of interest. According to Christiano & Fitzgerald (2003), the researcher may prefer to use the band pass filter when they are interested in analyzing lower frequency components of daily, weekly, monthly or annual data, for example. They argue that researchers interested in analyzing statistics based on business cycle and higher-frequency components of quarterly data may also elect to employ the Hodrick-Prescott (HP) filter. The band pass filter is designed to extract the cyclical component of a time series within a defined frequency. These filters define the cycles to be extracted, for example business cycles or seasonal fluctuations.

Baxter & King (1999) in their study on the use of approximate band pass filters to measure the business cycle component of macroeconomic activity, argue that a good business cycle filter is characterized by the ability to remove unit roots, the absence of phase shift and the ability to isolate business cycle frequencies without reweighting the past frequencies. In their evaluation of different filtering techniques in achieving these objectives, Baxter & King (1999) found that linear de-trending and first-differencing are not desirable for business-cycle filtering. Despite linear de-trending being a standard method for separating trends from cycles, evidence suggests that this does not remove unit roots from economic time series, which makes it undesirable. Hofmann (2006) hypothesized that the first-difference filter, on the other hand, alters the timing relationship between variables and involves a reweighting of frequencies. Meanwhile, Baxter & King (1999) argue that "moving-average analysis and HP filtering can, in some cases, produce reasonable approximations to an ideal business-cycle filter." However, they recommend the use of their optimal approximate band-pass filter as it is "more flexible and easier to implement" and provides a better approximation to the ideal filter.

Neumann & Greiber (2004) note that the band pass filter as put forward by Baxter & King (1999) and Christiano & Fitzgerald (2003) are designed to extract different frequency ranges from a time series and are mostly used to extract the business cycle component. They however assert that this filtering technique may also be used to extract a long-run trend, beyond the business cycle which normally lies between 1.5 to 8 years.

Hofmann (2006), in his assessment of the predictive power of monetary indicators on Euro Area inflation departs from existing studies by comparing both direct and iterated forecasting models. He argues that growth in M3, during the existence of the European Monetary Union, was a useful indicator of risk to price stability over the medium-term. However, the forecasting performance of M3 has become less useful as an indicator of inflation in recent time. Hofmann argues that a simple combination of all monetary forecasts as well as a M3 series corrected for portfolio shifts provides a more useful indicator for future price movements. In this regard, "a thorough and broad based monetary analysis" is required to adequately extract and analyze the impact of monetary developments and its effect on future price movements.

Broad based monetary analysis therefore highlights the importance of incorporating the DMA into the inflation forecasts. Stracca (2001), in his study of the properties of a synthetic DMA for the Euro Area, opines that "DMAs are firmly grounded in economic theory and should be of interest to monetary policy-makers aiming at price stability." He notes that this indicator may serve to complement its simple-sum counterpart in inflation analysis and argues that these results lend support to the view that liquidity and money should be assigned a prominent role in monetary policy-making.

Stracca (2001) in examining the properties of a synthetic DMA for the Euro Area, indicates that the DMA displays favorable econometric properties and that this indicator would be a useful complement in the analysis of the broad MA, M3, given the co-movement of both aggregates in the long run. He notes that overall results of his study suggest that simple-sum M3 has the largest information content for inflation from a forward-looking perspective, relative to M1 and Divisia money.

Shih (2000) assessed the usefulness of constructing DMAs for Taiwan. The MAs examined include: M1A, M1B and M2.[4] Empirical results indicated that there were no significant differences in terms of the controllability of these MA. However, while simple-sum M2 had a relatively strong relationship with nominal GNP in terms of the stability of velocities and the stability of money demand equations, Divisia M1B was most closely related to inflation. She noted that the results favoured "the use of simple-sum M2 to serve as the intermediate target variable, with Divisia M1B serving as an information indicator to help predict the movements in inflation." It was further noted that there was no indication of Divisia M2 being superior to simple-sum M2.

[4] MlA is composed of the monetary assets listed in categories (1) and (2); MlB is composed of the monetary assets listed in categories (1), (2) and (3); and M2 includes all the monetary assets listed in the eight categories below.

1. Currency in circulation and checking accounts;
2. Passbook deposits;
3. Passbook savings deposits;
4. Time deposits;
5. Postal savings deposits redeposited with the central bank and other monetary institutions;
6. Foreign currency deposits;
7. Negotiable certificates of deposit and Treasury bills; and
8. Bank debentures and savings bonds.

3.0 Data and Methodology

The data utilized in this study are monthly data over the period March 1996 to September 2012. The choice of this relatively short sample period was based on major revision to the basket of goods included in the CPI in 1996. In addition, domestic interest rates have fallen significantly since the early 1990s consistent with a more stable economic environment, following the financial crisis which occurred between 1996 and 1997.

Headline Inflation was computed using the annual point-to-point growth of Jamaica's consumer price index (CPI). In addition, core measures of inflation namely CPI without agriculture and fuel (CPI-AF), CPI without food and fuel (CPI-FF), CPI Trimmed Mean as well as a novel core measure of inflation using the HP filter with $\lambda = 100$ were also utilized in this study.[5] The annual point-to-point growth in M2, M2F, M3 and M3F, was also computed and indexed for consistency. M2 is defined as currency in circulation (cc_t) plus demand deposits (dd_t), savings deposits (sd_t) and time deposits (td_t) (see equation 1). M2F includes M2 plus foreign currency deposits (fd_t) (see equation 2). Meanwhile, M3 is defined as M2 plus other deposits (od_t) (see equation 3), M3F includes M3 plus foreign currency deposits (fd_t) (see equation 4) and M4 is defined as currency in circulation, currency issued by Central Government (ccg_t), deposits in depository corporations (ddc_t), deposits in nonfinancial corporations ($dnfc_t$), securities issued by depository corporations (sdc_t) and securities issued by Central Government (scg_t) (see equation 5).[6]

$$M2_t = cc_t + dd_t + sd_t + td_t \tag{1}$$

$$M2F_t = cc_t + dd_t + sd_t + td_t + fd_t \tag{2}$$

$$M3_t = cc_t + dd_t + sd_t + td_t + od_t \tag{3}$$

$$M3F_t = cc_t + dd_t + sd_t + td_t + fd_t + od_t \tag{4}$$

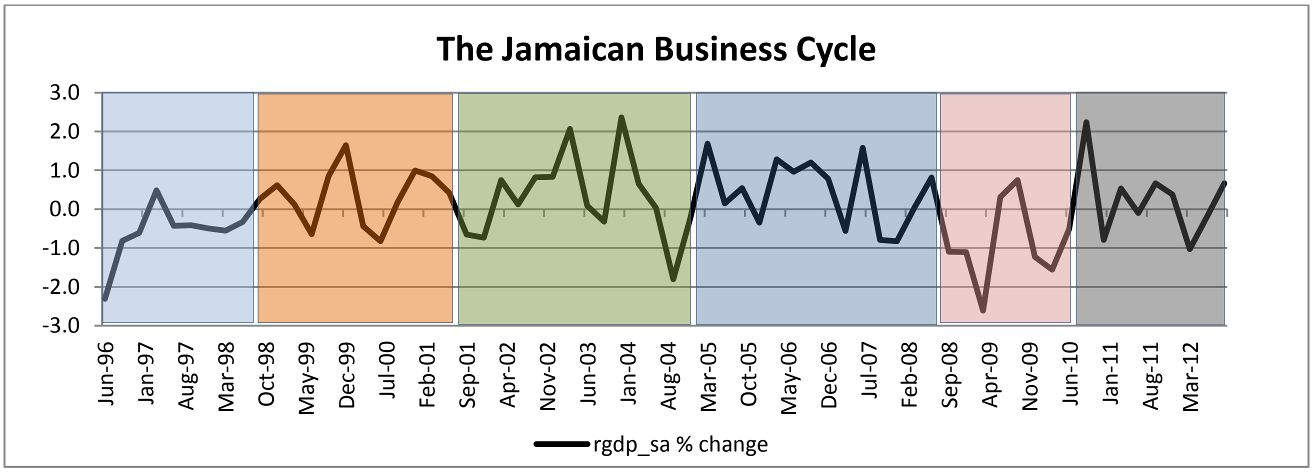
$$M4_t = cc_t + ccg_t + ddc_t + dnfc_t + sdc_t + scg_t \tag{5}$$

[5] The parameter $\lambda = 100$ was chosen as this gave the closest approximation to the CPI without fuel and food (CPI-FF) and CPI without agriculture and fuel (CPI-AF) measures of core inflation tracked by the BOJ.

[6] M4 is a new measure of broad money that is being explored at the BOJ. Despite its inclusion in this study, a more robust measure is required for policy analysis.

The low frequency component of money and inflation were then extracted using the asymmetric band pass filter as described in Christiano & Fitzgerald (2003). This was done to identify the lead and lag in which both variables are highest correlated. Given that the average Jamaican business cycle was found to last up to 33 months, the low frequency component is defined as cycles taking more than 33 months to complete (see Figure 1).[7]

Figure 1: The Jamaican Business Cycle



3.1 The Divisia Monetary Aggregate

According to Alkhareif & Barnett (2012), the Divisia monetary index is a measure of money supply which weights the monetary components (e.g., currency, demand deposits, savings and time deposits) according to their usefulness in transactions. They posit that “the Divisia index accounts for the variability of the share weights among monetary assets within an aggregate, when measuring the monetary service flows of the economy.” The Divisia index captures the prices and quantities of monetary assets, where the price of a monetary asset is referred to as its user cost. Meanwhile, the SSMA does not account for differences in liquidation and interest-yielding properties of all monetary components. Hence, the simple-sum aggregation assumes perfect substitutability of all monetary components.

[7] The Business cycle refers to fluctuations in economic activity and is measured by the (quarterly) growth rate of real gross domestic product (seasonally adjusted). The Business cycle occurs from peak to peak or trough to trough and was found to last for 33 months, on average (Cockerline & Murray, 1981).

In an effort to explore the information content of Jamaica's MAs, a Divisia monetary index was computed for the broader MAs to establish its forecasting ability relative to the current SSMA. It should be noted that the MAs used by most central banks are SSMAs, in which all monetary components are assigned the same weight as follows:

$$M_t = \sum_{j=1}^{n} x_{jt} \tag{6}$$

Where x_{jt} is one of the *n* monetary components of the monetary aggregate M_t.

In the SSMA all monetary components contribute equally to the money total which implies that all components are dollar for dollar perfect substitutes. It has been argued that such an index does not weigh these components in a way that properly summarizes the services of the quantities of money. Over the years, many attempts have been made to properly weight monetary components within a SSMA. Against this background, the Divisia index approach to monetary aggregation was derived and advocated by Barnett (1980). This Divisia index (approximated in discrete time) is defined as follows:

$$logM_t^D - logM_{t-1}^D = \sum_{j=1}^{n} s_{jt}^* \left(logx_{jt} - logx_{j,t-1}\right) \tag{7}$$

according to which the growth rate of the aggregate is the weighted average of the growth rates of the component quantities. The discrete time DMA weights are defined as the expenditure shares averaged over the two periods of the change

$$s_{jt}^* = \frac{1}{2}\left(s_{jt} + s_{j,t-1}\right) \tag{8}$$

for $j = 1, \ldots, n$. Where

$$s_{jt} = \frac{\psi_{jt} x_{jt}}{\sum_{k=1}^{n} \psi_{kt} x_{kt}} \tag{9}$$

is the expenditure share of asset j during period t, and ψ_{jt} is the real user cost of asset j, derived by Barnett (1978),

$$\psi_{jt} = \frac{R_t - r_{jt}}{1 + R_t} \qquad (10)$$

is the opportunity cost of holding a dollar's worth of the j^{th} asset. In the last equation, r_{jt} is the market yield on the j^{th} asset, and R_t is the yield available on a benchmark asset that is held for the purpose of transferring wealth between different time periods. The benchmark asset is assumed to provide no liquidity or monetary service as it is held only for accumulating or transferring wealth across time. The interest rate is also the highest in the economy. In this study, the Government of Jamaica (GOJ) 180-day Treasury Bill yield is used as a proxy for the benchmark asset given the unavailability of adequate data on longer tenor GOJ bonds.

For the DMAs, the prices of the components as defined by their respective interest rates must be obtained in order to compute their expenditure shares. In contrast, the only data required to compute the share of each component in the SSMAs are the quantities of the components themselves.

4.0 Comparison of the behavior of Jamaica's SSMAs and DMAs

It is argued that the direction and magnitude of growth in the MAs should be able to provide useful information on the current monetary policy stance and predict future economic conditions. In this regard, it is important to compare the behavior of each aggregate and its corresponding DMA index in order to establish the usefulness of alternative procedures used to construct MAs.

Indices of the monthly SSMAs and DMAs of M2, M2F, M3 and M3F were calculated and rebased to equal 100 in March 1996. Figure 2 shows the 12-month growth rates of these aggregates from April 1996 to September 2012.[8] A preliminary look at the new indicators, the

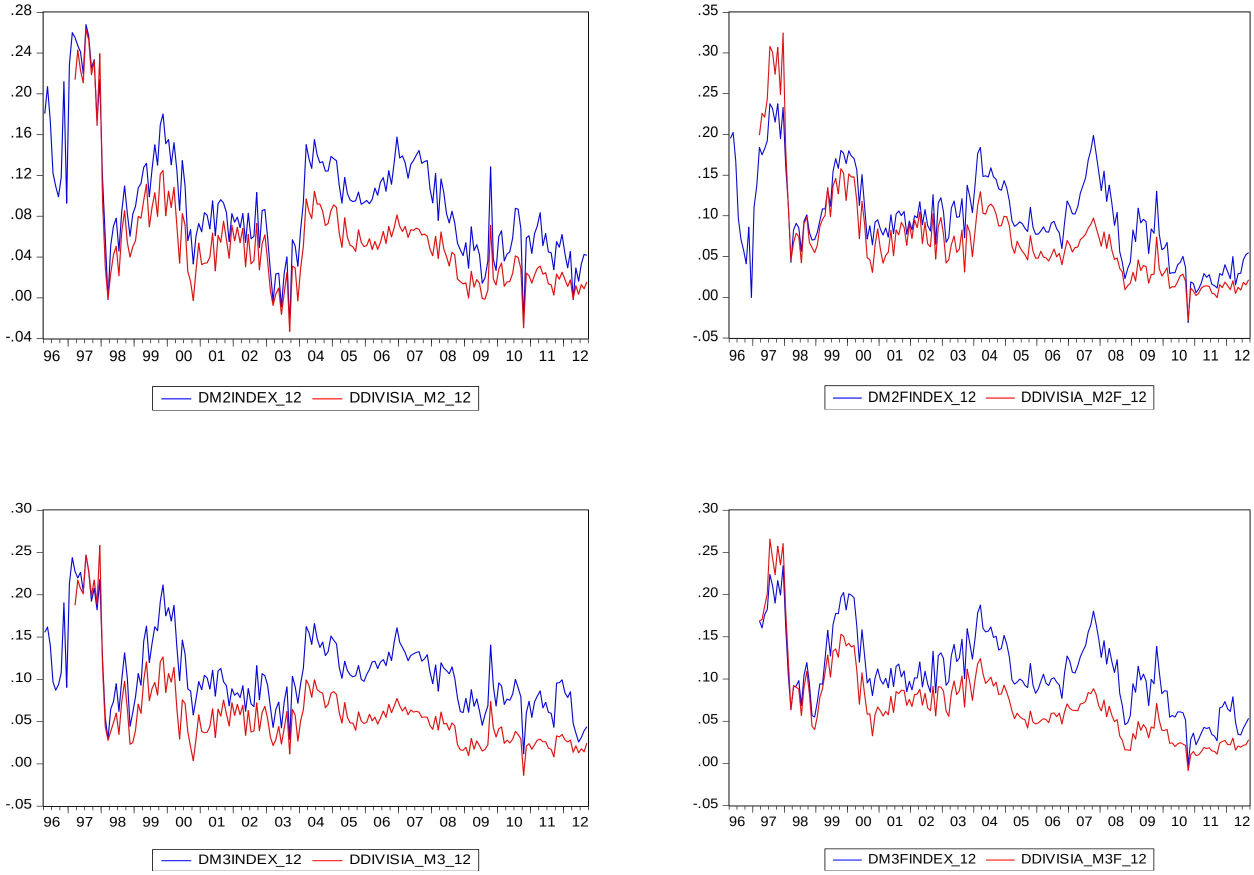
[8] The 12-month growth rate of the DMAs begins at January 1997.

DMAs, and Jamaica's SSMAs show that up to approximately 2004 there seems to be a much closer correlation between the DMA index and its corresponding MA. While the trend in both the SSMA and DMA have been similar since 2004, growth in the SSMAs has been more significant relative to its corresponding DMA index. From 2004 to 2008, for example, a significant decline in the benchmark rate resulted in a fall in the user cost of each MA. This, therefore, resulted in a reduction in the weight of each component in calculating its corresponding DMA index. In this regard, there was slower growth in the DMA indices since 2004. The increase in the SSMAs may have reflected a consistent increase in demand, savings and time deposits since 2004.

It is important to note that since DMAs are consistently lower than the SSMAs for all aggregates, focusing on SSMAs could therefore overestimate the future impact of money growth on inflation. This overestimation may lead to a stronger than required policy action to reduce the transmission of changes in MAs to prices.

It should be highlighted that the approach followed here is by no means exhaustive in its assessment of the information content of DMAs and SSMAs. It is, however, expected that this methodology should give some indication as to whether the DMA constructed in this paper adds value from a forward-looking perspective.

Figure 2: Comparison of annual pt-to-pt change in SSMA and DMA*



**Differenced*

5.0 Empirical Results

The construction and evaluation of a DMA and a new MA, M4, was included to complement the analysis of the current SSMAs and their effect on future price movements. The time series characteristics of the data are important for this empirical analysis. In particular unit root tests were conducted for all variables used in the estimation. The Augmented Dickey-Fuller (ADF) test was conducted to identify the order of integration for each variable. The optimal lag length was determined using the Schwartz criterion. The results, which are shown in the appendix, Table 2, suggest that inflation and money growth are non-stationary.[9]

The forward-looking information contained in current monetary developments and their ability to forecast future inflation trends was extracted by focussing on the low-frequency component of money and inflation. The low-frequency component was derived as a residual at the end of the average business cycle-frequency component using the band pass filter described above. Several interesting results emerged from this analysis.

Consistent with a priori expectation, there is a positive correlation between money growth and inflation. Subsequent to extracting the low frequency component, it was found that the contemporaneous growth rate of inflation is positively and significantly correlated to the lagged changes in the SSMAs and DMAs of M2, M2F, M3 and M3F. However, the analysis of the cross correlogram shows that despite these three monetary aggregates performing similarly, lagged values of M2F, its DMA counterpart and M3F (see Table 1 and Figures 3 & 4) were found to be the strongest predictors of current inflation.[10] The results of the correlation between headline inflation and M2F show that current movements in inflation may be best explained by changes in M2F nine periods prior. In addition, results showed that headline inflation further influenced the MA M2F up to six months. However this relationship is most significant in the first month. Despite the notable cross correlation between headline inflation and M3F, for the purpose of this study emphasis will be placed on the M2F and its divisia counterpart in order to assess their forecasting ability.

[9] For the purpose of this study, a 1% confidence level was used as these results were more precise and consistent with a priori expectation. At the 1% confidence level, all variables (with the exception of Divisia M3F) were non-stationary. Meanwhile, at the 5% confidence level, M3 and Divisia M2F were stationary.

[10] There was also a positive and significant relationship between M4 and headline inflation. However, a more robust and consistent measure of M4 is required for policy analysis.

Table 1: Correlation between inflation, SSMA and DMA

Headline Inflation	Lead		Lag	
M2	30	0.38	4	0.41
DM2	32	0.29	24	-0.33
M2F	**1**	**0.50**	**9**	**0.86**
DM2F	**1**	**0.55**	**5**	**0.63**
M3	31	0.39	3	0.38
DM3	1	0.48	4	0.51
M3F	**1**	**0.56**	**8**	**0.79**
DM3F	**1**	**0.48**	**9**	**0.66**
M4	2	0.33	36	0.71

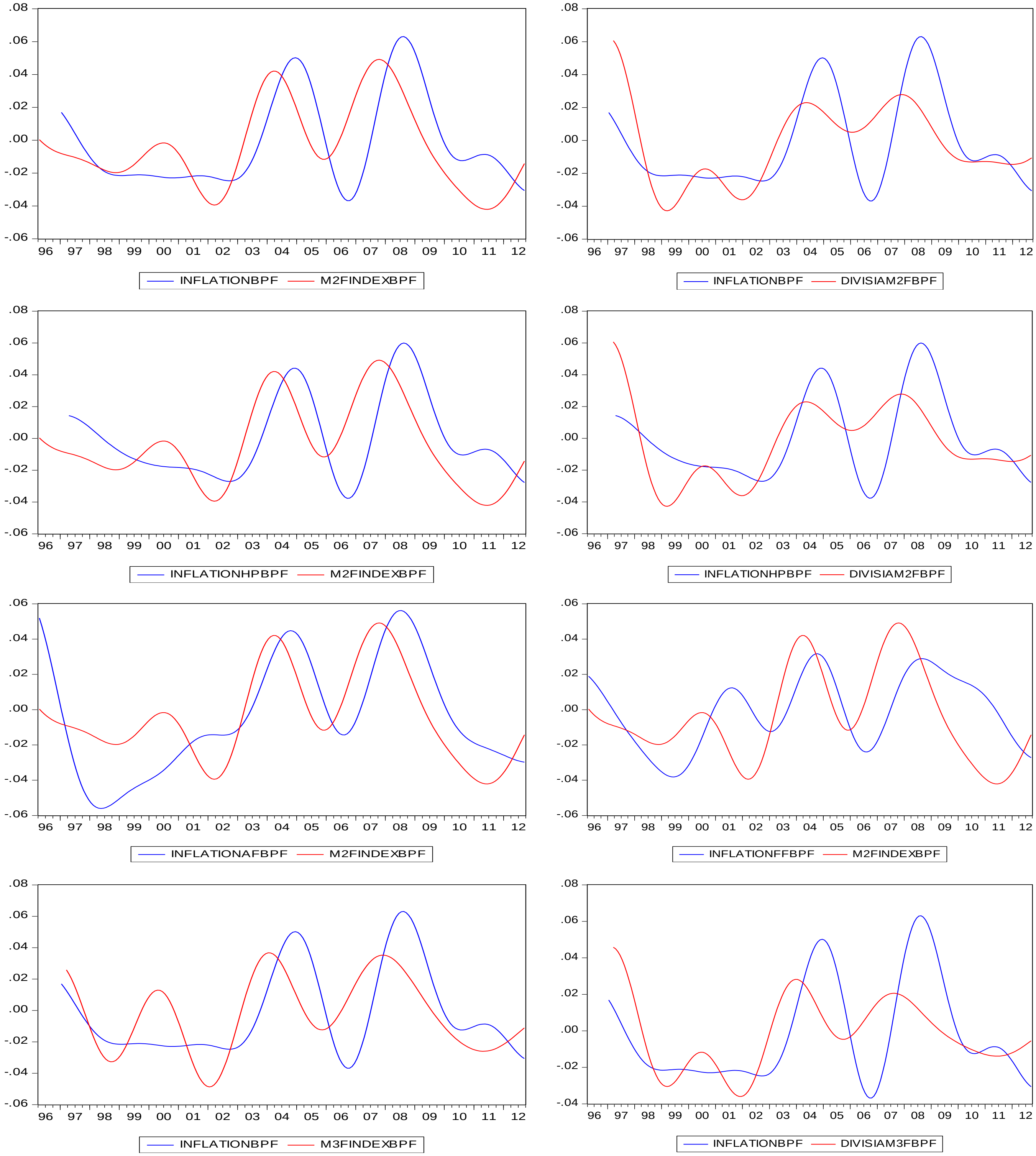
HP-filtered CPI	Lead		Lag	
M2	1	0.32	6	0.42
DM2	31	0.26	25	-0.26
M2F	**1**	**0.45**	**9**	**0.84**
DM2F	**1**	**0.50**	**7**	**0.68**
M3	29	0.34	6	0.40
DM3	1	0.39	8	0.51
M3F	**1**	**0.45**	**9**	**0.80**
DM3F	**1**	**0.40**	**10**	**0.73**
M4	2	0.24	36	0.75

CPIAF	Lead		Lag	
M2	2	0.41	1	0.39
DM2	4	0.60	1	0.57
M2F	**1**	**0.61**	**7**	**0.77**
DM2F	1	0.45	4	0.47
M3	36	0.44	1	0.31
DM3	5	0.59	1	0.55
M3F	**1**	**0.58**	**6**	**0.68**
DM3F	1	0.47	5	0.48
M4	5	0.43	36	0.48

CPIFF	Lead		Lag	
M2	36	0.50	1	0.21
DM2	34	0.45	1	0.38
M2F	**15**	**-0.32**	**9**	**0.68**
DM2F	34	0.43	7	0.36
M3	36	0.56	28	-0.30
DM3	32	0.44	1	0.38
M3F	**36**	**0.36**	**10**	**0.69**
DM3F	31	0.38	8	0.42
M4	3	0.66	1	0.60

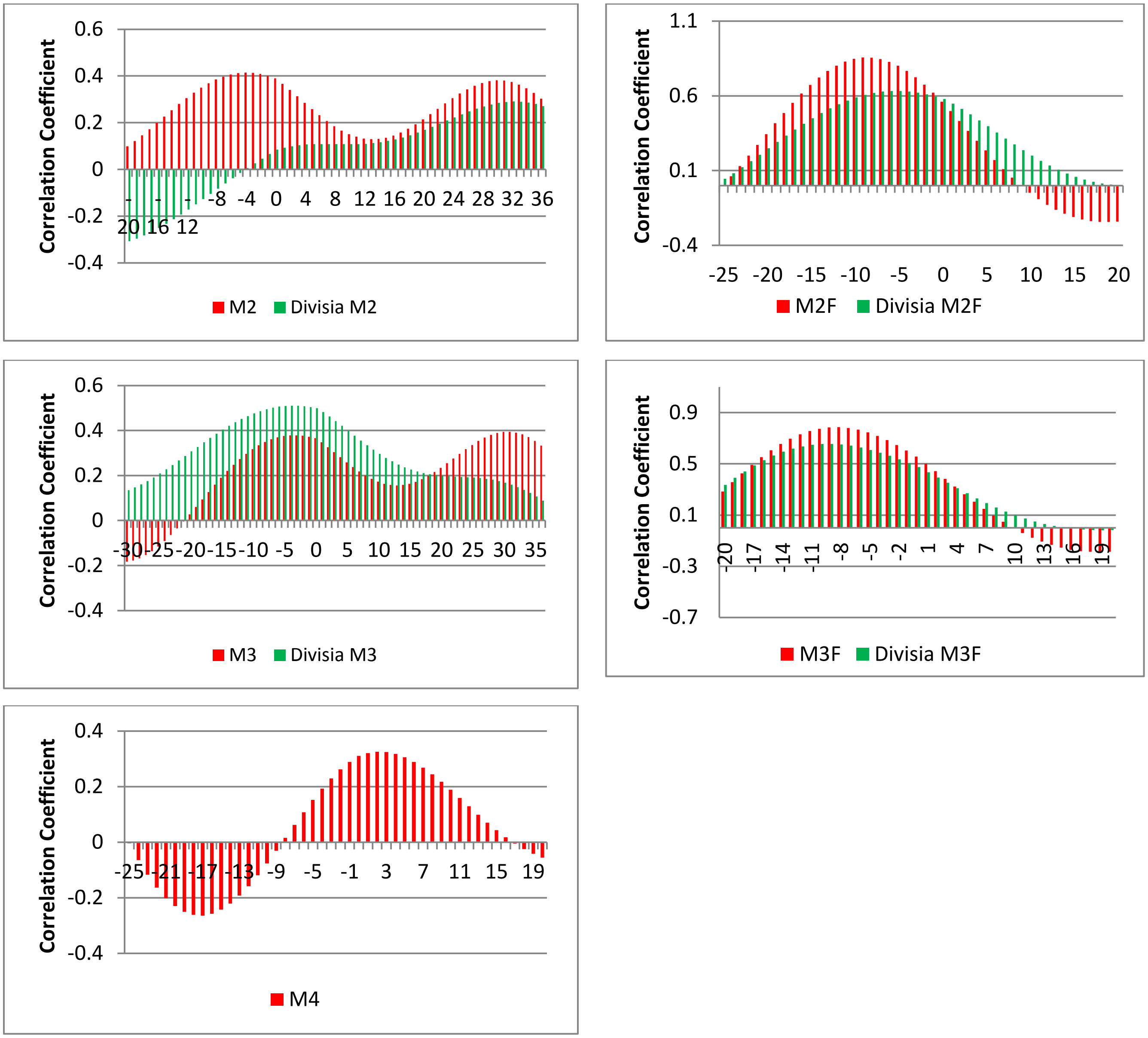
Trim	Lead		Lag	
M2	35	0.41	1	0.33
DM2	6	0.58	1	0.52
M2F	**1**	**0.57**	**6**	**0.72**
DM2F	1	0.37	3	0.36
M3	36	0.46	32	-0.28
DM3	10	0.57	1	0.47
M3F	1	0.53	6	0.59
DM3F	8	0.41	1	0.37
M4	4	0.46	1	0.41

Figure 3: Money growth and inflation, annual point to point, periodicity > 2.75 years



Note: The HP-filtered CPI is depicted here as "inflationhp".

Figure 4: Correlation between money growth and headline inflation



In the exercise to identify the relationship between headline inflation and money growth (M2F and Divisia M2F) in Jamaica for the period of study, granger causality tests were also conducted. A number of lagged terms were utilized and the results of the F-test are displayed in Table 3 and 4 below. In each case, the null hypothesis is that headline inflation does not (Granger) cause money growth and vice versa. The results of the tests revealed that there is no causal relationship between headline inflation and M2F nor headline inflation and DM2F in the short run. In this context, co-integration tests were conducted, in a Johansen framework, to explore the existence of a long-run relationship between inflation and M2F as well as its corresponding DMA. The existence of a co-integrating relationship specifies that if two time series are non-stationary and show a stochastic trend individually, their residuals should be $I(0)$. A co-integrating relationship was found between Divisia M2F and inflation which suggests that there is a long-run relationship between this MA and inflation (see Appendix, Tables 5 and 6).

Table 3: *Granger Causality Test of CPI and M2F*

Direction of causality	Number of lags	F value	Decision
CPI → M2F	2	1.85	Do not reject
M2F → CPI	2	2.46	Do not reject
CPI → M2F	6	1.10	Do not reject
M2F → CPI	6	2.01	Do not reject
CPI → M2F	8	0.98	Do not reject
M2F → CPI	8	1.53	Do not reject
CPI → M2F	10	1.08	Do not reject
M2F → CPI	10	1.51	Do not reject

Table 4: *Granger Causality Test of CPI and Divisia M2F*

Direction of causality	Number of lags	F value	Decision
CPI → DM2F	2	1.85	Do not reject
DM2F → CPI	2	2.46	Do not reject
CPI → DM2F	6	1.10	Do not reject
DM2F → CPI	6	2.01	Do not reject
CPI → DM2F	8	0.98	Do not reject
DM2F → CPI	8	1.53	Do not reject
CPI → DM2F	10	1.08	Do not reject
DM2F → CPI	10	1.51	Do not reject

The aforementioned results therefore suggest that the simple-sum M2F and its corresponding DMA are useful leading indicators of inflation in the long run. The average lead time for indicators of inflation constructed using a DMA is significantly longer than that provided by the SSMA. This implies that DMA could be used as an early signal of impending inflation. However, since the SSMA M2F was found to have the strongest correlation with inflation, this variable appears to be the best early signal of impending inflation among the monetary aggregates explored. These findings are supported by Binner, Fielding, & Mullineux (1999) who highlight that despite its theoretical superiority, the DMA does not always outperform its SSMA counterpart.

6.0 Conclusion

This paper compares the performance of the standard SSMAs with their corresponding DMAs, in order to provide leading indicators of inflation in Jamaica. The main findings are that simple-sum M2F and its corresponding Divisia counterpart are useful for understanding the low-frequency variation of inflation in Jamaica. These variables therefore add to the information content for monetary policy formulation and could complement current indicators. The construction of a DMA allows for the weighting of constituent components to produce an index which accounts for the monetary and store-of-value services provided by these components. Consistent with previous studies, empirical analysis found strong basis for preferring simple-sum M2F to Divisia M2F as an intermediate target variable. Despite its inability to outperform its SSMA counterpart however, the DMA proves to be a useful indicator of impending inflation.

The MAs utilized in this paper were filtered using the asymmetric band pass filter to extract the low-frequency component. This decomposition has been established as the best frequency for identifying the long-run relationship between money and inflation. While this methodology allowed for the identification of the component of inflation associated with monetary movements of a long-run persistence, the correlation between money growth and inflation established the forecasting ability embedded in the MAs in relation to inflation.

In concluding, it is important to emphasize the fact that fluctuations in money growth may prove to be important indicators in forecasting future inflation trends. In this context, a formal two-pillar approach, which incorporates both monetary and economic analysis in forecasting future price developments, may be adopted for Jamaica. The adoption of broad-based monetary analysis which incorporates the use of DMAs as a leading indicator of inflation will serve to complement the SSMAs that are currently being assessed. This monetary policy framework may serve as a means of cross-checking current methodology and can be used as an important approach to policy analysis under an inflation targeting monetary policy regime.

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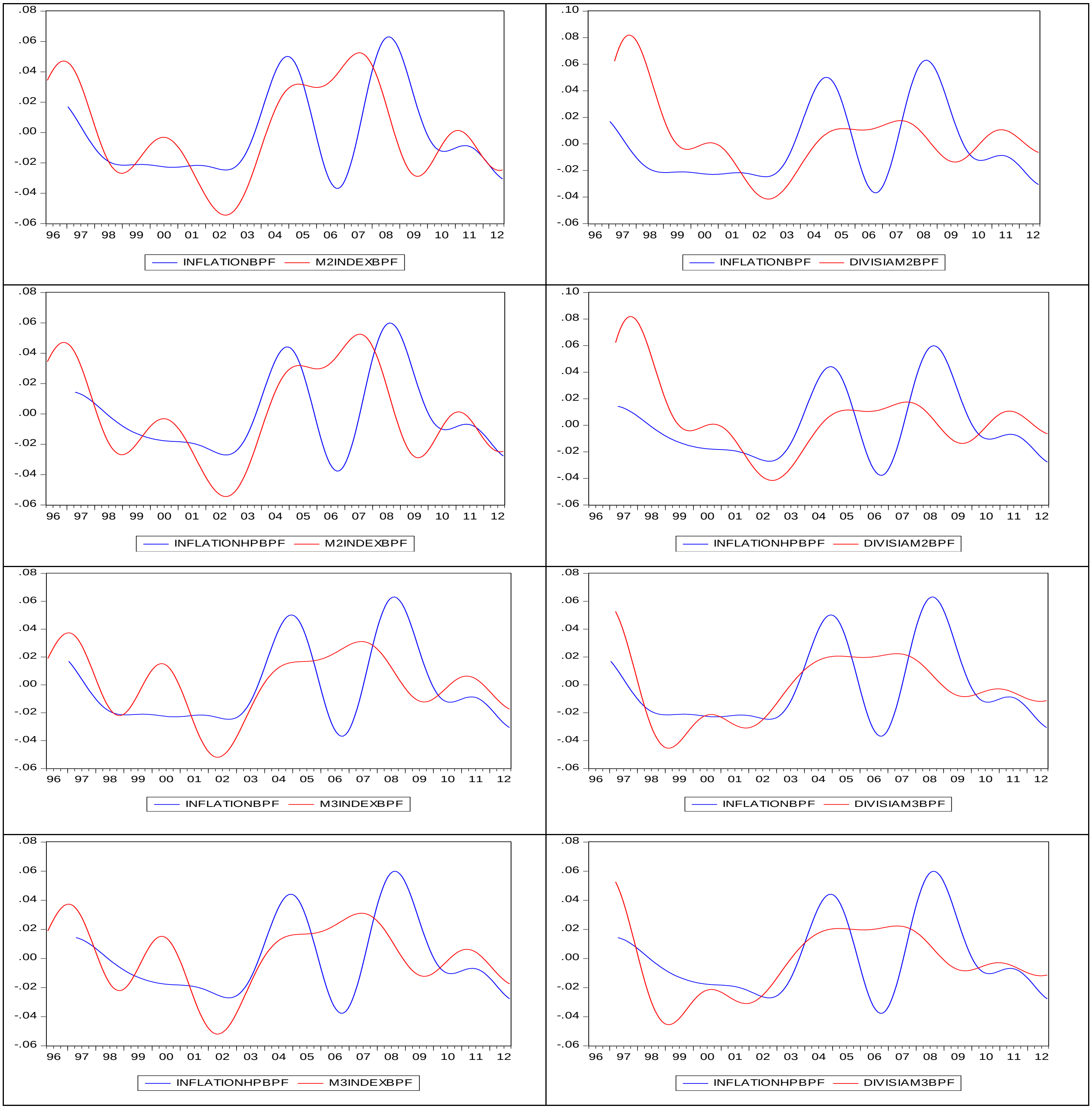
Appendix

Table 2: *Unit Root Analysis*

Variables	ADF t-statistic	P-value
lcpi	-1.876523	0.6629
Δlcpi	-8.331631	0.0000
lcpiaf	-2.111153	0.5360
Δlcpiaf	-5.485755	0.0000
lcpiff	-2.387385	0.3850
Δlcpiff	-10.94495	0.0000
ltrim	1.12377	0.9976
Δltrim	-6.92059	0.0000
lcpi_hp	0.431690	0.9838
Δlcpi_hp	-3.787058	0.0036
lm2index	-2.959189	0.0407
Δlm2index	-11.69537	0.0000
ldivisiam2	-2.972122	0.1428
Δldivisiam2	-10.37983	0.0000
lm2findex	-2.214796	0.2018
Δlm2findex	-18.20154	0.0000
ldivisiam2f	-3.101734	0.0280
Δldivisiam2f	-11.00780	0.0000
lm3index	-2.920782	0.0448
Δlm3index	-11.27910	0.0000
ldivisiam3	-2.775208	0.2083
Δldivisiam3	-10.39265	0.0000
lm3findex	-2.422768	0.1368
Δlm3findex	-17.11358	0.0000
ldivisiam3f	-3.531853	0.0081
lm4index	-3.051369	0.0320
Δlm4index	-14.72996	0.0000

Note: The 1% critical value for the tests including a constant and tend is -3.46. The 1% critical value for the tests including a constant only is -4.01. Δ is the first difference operator and L represents the natural logarithm.

Figure 5: Money growth and inflation, annual point to point, periodicity > 2.75 years



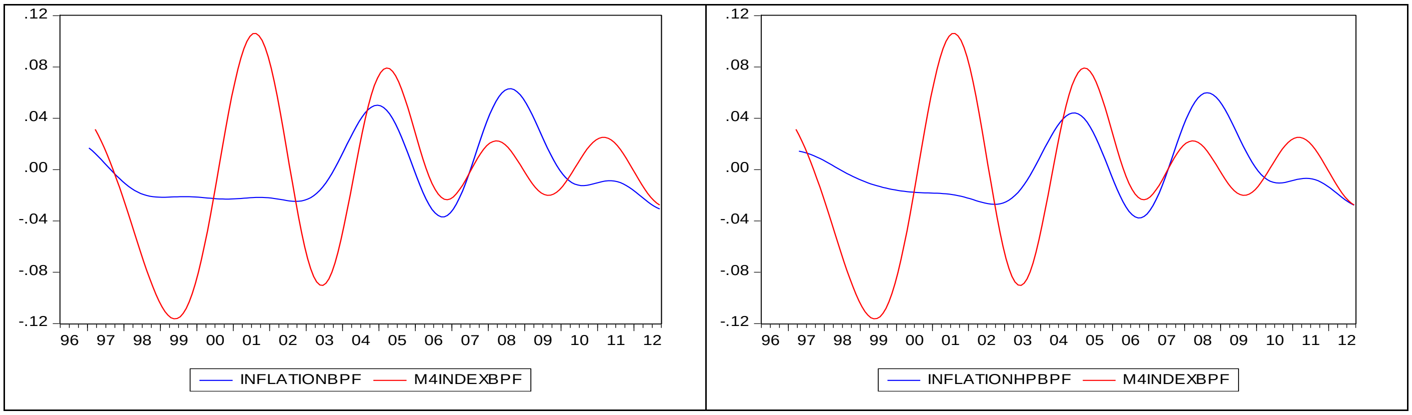


Table 5: *Cointegration Test of CPI and Divisia M2F*

Trend assumption: Linear deterministic trend
Series: LCPI LDIVISIA_M2F
Lags interval (in first differences): 1 to 5

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.129745	27.67415	15.49471	0.0005
At most 1	0.004411	0.853118	3.841466	0.3557

Trace 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

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.129745	26.82103	14.26460	0.0003
At most 1	0.004411	0.853118	3.841466	0.3557

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

Table 6: *Cointegration Test of CPI and M2F*

Trend assumption: Linear deterministic trend
Series: LCPI LM2FINDEX
Lags interval (in first differences): 1 to 5

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.042040	12.84326	15.49471	0.1207
At most 1 *	0.022654	4.468253	3.841466	0.0345

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.042040	8.375010	14.26460	0.3419
At most 1 *	0.022654	4.468253	3.841466	0.0345

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values