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Modeling the Inflation Rate in Jamaica: The Role of Monetary Indicators.

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Abstract

Controlling inflation has been a high priority of many countries, especially those with small open economies since the early 1970s when oil prices soared to record high levels. In this paper, the bases for the role of monetary aggregates in forecasting the inflation rate are reviewed. It is argued that money can act as a useful information variable in a world in which a number of indicators are imperfectly observed. Therefore, the paper discusses the role of excess money a reference value or benchmark for money in episodes of heightened financial uncertainty. Excess money is measured as the difference between the actual money stock and its fundamental value, the latter determined by a money demand function. The out-of sample forecasting performance is compared to a widely used alternative of monetary aggregate, the growth in the money supply. The results indicate that monetary indicators are useful to predict inflation, especially if the forecasting equations are based on the growth in money supply (M3).

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[1] The views expressed are those of the author and does not necessarily reflect those of the Bank of Jamaica.

1.0 Introduction

Maintaining price stability while ensuring an adequate expansion of credit to assist economic growth have been the primary goals of monetary policy in Jamaica. The concern about inflation emanates not only from the need to maintain overall macroeconomic stability, but also from the fact that inflation hits the poor particularly hard as they do not possess effective inflation hedges.

The extent to which monetary aggregates should influence monetary policy discussions has come under scrutiny in recent years. Many commentators put forward that monetary aggregates do not carry any additional information and therefore, from a monetary policy perspective, there is little need to care about it. On the other hand, others have posited that money serves as a useful crosscheck for monetary policy analysis and remains an important determinant of long-term inflation.

The role monetary aggregates should play, if any, in the conduct of monetary policy remains a controversial issue. Indeed, numerous research on the relationship between money growth and inflation in in the economy, in the form of estimated money-demand relationships or models for forecasting inflation; typically have not found much evidence of stability over time. By contrast, in the United States, where shifts to velocity have been large and unpredictable, money plays no role in the framework of monetary policy.

Similarly, in the case of the Jamaican economy there does not seem to be a direct link between the money supply or liquidity and the inflation rate. However, as the Bank of Jamaica (BOJ) is considering switching to an inflation targeting framework it is important to determine the impact of excess money on the predictive power of inflation forecasting.

This paper adds to the literature by assessing the forecasting power of the inflation rate in Jamaica, by first specifying and then estimating money demand functions for Jamaica. Following the estimation of the money demand function, the stability is formally analyzed. This is because stability is often quoted as a precondition for good forecasting power. Finally, using money overhang the extent of the information content contained in this monetary indicator is assessed with respect to its predictive power for future inflation rates.

The subsequent sections of this study are organized as follows: section 2 presents a brief review of the literature; section 3 presents the empirical and data specification, section 4 discusses the econometric technique; the penultimate section presents the discussion and findings and the final section presents the conclusion.

2.0 Literature Review

Given the BOJ's recent plans to adopt an inflation targeting framework in the near future, the consistent attainment of the target is important. This is so as it helps to anchor the public's expectations about future price movements including wages, thereby improving the ability to plan in the economy. Thus, it is important to determine the relevance of monetary aggregates in forecasting inflation, in order to determine the most parsimonious model that would then aid in the policy objective of inflation targeting.

There are a large number of papers that have estimated aggregate money demand functions and tested their stability, most of which are done for the Euro area. Most of these studies exclusively use synthetic data for the pre-European Monetary Union period, but the more recent papers add data. Gerlach and Svensson (2003) found that both the output gap and the real money gap, i.e. the difference between the actual real broad money stock and its equilibrium value derived from a long run money demand relation contains useful information with respect to one- and two-year ahead harmonized index of consumer prices (HICP) inflation rates for the Euro area[2]. However, the nominal M3 annual growth rate provides almost no information regarding the future inflation process.

Belke and Polleit (2006) investigated the relationship between inflation and excess liquidity in the Swedish economy. With the use of single equation and structural VECM estimation techniques, a significant relationship is uncovered and excess money is said to play a key role in future price movements.

Hoffman (2006) assessed the performance of monetary indicators in predicting euro area HICP inflation, out-of-sample, over the period since the start of the EMU. Using a wide range of

[2] The equilibrium money demand equation was estimated using M3 as a measure of broad money.

forecasting models, including standard bivariate forecasting models, factor models, simple combination forecasts as well as tri-variate two-pillar Phillips Curve type forecasting models the author found that monetary indicators are still useful indicators for inflation in the euro area, but that a thorough and broad based monetary analysis is needed to extract the information content of monetary developments for future inflation.

Carstensen et al (2009) in analyzing the money demand functions of the four largest EMU countries and the four-country EMU aggregate; reported evidence that an aggregated monetary overhang can predict country-specific inflation in large euro area countries. Specifically, the study found that the EMU-4 overhang measure strongly correlates with the country specific measures, particularly since the start of the EMU, and is useful to predict country-specific inflation. However, it does not encompass measures of country-specific money overhang as predictors of inflation.

Dreger and Wolters (2010) examined the forecasting performance of a broad monetary aggregate in predicting euro area inflation.[3] Using excess liquidity as measured by the difference between the actual money stock and its fundamental value, the latter determined by money demand function. The study indicated that the evolution of M3 is still in line with money demand even in the period of the financial and economic crisis. Monetary indicators are useful to predict inflation at the longer horizons, especially if the forecasting equations are based on measures of excess liquidity.

Research outside of the Euro area include: Wesche et.al (2007) who investigated the monetary factors and inflation in Japan, using band spectrum regression to assess the determinants of inflation. They found that inflation is related to money growth and real output growth at low frequencies and the output gap at higher frequencies. They further noted that the relationship reflects Granger causality from money growth and the output gap to inflation in the relevant frequency bands.

[3] M3 was used as the measure of broad money.

Careful examination of the literature reveals that in developing countries, the following variables are mostly responsible for the inflationary process: import prices; wage rates; interest rates; exchange rates; excess money supply; unemployment rate and productivity. Import prices seem most significant of these variables. Studies from the more developed countries emphasize output gap and excess liquidity measures, which indicate that demand pressures significantly influence inflation rates.

3.0 Theories of Inflation

There are two fundamentally tenets on which the theories of inflation are built, these include, the aggregate demand (demand pull) and cost-push theories. There are however some controversies surrounding these two theories (see Ball and Doyle, 1969, for a detailed discussion). However, they lay the foundation for debates on inflation.

The demand-pull theory states that inflation results from a rise in aggregate demand. As such, the theory regards price changes as a market clearing mechanism and inflation is seen as a result of excess demand in commodity and factor markets. Consequently, factors that influence demand-pull inflation include increases in money supply, government spending and the price level in the rest of the world.

Conversely, under the cost-push theory, inflation is seen as the result of factor prices accelerating more rapidly than factor productivities. Essentially, cost-push inflation occurs as a result of decreases in aggregate supply. This may be due to an appreciation in wages or the price of raw materials. Such increases lead to higher production costs, hence the term ‘cost-push’ inflation. Higher production costs may bring about a reduction in the employment rate and a drop in output.

Through the avenues of demand pull and cost push theories, followers of the Keynesian and Monetarist schools of thought have formulated different approaches to understand the inflationary process. According to the Keynesians (Keynes 1936), inflation is a result of income disturbances and shocks to the economy, like oil price increases, while the Monetarists (see

Freidman 1963) believe that inflation occurs because of excess demand and inappropriate monetary responses to economic situations.

The Keynesian Model may be represented as $\pi = f\left(l, w, u, o, p^{e}\right)$, where π ,l, w, u, o, p^{e} represent inflation rate, excess demand for labour, wage rate, unemployment rate, output and price expectations, respectively.

The Monetarist Model may be structured as $\pi = f\left(y, m_{s}, i\right)$, where y represents changes in real income, m_s means money supply and it refers to the cost of holding cash (interest rate). Classical theorists have also constructed models in an effort to better understand the causes of sustained price increases in an economy. Their approach is quite similar to that of the monetarists where inflation is a product of 'too much money chasing too few goods'. In this state, the increased money supply leads to a jump in the demand for goods and services, thereby causing inflation.

In an effort to combat criticisms from the Monetarists, the Keynesians put forward a modified theory of inflation, based upon imperfect competition. In this theory, the Keynesian theorists state that to an individual worker in wage negotiations, the price level is exogenous. However, to all the workers in the negotiation, the price level is endogenous. As a result, inflation occurs because workers want higher wages and firms want higher profits. Therefore, if workers are granted a wage increase, firms will increase prices (by a mark-up) and this leads to inflation. That is, inflation is influenced by wage increases and firms' mark-up prices.

Similar to the Keynesians, the Monetarists found an angle to combat criticism from the Keynesians by proposing a theory in which firms are unsure of the reason for a price increase. That is, they may be unsure if there are inflationary pressures at work or if consumer demand has actually risen. After finding out the reason for the price jump, firms will adjust their prices accordingly, based on rational expectations. Therefore, price expectations influence the inflation rate.

In addition to the theories described above, there is the supply side theory, which is also vaguely related to Monetarism and proposes that the supply of goods and services (instead of money supply) may be contributory to the inflationary process. That is, if there is ‘too much money chasing too few goods’ then two solutions are possible; either decrease the money supply or increase the supply of goods and services. The variables for the determination of inflation in this model include the output gap (representing the deviation of actual output from desired output) and excess money (which is the difference between actual and desired money).

Another approach to understanding the inflationary process is formulated under the Structuralist model of imported inflation (Frisch, 1977). This model shows that a country’s dependence on external markets may bring about inflation, since heavy reliance on external variables is expected to motivate upward pressure on domestic prices. Another model from the structuralist school of thought, the Scandinavian model (Frish, 1977), which seems mostly relevant to small open economies hypothesises that inflation is influenced by world prices, wages and productivity. Frisch (1977) also mentions an augmented Scandinavian model (developed by Branson and Myhrman, 1976), in which unemployment rate and expected inflation in the tradable sector are added to the determinants of inflation in the Scandinavian model.

Further development sights structural factors such as weather conditions, policies aimed at protecting certain industries or just trading policies, may also influence the rate of inflation. If there’s a hurricane, which damages food supply and infrastructure, then, prices of goods and services will definitely shoot up. Also, in protecting certain industries, cheaper goods and services may not be allowed into the country, which results in higher prices for certain goods and services. This shows that inflation may be a consequence of weather conditions and trading or protection policies.

Dlamini et al. (2001) surveyed more recent studies, in which the authors conclude that the newer theories on inflation focus on policy credibility, political stability and cycles and the reputation of the government. However, the authors point out that these theories are based on variables that are not quantifiable and are therefore excluded from most empirical studies. Also, Selialia (1995) (cited in Dlamini et al. (2001)) indicates that the political economy approach to macroeconomic policy places emphasis mostly on industrial countries. Therefore, this approach may not be appropriate for application to developing countries.

4.0 Data and Model Specification

4.1 Money Demand Specification

The stability of the relationship between the money stock and the price level is typically evaluated in the context of a money demand equation, which relates money to prices and other key macroeconomic variables (such as real income and interest rates). Therefore, following the literature, we assumed that real money demand depends on real GDP as the transaction variable and the opportunity cost of holding money, proxied by the real interest rate, as well as household wealth. Thus, a widely used specification of money demand is chosen as the starting point of the analysis. This specification of money demand leads to a long run relationship of the form:

$$(m-p)_t = \delta_0 + \delta_1 y_t + \delta_2 w_t + \delta_3 r_t \quad (1)$$

where m denotes nominal money balances taken in logs, p is the log of the price level, y is log of real income, representing the transaction volume in the economy, and w is log of real financial wealth. Opportunity cost of holding money is proxied by real interest rate, while real financial wealth is proxied by real commercial bank assets. The index t denotes time. To check for the potential stability problem, a number of stability tests are reported. Moreover, money demand instability will bias the forecasting results against the money overhangs.

The income variable exerts a positive effect on nominal and real money balances. Often, its impact is restricted to unity on theoretical grounds.[4] Money holdings are also related to portfolio allocation decision. For example, a surge in asset prices may trigger a rise in demand for liquidity due to an increase in net household wealth. Therefore, there should be a positive relationship between money demand and wealth, the substitution effect works in the opposite direction, as higher asset prices make assets more attractive relative to money holdings. If the opportunity costs of money holdings refer to earnings on alternative financial assets, possibly relative to the own yield of money balances, their coefficients should enter with a negative sign.

[4] See Dreger and Wolters (2009) for a discussion

The parameters δ_1 and δ_2 denote the elasticities of money demand with respect to income and wealth. The impact of the return of other financial assets is captured by the elasticity δ_3. Due to the ambiguity in the interpretation of the wealth variable, the signs of their impact cannot be specified *a priori* on theoretical grounds.

4.2 Inflation Specification

A review of the literature on inflation forecasting points to the employment of several different models to capture the determinants of inflation in developing countries. Furthermore, a number of similar variables from each model are found to be significant in the empirical work, which makes it difficult to choose a particular theoretical model to forecast inflation for the Jamaican economy. To constitute a benchmark, future inflation is predicted by current and lagged inflation and other variables are added to this benchmark. Therefore, an 'encompassing' model, pulling on several schools of thought is specified and a general-to-specific approach (GETS) employed. The advantage of the GETS approach lies in its ability to deliver results based on underlying economic theories of inflation, which are also consistent with the properties of the data. The general model is specified as follows:

$$\pi = f(xr, ygap, \pi^*, m) \qquad (2)$$

where the represented variables, in order of appearance, are: inflation rate, output gap, imported inflation and *m* represents some measure of monetary aggregate. Several specifications are explored. While the first alternative is based on excess money, calculated as the deviation of money demand from its equilibrium value, the second one includes quarterly M3 growth. This accounts for the fact that money is not an indicator for inflation *per se*. Instead excess liquidity matters. Additionally, the model excluding a monetary aggregate is estimated in order to assess the true contribution of monetary aggregates in forecasting inflation.

The *a priori* expectation of the relationship between money supply and output, among other variables are repeatedly seen in the literature as important to the inflation process. However, excess money and output gap are used to pick up on demand pressures in the economy, since studies show that they tend to perform better at times than simple money supply and output. A positive output gap indicates that demand pressures are present and inflation is increasing; while the excess money variable shows that 'too much money is chasing too few goods' and therefore, demand pull inflation is expected.

The inclusion of the imported inflation in the model serves to account for inflationary pressures in Jamaica's main trading partner the US, as well as the exchange rate component. Additionally, movement in the US inflation rate is thought to contain movement in oil prices. Oil price is included because it is thought that there might be some information contained in this variable that is not captured by the imported inflation variable. Therefore, both variables are included in the model, with the expectation of little or no multi-collinearity between the two (since the correlation coefficient between the two variables is 0.39).

4.3 Data

The data used to estimate the model consist of seasonally adjusted quarterly time series data from 1997:Q1 to 2011:Q1. The source of the data is the Bank of Jamaica. The inflation rate for Jamaica and the US is measured as the percentage change in the Consumer Price Index (CPI) for both countries. Money supply is measured by M3, which is the sum of currency outside banks, demand deposits other than those of the central government and time, savings and foreign currency deposits of resident sectors other than the central government. Real GDP signifies nominal GDP adjusted for inflation. Also, the real interest rate refers to the 180 T-bill rate adjusted for inflation. Commercial bank assets represent the total assets for the Jamaican banking system and will be used as a proxy for household wealth. The exchange rate is defined as the Jamaica Dollar per US dollar rate and it is measured at the average quarterly. The output gap is calculated as the difference between actual output for Jamaica and potential output, where potential output is estimated as an ordinary least squares (OLS) equation regressing GDP on trend and accounting for breaks with dummies. Table one below shows the unit root test for the variables used in the study.

Table 1: Unit Root Analysis

Variables	ADF	PP
lmd	-2.030012	-1.522111
Δlmd	-5.904915***	-5.904915***
lrgdp	-1.782699	0.891481
Δlrgdp	-2.166829***	--7.492402***
lba	-2.239337	-2.307856
Δlba	-6.389236***	-11.54753***
r	-3.021804	-3.206127
Δr	-7.567138***	-7.566954***
impinf	-1.410964	-1.410964
Δimpinf	-2.827288***	-4.152858***
gap	-6.281822***	-6.281822***

Notes: *, ** and *** denotes rejection of the null hypothesis at the 10%, 5% and 1% level, respectively. Δ is the first difference operator and L represents the natural logarithm.

5.0 Estimation Technique

In estimating the money demand equation, a cointegration analysis was utilized. This follows the works of Catensen (2009) and Dreger and Wolters (2010b). This methodology was chosen since in systems including real money balances, real income and real interest rates at least one relationship represents a long run cointegrated equation.

In their study Dreger and Wolters (2010) utilized the error-correction model to capture the long-run relationship between the variables. However, given the order of integration of the variables in this research, the autoregressive distributed lag (ARDL) approach to cointegration was applied. The ARDL approach deals with single cointegration and was introduced originally by Pesaran and Shin (1999) and further extended by Pesaran et al. (2001). The authors showed that the existence of a level relationship between a dependent variable and a set of regressors can be tested, when it is not known with certainty whether the regressors are trend or first-difference stationary. They proved that once the order of the ARDL has been determined, OLS may be used for the purpose of estimation and identification. The presence of a unique long-run relationship is crucial for valid estimation and inference. Such inferences on long and short-run parameters may be made, provided that the ARDL model is correctly augmented to account for contemporaneous correlations between the stochastic terms of the data generating process included in the ARDL estimation. Hence, ARDL estimation is possible even where explanatory variables are endogenous. Other econometric advantages of the ARDL method include: (i) the simultaneous estimation of long- and short-run parameters of the model; (ii) the inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle-Granger method are avoided; (iii) all variables are assumed to be endogenous. Whereas other methods of estimation require that the variables in a time series regression equation are integrated of order one, i.e., the variables are I(1), only that of Pesaran et al. could be implemented regardless of whether the underlying variables are I(0), I(1), or fractionally integrated.

The ARDL framework is implemented by modeling the money demand equation as follows:

$$\Delta lrmd_t = a_0 + \sum_{i=1}^{m} a_{1i}\Delta lrmd_{t-i} + \sum_{i=0}^{m} a_{2i}\Delta lrgdp_{t-i} + \sum_{i=0}^{m} a_{3i}\Delta lrbal_{t-i} + \sum_{i=0}^{m} a_{4i}\Delta r_{t-i} + \sum_{i=0}^{m} \Delta lcpi_{t-i} + a_5 lrmd_{t-i} + a_6 lrgdp_{t-i} + a_7 lrbasa_{t-i} + a_8 r_{t-i} + a_9 lcpi_{t-i} + \varepsilon_t \quad (3)$$

where a_1 to a_4 represents the short-run coefficients related to the determinants of money demand and a_5 to a_9 are the level effects. The long-run coefficients are computed as (a_6, a_7, a_8, a_9)/a_5 and a_5 represent the speed of adjustment to the long-run relationship. The term ε_t is the classical disturbance term with the usual assumptions of zero mean and independent, distribution.

To investigate the presence of a long-run relationship amongst the variables of equation (3) the bounds testing procedure of Pesaran et al is utilized. The bounds testing procedure is based on the F or Wald-statistics, which has a non-standard distribution. The bounds testing procedure involves applying a joint significance test that implies no cointegration, that is,

($Ho = a_5 = a_6 = a_7 = a_8 = a_9 = 0$)

Two sets of critical values are computed by Pesaran et al for a given significance level. One set assumes that all variables are I(0) and the other set assumes they are all I(1). If the computed F-statistic exceeds the upper critical bounds value, then Ho is rejected. If the F-statistic falls into the bounds then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no cointegration.

To check for the potential stability problem, a number of stability tests are reported. Moreover, money demand instability will bias the forecasting results against the money overhangs.

Similarly, inflation will be estimated using the ARDL framework. Thus, the inflation equation is as follows:

$$\begin{aligned}\Delta lcpi_t &= a_0 + \sum_{i=1}^{m} a_{1i}\Delta lcpi_{t-i} + \sum_{i=0}^{m} a_{2i}\Delta ygap_{t-i} + \sum_{i=0}^{m} a_{3i}\Delta impinf_{t-i} + \sum_{i=0}^{m} a_{4i}\Delta lwti_{t-i} + \sum_{i=0}^{m} a_{5i}\Delta lexcessm_{t-i} + a_6 lcpi_{t-i} \\ &+ a_7 ygap_{t-i} + a_8 impinf_{t-i} + a_9 lwti_{t-i} + a_{10} lexcessm_{t-i} + \varepsilon_t \end{aligned} \quad (4)$$

Further, the estimation process follows the procedures outlined above.

6.0 Results

6.1 Money Demand

As outlined above the cointegration properties are explored using the autoregressive distributed lag model (ARDL) by Pesarran and Shin (1999) and as is customary the estimation process begins by testing for stationarity. Unit root tests were used to ascertain the stationary properties of the series under investigation. Specifically, the study employs the Augmented Dickey-Fuller (ADF) test for unit roots (Dickey and Fuller, 1979, 1982). However, the power of the ADF can be significantly reduced since it corrects for serial correlation in the error term by adding lagged values of the first difference of the dependent variable. This reduced power can be more of an issue in small samples. As such, the paper also uses the Phillips-Perron, PP, (1988) which, instead of adding differenced terms as explanatory variables to correct for higher order serial correlation, makes the correction on the t-statistic of the coefficient of the lagged dependent variable. The results from the unit root analysis are presented in Table 1 below. The analysis indicates that four of the variables can be considered to be integrated of order one, that is, I(1).

Thus, having established the order of the variables as well as the fact that the dependent variable is I(1), the ARDL method was carried out.

Given that the dependent variable is I(1) (see table 1 above), the ARDL technique is applied to equation (2). The model starts by using a general model that includes five lags since quarterly data is being used and reducing to a specific model. Moreover, an unrestricted constant and trend terms are added. The model was estimated with 5 lags and the general-to-specific approach (Hendry, 1995) utilized to reduce the model to a parsimonious representation. Five lags are considered to be sufficient since quarterly data is being used. Several diagnostic tests are conducted on the final model including tests for normality, serial correlation, model misspecification and heteroskedasticity.

The results of the ARDL are shown in Table 2 and the results of bounds test is reported in Table 3. The calculated F-statistics for the model as shown in Table 2 are greater than the upper bound critical value at 5% level. Thus, the null hypothesis of no cointegration is rejected. Thus, there is a cointegration relationship among the variables as presented in Equation (3).

Table 2: The Estimated ARDL Model of Money Demand

$$lmd = \underset{(2.89)}{0.261} + \underset{(2.45)}{0.2078} * \Delta lrmd_{t-3} + \underset{(-2.50)}{0.081} * \Delta lrgdp_{t-2} + \underset{(5.86)}{0.055} * \Delta lrba_{t-2} + \underset{(4.51)}{0.041} * \Delta lrba_{t-3}$$

$$\underset{(-4.57)}{-0.0004} * \Delta r \underset{(-7.28)}{-0.119} * \Delta l\pi \underset{(-7.09)}{-0.123} * l\pi_{t-1} \underset{(-3.07)}{-0.051} * \Delta l\pi_{t-2} \ \underset{(-2.87)}{0.128} * lrmd_{t-1}$$

$$\underset{(-2.65)}{-0.00014} * r_{t-1}$$

Diagnostics

$\bar{R}^2 = 0.71$	F =13.65 [0.000]	$Norm = 0.2308$ [0.8910]	AR =1.126 [0.3343]	$ARCH$ =0.1031 [0.7495]
$RR = 2.022$ [0.1626]	$HET = 0.3808$ [0.9481]	$DW = 2.26$		

Long Run Elasticities of Money Demand
r =0.0011

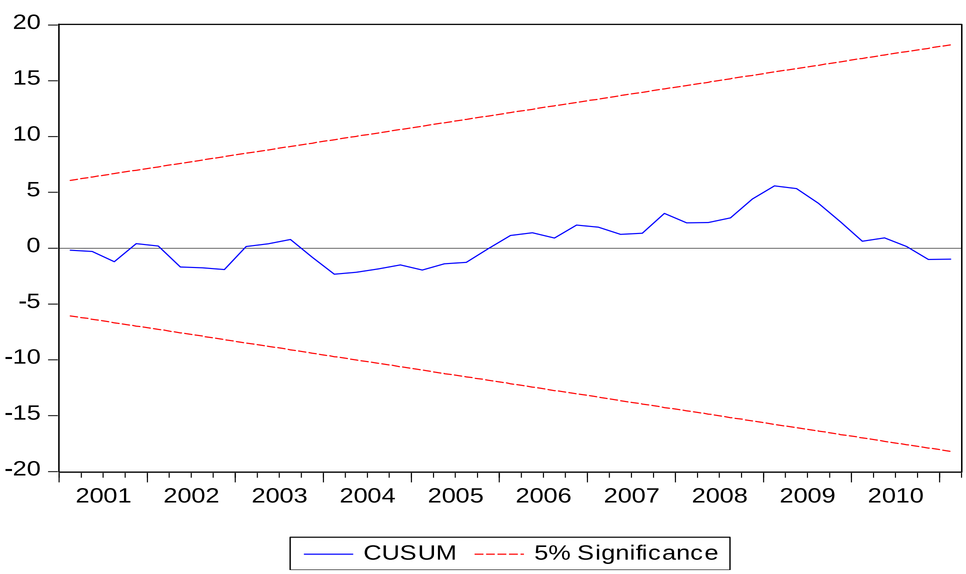
Notes: T-statistics are shown in parentheses. R2 is the fraction of the variance of the dependent variable explained by the model, F is the F-statistics for the joint significance of the explanatory variables, DW is the Durbin Watson statistic, AR is the Lagrange multiplier test for p-th order residual autocorrelation correlation, RR = Ramsey test for functional form mis-specification (square terms only); Norm is the test for normality of the residuals based on the Jarque-Bera test statistic ($\chi 2$ (2)). ARCH is the autoregressive conditional heteroscedasticity for up to p-th order (see Engle, 1982). HET is the unconditional heteroscedasticity test based on the regression of squared residuals
on squared fitted value.

Table 3: F-statistic for testing the existence of a long-run relationship for Money Demand

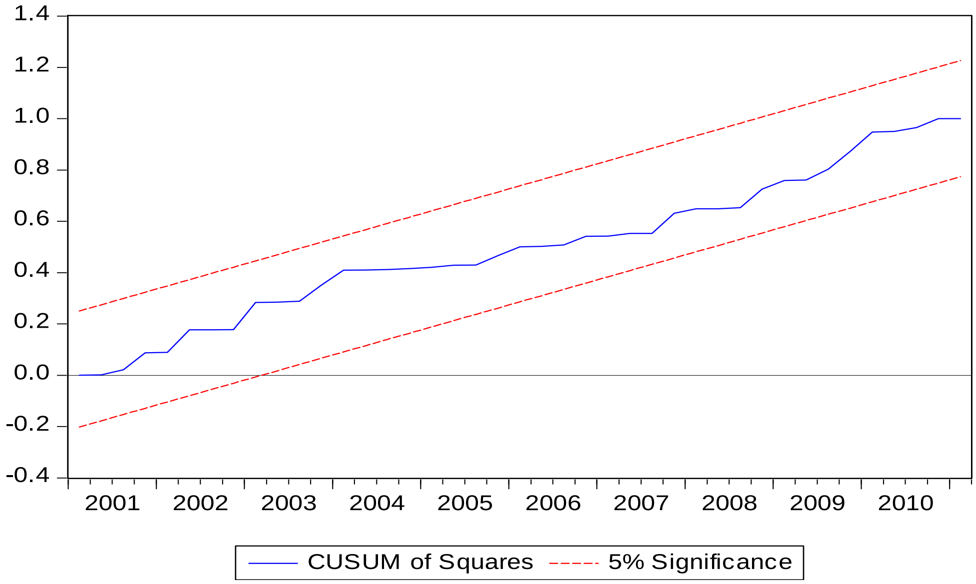
Order of lag	F-statistic
5	F(4,41) = 5.23**

Notes: The relevant critical value bounds are obtained from Table CI(iii) (with an unrestricted intercept and no trend; with four regressors) in Pesaran et al. (2001). They are 2.45 – 3.52 at 90% and 2.86 – 4.01 at 95%. **denotes that the F-statistic falls above the 95% upper bound.

Figure 1: CUSUM and CUSUMSQ Plots for Stability



Note: The dash lines represent critical bounds at the 5% significant level.



Note: The dash lines represent critical bounds at the 5% significant level.

The stability tests done on the ARDL model of real money balances reveals that the model is stable. In fact the stability tests reveal that even during the economic and financial crisis the model is stable.

6.2 Inflation Forecasts

To assess the contribution of monetary indicators to the inflation rate in Jamaica, an ARDL model is estimated using data from 1997q1 to 2009q4. Thereafter, an out-of-sample forecast is done for the period 2010q1 to 2011q1. The model for inflation when excess money is included passes all the diagnostic tests. Specifically, there is no evidence of autocorrelation in the disturbance of the error term, the errors are heteroscedastic and independent of the regressors, the normality test suggests that the errors are normally distributed, and the RESET test indicates that the model is correctly specified. The computed F-statistic of 17.34 exceeds the upper critical bound value and thus indicates that there is a long-run equilibrium relationship between inflation and its determinants. The coefficient on the lagged inflation variables is negative and highly significant, and suggests that approximately 73 percent of the short-run deviations from this equilibrium relation is corrected each year.

Table 4: The Estimated ARDL Model of Inflation with Excess Money

$$\pi = -0.884 + 0.247 * \pi_{t-3} - 0.266 * \pi *_{t-5} + 0.02 * \Delta lwti - 0.726 * lcpi_{t-1} + 1.268 * lexcessm_{t-1}$$

(-2.06) (2.42) (-2.79) (1.96) (-5.876) (2.097)

Diagnostics

$\bar{R}^2 = 0.54$	F =11.423 [0.000]	$Norm = 0.042$ [0.9792]	AR =0.7434 [0.4824]	$ARCH$ =0.071 [0.7907]
$RR = 0.0713$ [0.7917]	$HET = 1.604$ [0.1819]	$DW = 1.91$		

Long Run Elasticities of Money Demand:
$lexcessm = -1.74$

Note: π is equal to $\Delta lcpi$ and $\pi *$ is equal to Δ (lexrate + luscpi)

The findings show a one percent increase in the inflation rate three quarters prior would result in a 0.25 percentage point increase in the inflation rate in the current period. This points to some inertia in the inflation process in Jamaica. Further, this could be capturing economic agents' revisions to their inflation expectation. Also, the results show oil price inflation as having a short-run or transitory impact on the domestic inflation rate but no impact in the long run. A 1.0 percentage point rise in the price of oil in any given year will lead to a 0.02 percentage point expansion in the local inflation rate in the following quarter. Imported inflation also only has a short-run impact on inflation, where the immediate effect on a one percentage point increase in imported inflation is a 0.3 percentage point decline in inflation. This is contrary to theoretical expectations and could be because the prices were not passed on to the consumers. Also, Excess money only has a long-run impact on the inflation rate and contrary to expectations has a negative impact on inflation with an estimated 1.74 percentage point decrease.

Table 5: The Estimated ARDL Model of Inflation with Growth in Money Supply

$$\pi = -0.175*\pi* - 0.361*\Delta lrm3 - 0.186*\Delta lrm3_{t-2} + 0.032*\Delta lwti$$

(-2.08) (-4.84) (-2.48) (2.92)

$$+ 0.918*lcpi_{t-1} + 0.018*lrm3_{t-1}$$

(-8.00) (6.87)

Diagnostics

$\bar{R}^2 = 0.66$ F =2.96 [0.002] $Norm = 0.88$ [0.6439] AR =0.127 [0.8812] $ARCH$ =0.4499 [0.5060]

$RR = 1.14$ [0.2923] $HET = 1.81$ [0.1237] $DW = 1.96$

Long Run Elasticities of Money Demand:
$lrm3 = -0.002$

Note: π is equal to $\Delta lcpi$ and $\pi*$ is equal to Δ (lexrate + luscpi)

The result for the inflation model with money growth is shown in Table 5. Here too, the model passes all the diagnostic tests. Specifically, there is no evidence of autocorrelation in the disturbance of the error term, the errors are heteroscedastic and independent of the regressors, the normality test suggests that the errors are normally distributed, and the RESET test indicates that the model is correctly specified. The computed F-statistic of 32.04 significantly exceeds the upper critical bound value and thus indicates that there is a long-run equilibrium relationship between inflation and its determinants. The coefficient on the lagged inflation variable is negative and highly significant, and suggests that approximately 92 percent of the short-run deviations from this equilibrium relation is corrected each year.

Similar to the previous model, oil price has a positive impact on domestic inflation in Jamaica, with a transitory effect. A 1.0 percentage point rise in the rate of change of oil prices would have an immediate 0.03 percentage point expansion in the inflation rate. Imported inflation has a transitory negative impact on the inflation rate, a 1.0 per cent increase results in a 0.18 per cent decline in the inflation rate. Growth in money supply has both a short-run and a long-run relationship with the domestic inflation rate, where a 1.0 percent depreciation in any given quarter would lead to a cumulative 0.6 percentage point decrease in the inflation rate in the short-run and decrease the inflation rate by 0.002 percentage point in the long-run.

Table 6: The Estimated ARDL Model of Inflation without Monetary Aggregate

$$\pi = 0.241 * \pi_{t-3} - 0.268 * \pi *_{t-5} + 0.027 * \Delta lwti - 0.754 * lcpi_{t-1} + 0.005 * lwti_{t-1}$$

(2.39) (-2.85) (-2.31) (-5.97) (5.06)

Diagnostics

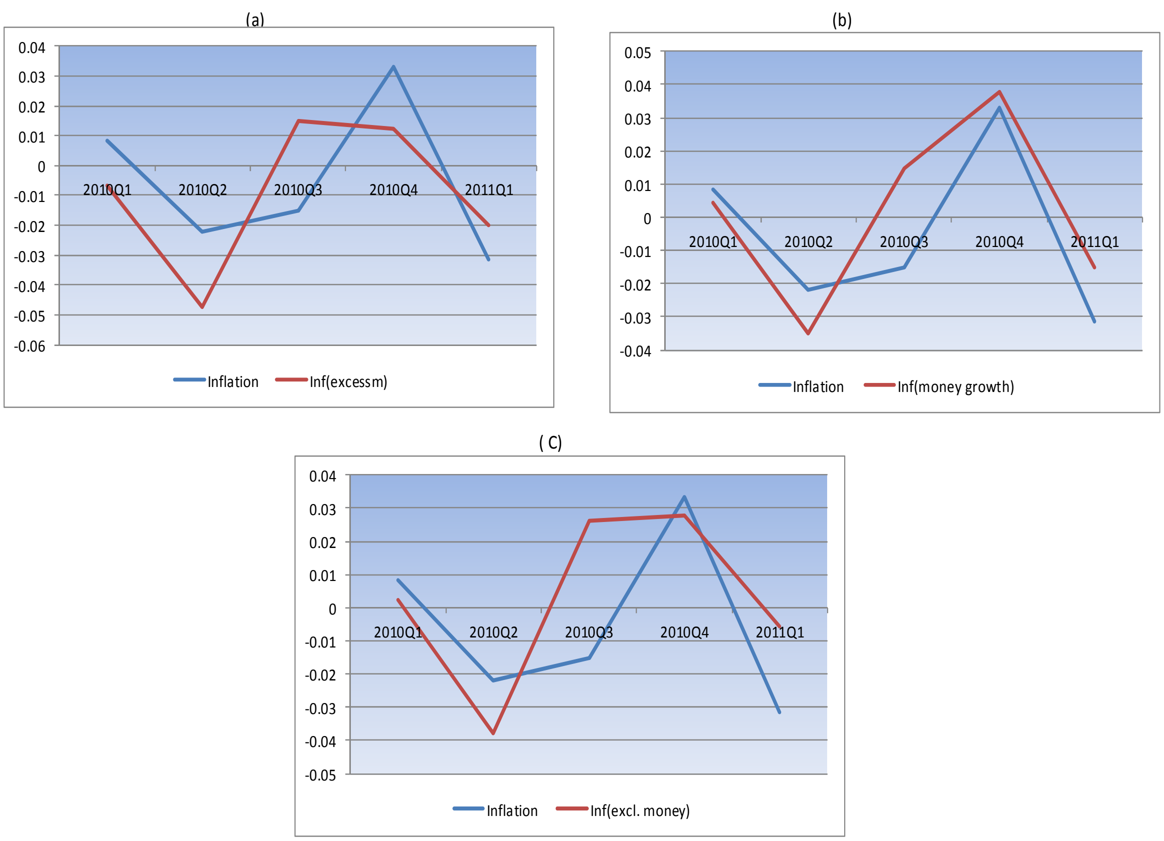
$\bar{R}^2 = 0.55$	F =6.26 [0.000]	$Norm = 0.900$ [0.6375]	AR =0.9072 [0.4122]	$ARCH$ =0.1513 [0.6992]
$RR = 0.248$ [0.6212]	$HET = 1.2541$ [0.3031]	$DW = 1.85$		

Long Run Elasticities of Money Demand:
$lwti$ = -0.007

Note: π is equal to $\Delta lcpi$ and $\pi *$ is equal to Δ (lexrate + luscpi)

The estimated results for the model without monetary aggregate are presented in Table 6. The model passes all the various diagnostic tests and the computed F-statistics of 19.99 for the cointegration test exceeds the bounds upper critical value for a 5% significance level. Thus, the null hypothesis of no cointegrating relation is rejected, which indicates that inflation and its determinants are cointegrated, these determinants being the past inflation rate, oil prices, output gap, and imported inflation. Cointegration is also confirmed by the presence of the significant lagged inflation term, whose coefficient points to an adjustment speed of approximately 75 percent. Based on the significance of changes in lagged inflation variable, inertia is a significant factor in the inflation process in Jamaica, where a one percentage point increase in inflation in a given quarter would translate into a 0.24 percentage point rise in inflation in the next quarter. In such an environment and faced with higher than expected inflation in the current quarter, economic agents are likely to revise their inflation expectations upwards, which would tend to lead to increases in wages and the prices of other goods and thus bringing about further inflation. The results also show that changes in oil price affects inflation in Jamaica, both in the short- and long-run. A one percentage point expansion in oil price would lead to approximately a 0.005. However the findings show that in the long-run a one percentage point increase in oil price would result in a decline of 0.007 percentage point in the inflation rate.

Figure 2: Out-of-Sample Forecast of Inflation



To account for the actual situation that forecasters are confronted with the forecasting performance of the different models is evaluated in an out-of-sample exercise. The forecast accuracy is evaluated by the root mean square forecast error, expressed relative to the benchmark model. The results are exhibited in Figure 2. These results show that the model with the growth in the money supply is better at forecast in the inflation rate in the out of sample forecast. Also, with a root mean square error of 0.0165, relative to root mean square error of 0.0219 and 0.02406 for the model with excess money and without monetary aggregates respectively. Additionally, both models with a measure of monetary aggregate out-perform the one without.

7.0 Conclusion

This paper examines the forecasting performance of a broad monetary aggregate (M3) in predicting inflation in Jamaica. Excess money is measured as the difference between the actual money stock and its fundamental value, the latter derived from a money demand function. The out-of sample forecasting performance is compared to widely used alternatives of monetary aggregate such as the growth in the money supply as well as the model without monetary aggregate. The results indicate that the money demand function is stable, even in the period of the financial and economic crisis.

Compared to money growth, excess money does not perform better to predict inflation. However, excess money outperforms the model without a monetary aggregate. According to these results, money does matter in the process of inflation forecast as such should be included.

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