Working Paper

Investigating the Stability of Money Demand in Jamaica:

A Rolling Co-integration Approach

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Abstract

This paper investigates the stability of money demand in the Jamaican economy by examining four monetary aggregates and a measure of the opportunity cost of holding money. It utilizes a rolling regression approach that incorporates the bounds testing procedure for co-integration in an autoregressive distributive lag (ARDL) models similar to (Tang, 2007). The data in the study spanned 1990q1 to 2013q1, which covers several periods of changes in the monetary policy framework of the central bank. The results suggest that there is a unique and cointegrating relationship between each aggregate and their determinants. Also, while the demand for M3 and M3* have been the most resilient to shocks, M2 is the only aggregate that has improved in stability since the structural reforms that began at the beginning of 2013.

Keywords: Econometrics; Money Demand; Rolling Co-integration Test

JEL Classification: C22; E41

[1] The views and results expressed in this paper represent those of the authors and not necessarily those of the Bank of Jamaica.

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1.0 Introduction

The relationship between money and its determinants plays an important role in macroeconomic analyses and monetary policy decision making. Therefore, a stable money demand had traditionally been viewed as critical to the effective conduct of monetary policy. However, many countries saw evidence of increased instability in their measures of the demand for most monetary aggregates at the end of the 1990s into the early 2000s. This instability resulted in a number of central banks abandoning monetary aggregates as the focus of monetary policy, to focus on the price of money instead. A resurgence in the interest in monetary aggregates and it determinants was sparked by the European Central Bank (ECB) "twin pillar" strategy to policy analysis which was developed following the global financial crisis of the late-2007 to mid-2008. In that strategy monetary analysis supported the analysis of the real economy by providing critical early warning indicators of key aspects of the real economy.

The most significant causes of money demand instability in the money demand system is rapidly occurring financial innovations (Nayaran & Nayaran, 2008). Like many other developing countries, the Jamaican economy experienced several periods of shocks to its financial system due to financial, economic and/or structural changes. The most significant of which were the international debt crisis of the 1980s, the financial crisis of the mid-1990s, the economic crisis of early-2000s and the global financial crisis of 2007-2008. Additionally, the economy underwent several periods of structural changes due to changing exchange rate regimes, monetary policy operational frameworks and trade and economic policies.

These shocks were expected to have had a significant impact on the stability of the money demand relationship in Jamaica. However, studies such as Whyte (2011), Ghartey (1998), Atkins (2005) and Allen & Robinson (2005) have found evidence of stability over different time horizons, including periods of crises and financial innovations. Notwithstanding this, very little research has been undertaken to test the time varying stability of money demand or to test which aggregate is most stable. Therefore, the objective of this study is to determine whether there exists overall money demand stability as proposed by previous researchers as well as to ascertain whether there is sub-sample money demand stability. These attributes will be examined using a rolling co-integration approach. Further, by examining the money demand for

different aggregates, the study should also shed some light on the monetary aggregate that is most robust to the aforementioned shocks.

The remainder of the paper is organized as follows: Section 2 gives a review of the existing literature on money demand stability; Section 3 gives a brief description of the data used in the study and presents the econometric methodology; the results and policy implications are discussed in Sections 4; and the Section 5 concludes the study, highlights the limitations and provides recommendations for further studies.

2.0 Literature Review

The stability of the money demand function is essential to policy makers, since a country's monetary policy is most effective when the economy's monetary and financial systems are stable and well developed (Khan & Agenor, 1996). Despite the considerable reforms and streghtening over the years, Jamaica's financial system is not considered well developed due to the risky macroeconomic environment in which institutions operate (Baumgartner & Collyns, 2006). Jamaica experienced two significant financial crises that were expected to generate some level of instability in money demand. The first occurred in 1980s in the context of revised domestic policies and the international debt crisis, and the second, in the mid-1990s following the liberalization of the financial sector (Atkins, 2005). In addition to these, the economic crisis of the early-2000s and the global financial crisis of 2007/2008 may have also impacted the stability of domestic money demand. Emerging from these crises were various periods of increased public debt, rapid exchange rate depreciation, high interest rates and eventually a deceleration in output growth. Moreover, there were periods of structural reforms in the context of changing exchange rate regimes and trade liberalization that should have had some impact on money demand stability.

In order to estimate money demand in a small open economy with free capital movement like Jamaica, the traditional determinants; price, income and opportunity cost, have to be augmented with factors that address issues of currency substitution. Currency substitution takes the form of an official replacement or in some cases partial substitution of domestic money balances for foreign currency as a store of value, unit of account and medium of exchange.

When this phenomenon exists, domestic monetary policy is also influenced by foreign economic variables and as a result, domestic money demand may face some levels of instability (Bahmani, 2011).

In money demand models, currency substitution justifies the link between the exchange rate and changes in the demand for domestic money balances (Khan & Agenor, 1996). This relationship may take either of two forms; when the domestic exchange rate depreciates, market participants perceive their holdings of foreign assets to be more valuable and therefore increase their demand for domestic money because of the perceived increase in wealth (Bahmani, 2011). On the other hand, continued depreciation of the domestic exchange rate may induce inertia and cause market participants to expect further depreciation (Khan & Agenor, 1996).This results in a reduction in demand for domestic money balances, thereby inducing a negative expectations effect. The final relationship however may vary across countries depending on the strength of the wealth effect versus the expectations effect.

With regards to assessing the stability of money demand for Jamaica, Ghartey (1998) investigated the presence of a long-run and stable relationship between real money demand (M_1) and its determinants using the Johansen and Engle Granger Cointegration techniques .Quarterly data spanning 1960q2 to 1990q3 was used in the study. Both the Chow and CUSUM tests were used to investigate stability in which 1977 and 1989 were used as structural breakpoints representing the era of structural and political changes in the mid-1970s and the end of one political regime, respectively. The results of the study showed that the demand function was stable over both periods. He therefore concluded that there was a long run and stable demand for money relationship in Jamaica.

Atkins (2005) also estimated and tested the stability of money demand in Jamaica. However, unlike Ghartey (1998), the study utilized annual data and money demand was measured by the M_2 aggregate. Similar to Ghartey (1998), the author tested the stability of the demand function using the CUSUM and CUSUM of Squares recursive tests, particularly emphasising the financial crisis in the 1990s. The results of the study indicated that the demand function was generally stable over the review period. However, he noted that the level of instability increased in the first half of the 1990 and reverted in the latter half of the year. The author posited that this is indicative of the fact that the financial accommodative strategies

employed by the government during the crisis were successful in maintaining confidence in the financial system and thereby ensuring money demand stability.

Whyte (2011) also estimated a money demand model for Jamaica, but utilized the ARDL bounds testing approach. The study used quarterly data spanning 1997-2007. In this study M_3 was used as the monetary aggregate. Similar to the conclusions of previous studies, this study revealed that the demand for money was stable even during the financial and economic crises.

This study makes several contributions to the existing literature on money demand in Jamaica. It estimates the demand function for four monetary aggregates allowing for a comparison of the stability over the same time horizon. Additionally, it utilizes a method to test for stability that is superior to the CUSUM and Chow tests used in other money demand studies. While the CUSUM and Chow techniques are sound, there are disadvantages to both methods. The Chow test requires the knowledge of the exact breakpoint(s) while the CUSUM test has poor analytical power for early and late structural changes (Narayan, 2005). In addition, the CUSUM and CUSUM of Squares tests are not valid when the model contains lagged dependent variables (Tang, 2007). These drawbacks are eliminated by using the rolling cointegration approach to test the stability of the demand function over the estimation period.

The rolling cointegration approach is advantageous because it accommodates a time varying approach to cointegration. That is, it allows for changes in the relationship between the system of variables over different periods of time (Brada, Kutan, and Zhou, 2005). Additionally, by using a fixed window length, and varying sub-samples, the methodology accounts for various policy changes and the issue of sub-sample instability in a possible evolving system (Swanson, 1998). This is important as the money demand relationship can change over time as the central bank changes its policy regimes and people respond by adjusting their preferences for holding domestic currency (Pesaran, 2002).

3.0 Model Specification and Data

3.1 Data

The data utilized in the study include quarterly real gross domestic product (RGDP), monetary aggregates (M2, M2*, M3 and M3*), nominal interest rates, consumer price index (P) and exchange rates over the period 1990:Q1 to 2013:Q1.[2] Nominal variables were transformed to real variables by deflating each series by P. The opportunity cost of holding money was measured as:

$h_i = \frac{M0}{Mi} r$ for i=M2, M2*, M3 and M3*

This definition was used in (Allen & Robinson, 2005) as it was shown to be superior in capturing the opportunity cost of money, relative to the domestic interest rate. The exchange rate was defined as the Jamaica Dollar per US dollar rate. With the exception of the interest rate, all variables were logged and seasonally adjusted.

Table 1 Descriptive Statistics

GDP	176,495.40	175,138.20	194,085.90	159,513.90	8,666.88
M2	114,571.30	105,818.00	253,848.70	9,746.30	74,609.50
M2*	165,118.40	141,579.50	396,423.90	10,411.70	114,927.10
M3	149,718.40	127,000.00	357,503.70	10,819.30	107,215.30
M3*	200,322.80	162,761.50	499,512.50	11,484.70	147,524.40
Mb	39,391.87	32,532.70	97,648.46	3,513.00	24,855.23
Ex_Rate	51.11	45.80	95.64	6.82	24.22
H_M2	8.53	6.44	24.38	2.25	5.97
H_M2*	6.48	4.79	18.36	1.43	4.76
H_M3	7.14	5.27	20.37	1.55	5.26
H_M3*	5.65	3.93	16.30	1.14	4.26
R	21.64	17.96	51.42	6.22	11.55

[2] See appendix A for the definitions of these monetary aggregates.

3.2 Trends in Velocity

The velocity of money measures the average number of transactions made with each unit of currency. In this study the velocity is measured as the ratio of nominal GDP to nominal money stock.

$$V_{Mt} = \frac{P * Y}{Mt}$$

The data shows that there was a sharp increase in the velocity of M2, M2* and M3 in 1992Q1 and an increase in M3* velocity in 1992Q2. The rise in 1992 is reflective of the financial liberalization period which as associated with relatively higher interest rates, greater levels of capital movement and hence lower holdings of money balances in relation to other financial instruments. Additionally, the early 1990s was characterised by a highly volatile exchange rate, due also in part to the financial liberalization process which facilitated heavy capital movements. This resulted in increased uncertainty, which caused domestic investors to optimize on their holdings of money balances. The rapid money velocity increases in 1992 was followed by a sustained period of decline until 2002. The velocity of all aggregates plummeted to their lowest respective levels in 2002q3 reflecting the global economic slowdown. Velocity has since increased during the 2006 and 2008 economic crisis periods.

3.3 Model

This model employed was the ARDL bounds testing procedure developed by Pesaran et al. (2001). This estimation technique was used as it provides robust estimators when lagged values of the dependent variable are used as regressors in the model (Pesaran, Shin, & Smith, 2001; Tang, 2007). An additional advantage of the bounds testing procedure is that it does not require the all variables in the model to be integrated of the same order.

The long run money demand relationship is specified as a standard open economy model in which the demand for real money balances is a function of income Y_t , the opportunity cost of holding money R_t and nominal exchange rate S_t. The model takes the functional form:

$$\frac{M_t}{P} = f(Y, R, \Delta S) \quad (1)$$

Using lower case letters to denote the natural logs of the respective variables, the long run money demand equation is given in (2) as;

$$m_t - p_t = \alpha_1 + \alpha_2 y_t + \alpha_3 R_t + \alpha_4 \Delta s_t + \varepsilon_t \quad (2)$$

for $m_t = m_2,\ m_2{}^*,\ m_3$ and $m_3{}^*$ and $\varepsilon_t \sim i.i.d.(0, \sigma^2)$.

Long run money demand is expected to have a positive relationship with income based on the transaction theory of money, in which the demand for real money balances increases as consumers stock of wealth or income increases. The opportunity cost of money should have a negative relationship with money demand. Changes in the exchange rate are included in the model to account for currency substitution impulses. Therefore, the change in the exchange rate may have either a negative or positive relationship with long run money demand, depending on whether the 'wealth effect' is greater than the 'negative expectations effect'. Based on the continued periods of depreciation, this study posits that the 'negative expectations effect' will be greater in this study and therefore a negative relationship is expected between long run money demand and the exchange rate.

3.3.1 Testing for Unit roots

While the ARDL bounds testing technique does not require variables to be integrated of the same order, it is important to pre-test the variables to exclude any I(2) variables from the model, as the inclusion of I(2) variables may generate spurious regression results. To determine the order of integration of the variables, the Augmented Dickey-Fuller (ADF), Phillips-Perron

(PP) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root tests were applied to all variables. The results are shown in table 2 below:

Table 2: Results of cointegration tests

	ADF	PP	KPSS		ADF	PP	KPSS
M2	-1.716	-2.145(2)	0.244(6)	**ΔM2**	-5.223(4)*	-6.458(2)*	0.101(1)*
M2*	0.925	-1.475(4)	0.261(7)	**ΔM2***	-5.945(4)*	-6.921(3)*	0.079(4)*
M3	-1.968	-2.398(2)	0.225(6)	**ΔM3**	-5.215(4)*	-6.501(2)*	0.105(1)*
M3*	-0.990	-1.550(4)	0.248(7)	**ΔM3***	-5.334(3)*	-7.033(4)*	0.080(4)*
S	-4.725(1)***	-3.709 (1) **	0.181(6)*	**ΔS**	-5.888(1)*	-3.385(6)*	0.126(3)*
R	-4.033**	-4.136(4)***	0.145(4)*	**ΔR**	-7.468*	-7.945(9)*	0.079(6)*
P	0.513 (1)	0.622 (4)	0.294(7)	**ΔP**	-6.346*	-6.373(4)*	0.147(4)*
Y	-1.754 (3)	-2.271(5)	0.101(7)***	**ΔY**	-5.321(2)*	-11.607(4)*	0.078(4)*

Note: The asterisks ***, ** and * denotes the significance level at 1, 5 and 10 per cent. ADF, PP and KPSS refer to Augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski et al. (1992) unit root tests. The optimal lag length for ADF test is selected using the SIC while the bandwidth for PP and KPSS tests are selected using the Newey-West Bartlett kernel. Figure in parentheses denotes the optimal lag length and bandwidth. The critical values for ADF and PP tests are obtained from MacKinnon (1996) while the asymptotic critical values for KPSS test are obtained from Kwiatkowski et al. (1992).

3.3.2 ARDL -Bounds Testing

To test for Cointegration we employed the bounds testing procedure developed by Pesaran et al. (2001). To implement this procedure, equation 2 was estimated as an autoregressive distributed lag model as shown in equation 3 below:

$$\Delta(m_t - p_t) = \alpha_1 + \alpha_2 y_{t-1} + \alpha_3 r_{t-1} + \alpha_4 s_{t-1} + \alpha_5 (m_t - p_t)_{t-1} + \sum_{i=1}^{k} \beta_{1i} \Delta(m_{t-i} - p_{t-i}) + \sum_{i=1}^{k} \beta_{2i} \Delta y_t + \sum_{i=1}^{k} \beta_{3i} \Delta r_t + \sum_{i=1}^{k} \beta_{4i} \Delta s_t + \varepsilon_t \quad (3)$$

Where $\beta_1,\ \beta_2, \beta_3,$ and β_4 represent the short run coefficients of lagged values of money, income, interest rate, and exchange rate changes, respectively. Whereas, the long-run coefficients on income, interest rate and exchange rate changes are computed as $a_2 = \frac{-\alpha_2}{\alpha_5}, a_3 =$

$\frac{-\alpha_3}{\alpha_5}$ and $\alpha_4 = -\frac{\alpha_4}{\alpha_5}$, respectively. It should be noted that α_5, the coefficient of the lagged-level dependent variable is the error correction term representing the speed of adjustment of money to any shocks that may result in a deviation from equilibrium.

The bounds test detects evidence of a cointegrating relationship among the variables using the F-statistic obtained from the Wald test. A joint test of significance is conducted on the lagged level variables in equation 3, that is $H_0 = \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$. The critical values (CVs) are obtained for cases in which the variables are purely I(0), purely I(1) or a mixture of both I(0) and I(1). The critical values used in the analysis are obtained from Pesaran et al. (2001). To detect cointegration, the F-statistic from the Wald test is compared to the upper and lower bounds of the critical values. If the F-statistic falls outside the upper bound, the null hypothesis of no cointegration is rejected whereas, if it falls below the lower bound, the null hypothesis is not rejected. The test is inconclusive if the statistic falls within the upper and lower bounds.

3.3.3 Rolling Cointegration Test of Stability

The time varying stability of the money demand functions are investigated using the rolling cointegration test for each function. A rolling window of 14 years is used in this analysis. Therefore, the rolling cointegration test is conducted with a sub-sample of 56 quarters. Equation (3) is re-estimated in each sub-sample window using the backward stepwise general to specific methodology to ensure the most parsimonious relationship is arrived at. For each subsample the F-Statistic from the Wald test is obtained and its evolution is used to determine the relative stability of the demand functions in each period. The critical values used in this section were generated using the Turner (2006) response surface procedure as done in by Narayan (2005).[3] The computed critical values were used to normalize the F-statistics obtained by performing the Wald-test on the rolling regressions. The normalized F-statistics were then plotted over time to assess stability. Therefore, the money demand function is stable and cointegrated for periods in which the values are greater than one and unstable otherwise.

[3] The CVs are computed as $C(p) = B_0 + \frac{B_1}{T} + \frac{B_2}{T^2}$; See Turner (2006) for the coefficient values

4.0 Results

4.1 Money Demand Models

The results of the money demand models for the four monetary aggregates estimated over the entire sample period is included in Table 3 below.

Table 3: Results

Variables	M2	M2*	M3	M3*
		Long run coefficients		
a_5	-0.2269	-0.1973	-0.2007	-0.1636
	(0.0439)	(0.0439)	(0.0501)	(0.0429)
Y_{t-1}	0.6817	0.6984	0.6800	0.7085
	(0.0291)	(0.0287)	(0.0330)	(0.0293)
R_{t-1}	-0.032	-0.0487	-0.0378	-0.0513
	(0.0017)	(0.0022)	(0.0019)	(0.0024)
ΔS_{t-1}		1.3356		1.1455
		(0.1116)		(0.0921)
Short run coefficients				
ΔY_{t-1}				0.5508
				(0.2027)
ΔY_{t-2}	-0.4721	-0.5055		
	(0.2219)	(0.2351)		
ΔY_{t-3}	-0.5549	0.4674	0.4314	0.4684
	(0.2059)	(0.2251)	(0.1942)	(0.1926)
ΔY_{t-4}	0.9619	-0.6885	-0.5165	-0.4128
	(0.2068)	(0.2258)	(0.1835)	(0.1920)
ΔY_{t-5}	-1.0576	0.7514	0.5585	0.3388
	(0.2280)	(0.2197)	(0.2084)	(0.1793)
ΔY_{t-8}	-0.6452		-0.7287	
	(0.2044)		(0.2120)	
ΔY_{t-9}	-0.8095			
	(0.1977)			
$\Delta\Delta S_{t-5}$		0.1774		0.3043
		(0.0798)		(0.0810)
$\Delta\Delta S_{t-6}$	0.2535	0.2887		
	(0.0779)	(0.0751)		
$\Delta\Delta S_{t-9}$	-0.2364		-0.2450	
	(0.0772)		(0.0672)	
$\Delta\Delta S_{t-10}$			-0.1517	-0.3175
			(0.0672)	(0.0664)
ΔM_{2t-5}	-0.2286			
	(0.0670)			
ΔM_{2t-6}	0.2790			
	(0.0728)			

Variables	M2	M2*	M3	M3*
ΔM_{2t-10}	0.2870			
	(0.0617)			
$\Delta M_2{}^*{}_{t-5}$		-0.2616		
		(0.0847)		
$\Delta M_2{}^*{}_{t-6}$		0.1721		
		(0.0802)		
ΔM_{3t-4}			-0.3690	
			(0.0876)	
ΔM_{3t-6}			0.1594	
			(0.0707)	
ΔM_{3t-8}			-0.1516	
			(0.0740)	
ΔM_{3t-10}			0.2263	
			(0.0638)	
$\Delta M_3{}^*{}_{t-4}$				-0.3252
$\Delta M_3{}^*{}_{t-8}$				-0.2796
				(0.0749)
ΔR_{t-3}				0.0068
				(0.0029)
ΔR_{t-7}				0.0075
				(0.0026)
ΔR_{t-10}				-0.0049
				(0.0018)
trend	-0.0022	-0.0018	-0.0015	-0.0013
	(0.0004)	(0.0003)	(0.0003)	(0.0003)
Diagnostics				
R^2	0.72	0.62	0.65	0.68
Adjusted R^2	0.65	0.55	0.57	0.60
DW	2.20	1.97	2.24	2.09
Jarque − Bera	0.95	0.30	0.97	0.19
LM Test	0.36	0.98	0.30	0.68

Based on the lag length selection criteria from the VAR analyses, 10 lags of each variable were included in the M2, M3 and M3* models while 9 lags of the each variable were included in the M2* model. A backward step-wise general to specific regression approach was used to obtain a parsimonious representation of each model. For the purpose of robustness, a battery of diagnostic tests were performed, most importantly the Breusch-Godfrey LM test, Jarque-Bera test of normality, Ramsey RESET and White's heteroskedasticity tests. The test results suggest

that we do not reject the null hypothesis of no serial correlation at the 5% level. The Jarque-Bera test indicates that the residuals from the model are normally distributed.

The signs of the long run coefficients in all models are in conformity with economic theory, wherein income has a positive long run elasticity coefficient, while interest rate is negatively related to real money demand. The long run elasticity on the exchange rate depreciation varies in sign and significance across models.

Income elasticity is approximately two-thirds in each model, whereas it is standardized in the literature to be equal to unity. This result is consistent with the transaction and precautionary theories of money demand as well as the Baumol–Tobin, "Transaction Demand for Cash" approach. The magnitude of the elasticity also indicates that any significant increase in the domestic money supply greater than the increase in output will generate inflationary pressures on the economy. The income elasticity values obtained in this study were lower than that of Allen & Robinson (2005) which reported a long run income elatsictiy value of 1.1.

The elasticity of exchange rate depreciation, a representation of currency substitution impulses is positive but not statistically significant in either the M2 or M3 model. Its insignificance may be attributable to the composition of the aggregates. That is, despite the fact that domestic currency savings deposit represents the largest component of M2 and hence M3, an investor's portfolio may be constructed such that changes in the exchange rate does not have a significant impact on their overall portfolio. This compares to the results of Allen & Robinson (2005), in which the long run exchanges rate change is reportedly statistically significant and positively related to the demand for real money balances. They attributed this result to the increasing financial sophistication and awareness (their willingness to shift to other instruments given exchange rate depreciation) of investors.

On the other hand, the long run exchange rate elasticity values of M2* and M3* provide clear evidence that these monetary aggregates are highly responsive to changes in the exchange rate. Moreover, the elasticity values indicate the presence of a 'wealth effect' of exchange rate depreciation in the domestic economy as the owners of foreign assets perceive that their stock of wealth has increased due to gains from depreciation. Moreover, the positive relationship between exchange rate depreciation and the demand for real money balances represents possible evidence

of 'currency substitution' and further accredits the financial sophistication theory posited by Allen & Robinson (2005). This is in a context where continued exchange rate depreciation results in increases in money demand as people shift from the domestic component of M2* and M3* to demand foreign currency balances or other foreign currency instruments. Further, the magnitude of the elasticity suggests that small changes in the exchange rate, results in even larger shifts in the demand for these monetary aggregates.

All models reported relatively low long run interest rate elasticity values, thereby indicating that money demand is relatively insensitive to changes in the interest rate. This means that any increase in the interest rate on other financial or real assets will result in a marginal decline in the demand for real money balances. This corresponds with the results from (Allen & Robinson, 2005) and Whyte (2011). Further, excluding M3, short run interest rates do not affect money demand. However, both short run GDP and exchange rate changes have a significant impact on money demand. This suggests that policies aimed at containing money demand through the use of short run interest rates will not be effective. Therefore, for best results the central banks ensure open market operations are included in the menu of policy strategies to correct short run deviations in the money market.

The error-correction terms are all negative and highly statistically significant, similar to the ECM terms in Allen & Robinson (2005) and Whyte (2011). This further gives credence to the existences of a cointegrating relationship between the monetary aggregates and their determinants. The feedback coefficients for M2, M2*, M3 and M3* are 0.22, 0.2, 0.2 and 0.16, respectively. These speeds of adjustment are relatively slow and suggest that on average approximately 20% of the disequilibrium in the money market are corrected in the current year to ensure full convergence to the equilibrium level. Cuthbertson & Taylor (1990) in Allen & Robinson (2005) posited that the slow speed of adjustment may be due to the impact of future income and returns on agents' portfolio choices. Meanwhile, Hall & Robinsion (2002) in Allen & Robinson (1998) argued that the pace of adjustment may be due to increasing financial sophistication of domestic investors.

Following the estimation of the models, the bounds testing and rolling cointegration procedures were conducted. The results are presented below:

4.2 Rolling Cointegration results

Table 4: Results of Bounds Test

Wald Test-F-Statistics					
M2=12.08		M2*=12.13		M3=9.99	M3*=13.55
Critical Values Bounds-Test F-Statistics					
90% Level		***95 % Level***		***99% Level***	
I(0)	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**
3.47	4.45	4.01	5.01	5.17	6.36

Critical values extracted from Pesaran, et al. (2001), page 301, Table CI (V)-Unrestricted intercept and unrestricted trend, (k=3)

The results of the Bounds Testing procedure show that the F-statistic from the Wald-test exceeds the critical values for all monetary aggregates at all levels of significance. Therefore, we do not reject the null hypothesis that each monetary aggregate has a cointegration relationship between its determinants at the 95% level of confidence.

4.3 Rolling Cointegration results

The rolling cointegration test, a test of sub-sample stability shows that for the most part, money demand has been stable over the period examined (**see figures 1-8 below**). Specifically, the results showed that despite the cointegrating relationship between the respective monetary aggregates and their determinants, the demand for these aggregates have displayed differing levels of robustness to financial innovations or shocks in the domestic market. Of note, most demand functions showed considerable decline in stability during the 2006/2007 economic crisis, the global economic crisis of 2008 as well as the Jamaica Debt Exchange (JDX) and the National Debt Exchange (NDX) which took place in the domestic economy in 2010 and 2013, respectively.

As a check for robustness, the results from the rolling cointegration tests were compared with the CUSUM of Squares test for stability. Despite the relative instability shown in the rolling cointegration results, the CUSUM of Squares stability tests provided no evidence of instability in

money demand over the period as suggested by Atkins (2005), Whyte (2011) and Ghartey (1998). These results give credence to the theory that the CUSUM tests may not be the best method of assessing stability when lagged dependent variables are included in the model as suggested in Tang (2007).

Results of Rolling Cointegration and CUSUM of Squares Tests

Figure 1: Normalized F-Statistics for M2

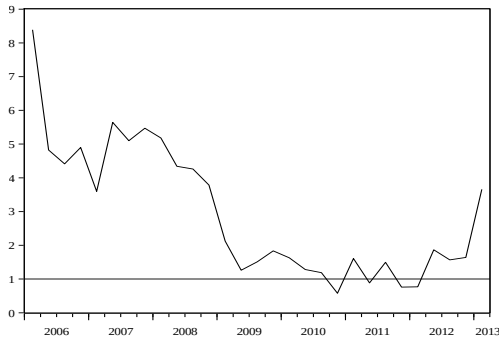


Figure 2: CUSUM of Squares test for M2

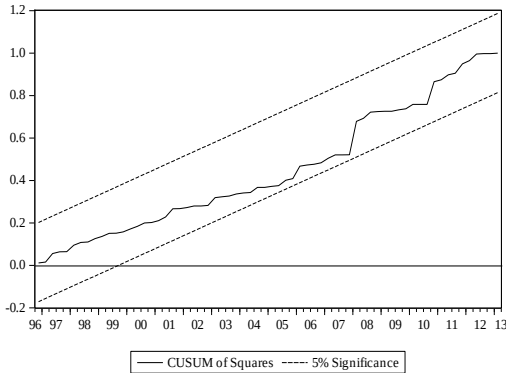


Figure 3: Normalized F-Statistics for M2*

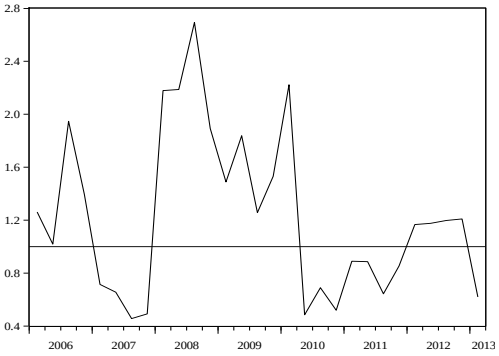


Figure 4: CUSUM of Squares test for M2*

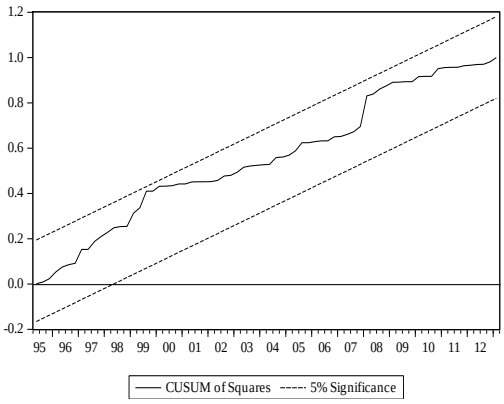


Figure 5: Normalized F-Statistics for M3

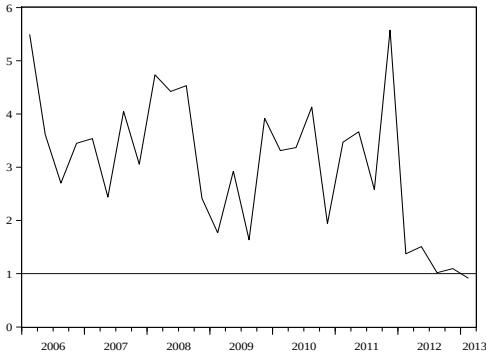
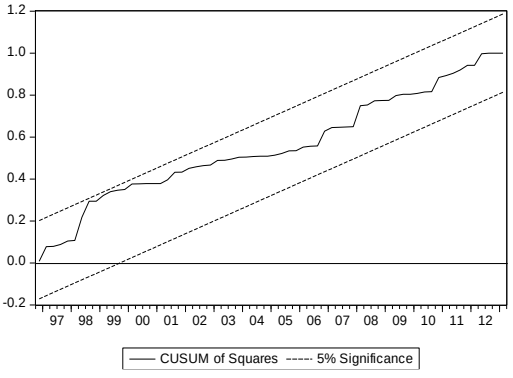


Figure 6: CUSUM of Squares test for M3



Results of Rolling Cointegration and CUSUM of Squares Tests Cont'd

Figure 7: Normalized F-Statistics for M3*

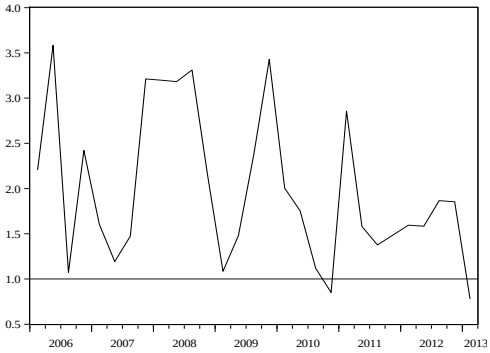
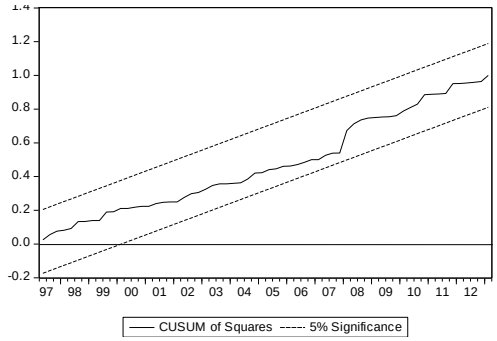


Figure 8: CUSUM of Squares test for M3*



5.0 Conclusion and Policy Implications

This study assessed the stability of Jamaica's money demand function by estimating a model for each of the four aggregates (M2, M2*, M3 and M3*) for the period 1990q1 to 2013q1. The research was conducted using the Pesaran et. al (2001) ARDL Bounds Testing approach. The motivation underlying this study is that the framing the sound monetary policy is dependent upon the strength of the relationship between money and its determinants and as a result, this relationship is critical to policy makers. The period covered by the research is also significant because during this period the domestic financial market experienced several signifiant reforms. Additionally, throughout this period the central bank transitioned through various monetary policy strategies. These innovations were expected to create some volatility in money demand and by extension instabililty in one or more money demand functions.

The investigation revealed that despite the shocks to the system, over the entire sample period, each monetary aggregate had a long run cointegrating relationship with its determinants (income, exchange rate and interest rate). However, the results of the assessment of the time response of the demand for money to various shocks suggests that the demand for domestic money balances became unstable during periods of significantly large shocks to the financial or macroeconomic system. The demand for M3 and M3* proved to be the most robust over the entire sample period. However, all models except M2 displayed increasing instability at the end

of the sample period, following the structural adjustments that formed a part of the economic programme which started at the beginning of 2013.

These results suggest that demand money remains stable enough for the central bank in Jamaica to utilize monetary analysis in a similar twin pillar fashion as the ECB. Given Jamaica's vulnerability to economic and financial shocks, the analysis suggests that the authorities should focus on their analysis on the broader monetary aggregates of M3 and M3*. However, results also indicate that the demand for M2 is the only aggregate that has been increasing in stability since the economic transformation that began in 2013 and therefore should be the aggregate of choice in the short to medium term. Furthermore, the stability of money demand also provides support for the central bank's monetary policy. That is, forecasting and maintaining the inflation target largely depends on the predictability of the monetary framework.

It is the conclusion of the authors that irrespective of the stability of the demand functions, based on the strength of the relationship between the aggregates and their determinants, inflation targeting may be a superior monetary policy strategy for Jamaica. In this context, the authors recommend that future studies seek to investigate the optimal rate of inflation required to maximize output growth in Jamaica.

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Appendix

A. *Definition of Monetary Aggregates*

$$\boldsymbol{MB = Currency\ \ Issue + Commercial\ Banks\ reserves + Cash\ Reserves} \quad (1)$$

$$\boldsymbol{M2 = MB + Domestic\ Currency\ Deposits} \quad (2)$$

$$\boldsymbol{M2^{*} = \ M2 + Foreign\ Currency\ Deposits} \quad (3)$$

$$\boldsymbol{M3 = M2 + Other\ Deposits} \quad (4)$$

$$\boldsymbol{M3^{*} = \ M3 + Foreign\ Currency\ Deposits} \quad (5)$$

B. *Money Velocity of Circulation*

Figure 8: M2 velocity of circulation

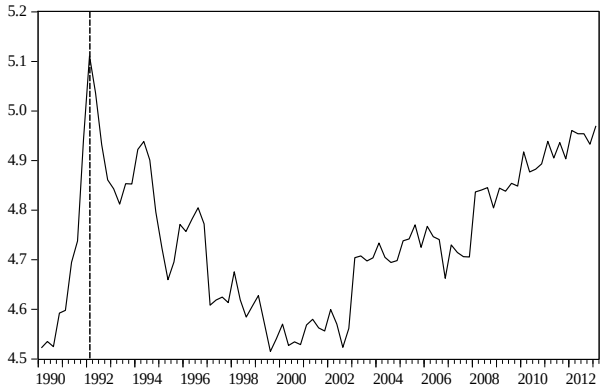

Figure 9: M2* velocity of circulation

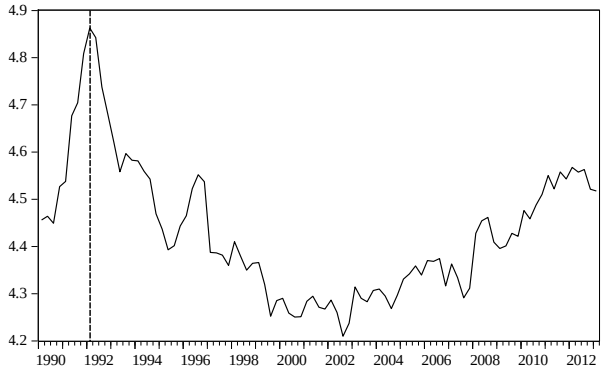

Figure 10: M3 velocity of circulation

Figure 12: M3* velocity of circulation