Estimating the Impact of the Alternative Means of Payment on Currency Demand in Jamaica

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2008

Abstract

In the decade of the 1990's, retail payments made in Jamaica were dominated by the use of cash and cheques. However, similar to the experience of other countries, innovations in transaction technology such as Automated Teller Machines (ATMs) and Electronic Funds Transfer Point of Sale systems (EFTPOS) have revolutionized the payments landscape in the economy. Although cash has remained the dominant payment instrument, its use has been declining as an increase in the number of EFTPOS terminals has significantly expanded the use of debit and credit cards in retail payments. Using a cointegration and error correction framework, this paper estimates the impact of cashless payments on currency demand in the Jamaican economy with the aim of improving projections of currency issue. The estimated model suggests that the demand for currency is positively affected by the volume of ATM transactions in the previous two periods and negatively affected by EFTPOS transactions in the prior period. A comparison of the forecasting performance of the ECM model with that of a short-run and an ARIMA model showed that all three models demonstrated good predictive capabilities. However, the ARIMA model demonstrated superior performance in the out-of-sample forecasts.

JEL Classification: E41, C32, C51, C52

Keywords: Credit cards, Debit cards, Currency demand, Cointegration, Error correction modeling

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[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.

Introduction

In the decade of the 1990's, retail payments made in Jamaica were largely dominated by the use of cash and cheques. However, innovations in transaction technology such as Electronic Funds Transfer Point of Sale systems (EFTPOS) have revolutionized the payments landscape in the economy. Although cash has remained the dominant payment instrument, its use has been declining as an increase in the number of EFTPOS terminals in retail payments has significantly expanded the use of debit and credit cards. Debit cards facilitate electronic transfers directly from customers' deposit accounts to the merchants' account while credit cards fund payments by way of loans granted by the issuing financial institution.

Research work on the demand for currency in other countries has found that the option of cashless payments, changes the demand for cash causing changes in the volume of cash transactions. The purpose of this paper is to estimate the impact of the non-cash means of payment, particularly the use of debit and credit cards on the demand for currency in Jamaica. This is with the aim of improving projections of currency issue. The paper will employ the use of an error correction framework to derive the estimate for the period April 2003[2] to June 2008. The adequacy of this model will be tested by comparing its forecasting performance to that of a short run model and a univariate Autoregressive Integrated Moving Average (ARIMA) model.

The organization of the paper will be as follows. Section 2.0 presents the factors influencing currency demand and the recent trends in currency in circulation in Jamaica. An overview of the retail payment system is presented in Section 3.0. Section 4.0 presents the review of literature on the impact of non-cash payment instruments on the demand for money while Section 5.0 provides a description of the data and econometric methodology applied. In Section 6.0, a currency demand function for Jamaica is estimated using cointegration and error correction where the substitution effect is accounted for by data on payment cards. This section is followed by an evaluation of the

[2] Data on non-cash means of payment is unavailable prior to April 2003.

forecast of the error correction model which is achieved by comparing its performance with two other models. Relevant conclusions are presented in the final section.

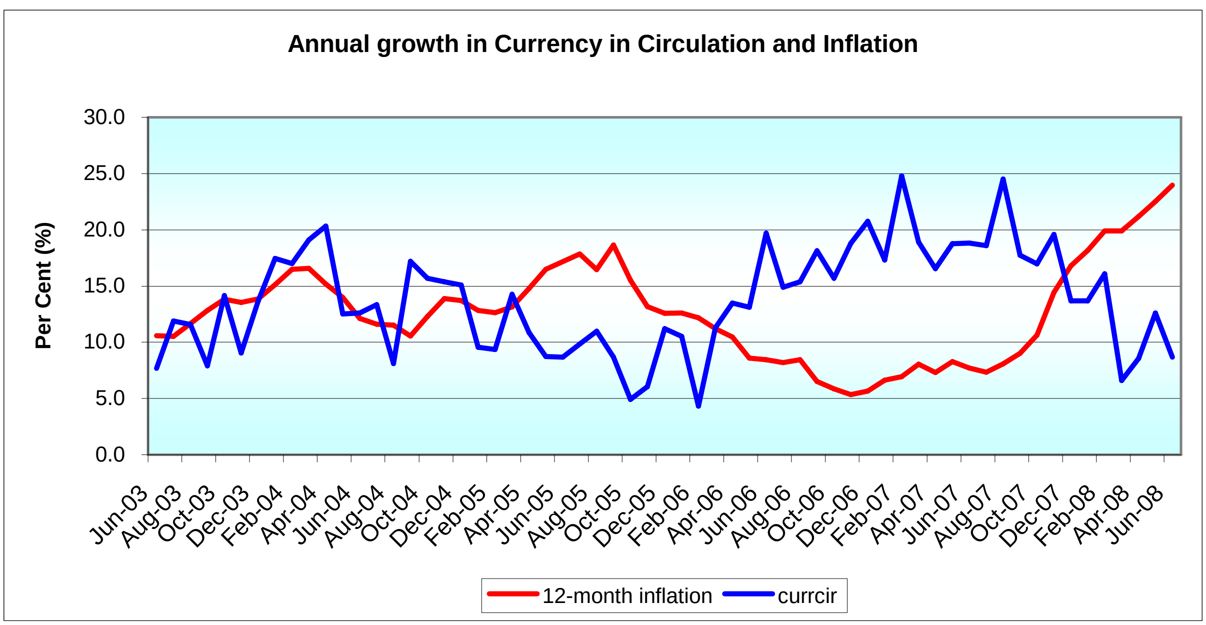
2. Currency Demand in Jamaica

a. Background

The Bank of Jamaica (BOJ) issues currency solely to deposit-taking institutions and cambios based on orders placed by these institutions.[3] These notes and coins may be divided into two components, currency in circulation and vault cash. Currency in circulation is the amount of cash that the public holds, largely based on the need to conduct transactions. Vault cash is the term given to notes and coins in the vaults of the deposit-taking institutions. During the period January 2003 to June 2008, currency in circulation accounted for an average of 86.5 per cent of currency issued by the BOJ.

b. Trends in currency demand

Figure 2



One of the most significant macroeconomic factors which has influenced the trend in currency in circulation is inflation. This was most evident during the period June 2003 to April 2004 when there was acceleration in the rate of growth in prices... This faster

[3] The deposit-taking institutions are commercial banks, building societies and FIA licensees.

growth in prices was a major influence on an acceleration in the annual growth in currency in circulation to 20.3 per cent from 10.1 per cent, as people sought to maintain their standard of living (see Figure 2).

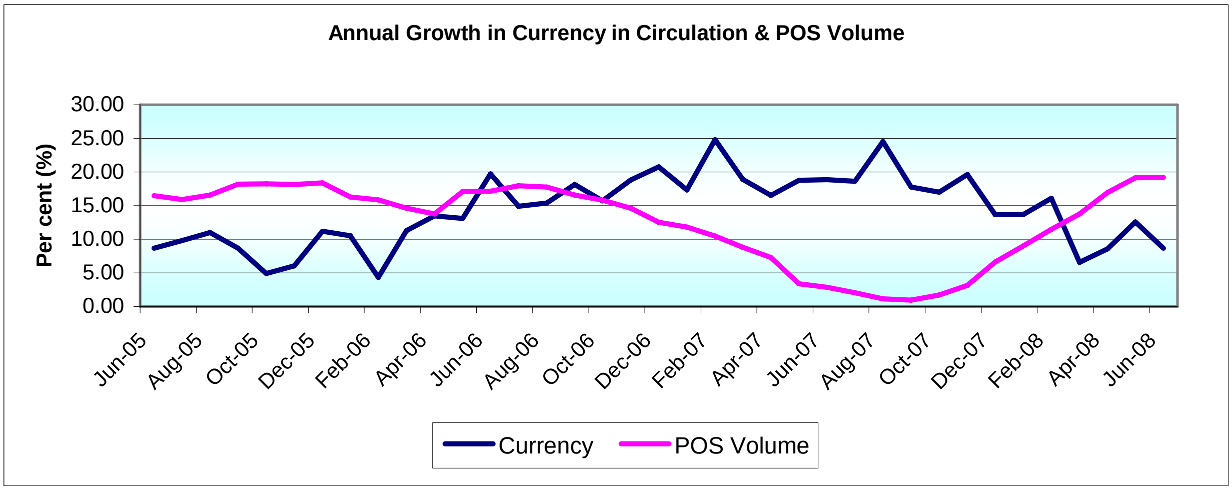
Although inflation was also high during 2005, there was a deceleration in the annual growth in currency in circulation in a context where there were wage restrictions and expectations of a lowering in inflation. This slowdown in currency was short-lived as during the period February 2006 to June 2007, the annual growth in currency increased significantly, peaking at several points in the period. The annual growth in currency increased to 19.7 per cent as at June 2006, the fastest annual expansion since April 2004. This expansion in currency in circulation was influenced by increased public sector salary payments under a new Memorandum of Understanding (MOU). The growth in currency remained high until the mid-2007 consistent with improved confidence as a result of buoyancy in economic activity and lower than expected inflation, additional increases in wages as well as significant pay-out from alternative investment schemes.

There was a notable slowdown in the growth rate of currency in circulation during the last twelve months of the review period, despite acceleration in inflation. This trend was in sharp contrast to the period of high inflation in 2003 when currency in circulation grew in line with inflation. The deceleration in the growth rate in currency since August 2007 occurred in the context of a fall-out in the alternative investment schemes and a slowdown in economic activity during the 12-month period ended June 2008. The decelerating trend in currency in circulation resulted in a real decline in currency of 12.3 per cent in June 2008 relative to the increase of 10.4 per cent as at June 2007.

c. Currency Demand and the Trend in the Volume of Point-of-Sale Transactions

Figure 2a shows an inverse relationship between the annual growth in the number of EFTPOS transactions and the growth in currency in circulation. Most notable was the period December 2006 to December 2007 when currency demand was high in a context of significant payouts from alternative investment schemes. This coincided with a slowdown in the volume of EFTPOS transactions, in particular credit card transactions.

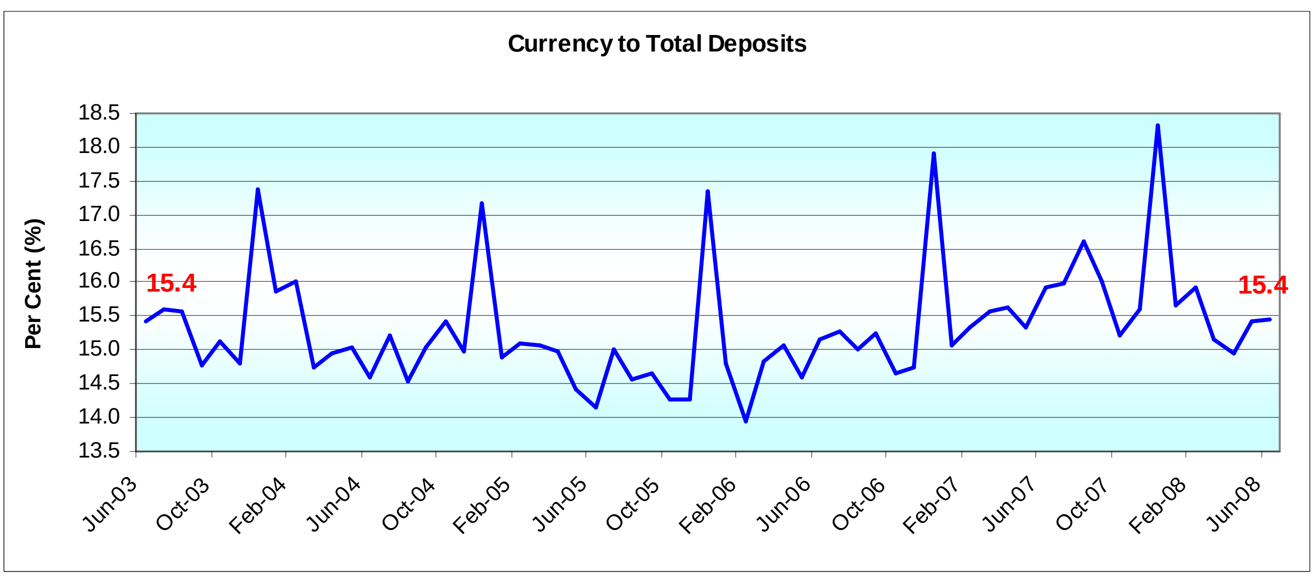
Figure 2a



d. Currency to deposit ratio

The currency to deposit ratio is an indicator of individuals' preference for holding currency (the most liquid form of money) relative to deposits. Figure 3 reveals that there was no trend decline in the currency to deposit ratio during the review period. However, there was a notable increase between the second half of 2006 and the latter half of 2007 when there was robust growth in the alternative investment schemes. The ratio subsequently declined in a context where there was a fall-out of these schemes and a slowdown in economic activity.

Figure 3



3. Retail Payment in Jamaica: Stylized Facts

There are various non-cash means of payment available, in particular credit and debit cards as well as cheques. During the period April 2003 to June 2008, growth in the number of debit and credit card transactions was an average of 1.7 per cent and 1.5 per cent, respectively. There was deceleration in the growth in the volume of debit card transactions over the period, particularly in the years ended June 2006 and June 2007, when growth in the volume of these transactions was below that of credit card transactions. In contrast, the annual growth rate in the volume of credit card transactions increased significantly, decelerating in the year ended June 2008 (see Table 1).

Table 1

Average Growth In Number of Transactions		
	Debit Cards	Credit Cards
April 03 -June 08	**1.7**	**1.5**
12 mth ended June 04	2.2	1.6
12 mth ended June 05	1.9	1.2
12 mth ended June 06	1.3	2.0
12 mth ended June 07	1.3	1.7
12 mth ended June 08	1.7	1.0

Despite the relatively low growth rate in the volume of debit and credit card transactions, there was a two-fold growth in the value of both ATM and POS transactions during the period. This increase occurred in the context of greater availability of access terminals (see Figure 5).

Figure 4

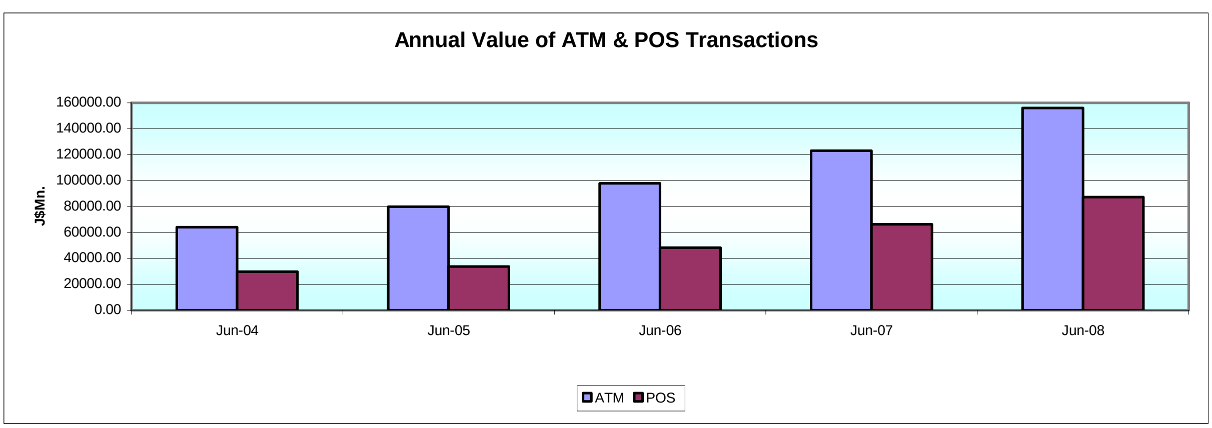
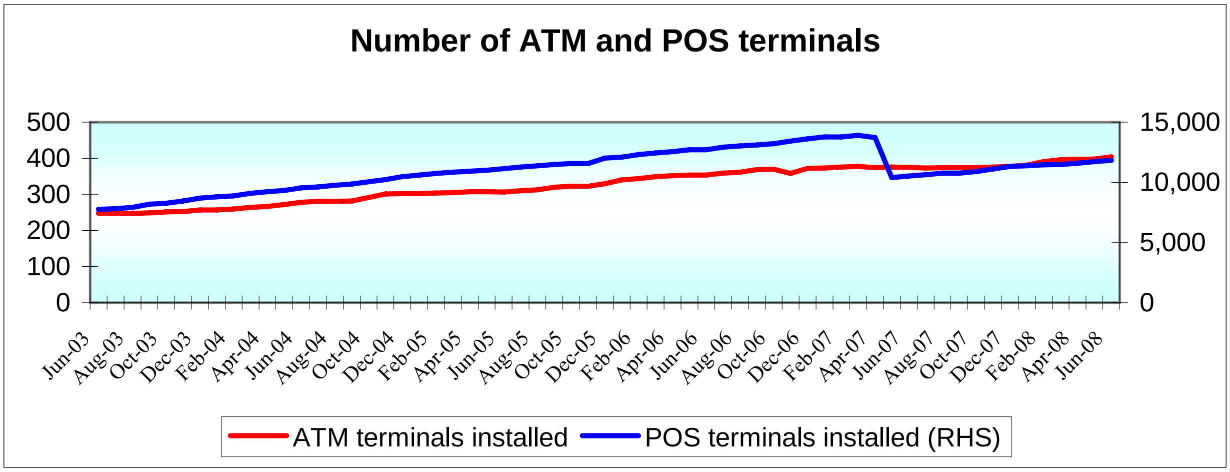


Figure 5



With regard to average transaction size, this indicator exhibited a trend increase, however, the average size of ATM and POS transactions did not exceed $8,000.00 which suggests that alternative means of payments are used largely to finance low value purchases (see Table 2). A disaggregation of the data reveals that the average size of ATM debit card transactions, which is an indicator of the average holding of cash was $4 546.9 for the 12-month period ended June 2008 relative to $3 393.4 for the 12- month period ended June 2004.

Table 2

Average Transaction Size				
	ATM Debit	ATM Credit	POS Debit	POS Credit
April 03 - June 08	3,971.91	5,536.07	2,889.79	5,200.26
12-mnth ended June 04	3,393.43	4,654.01	2,451.63	3,435.72
12-mnth ended June 05	3,675.58	4,358.09	2,549.86	3,320.90
12-mnth ended June 06	3,906.70	6,343.55	2,790.11	4,544.62
12-mnth ended June 07	4,510.03	6,085.58	3,285.92	7,434.15
12-mnth ended June 08	4,546.88	6,366.02	3,510.11	7,601.39

Disaggregating the data on debit cards showed that the proportion of debit card transactions done at the ATM has declined relative to POS transactions during the period. However, the value of debit card transactions at ATMs continued to account for the dominant share of total debit card transactions. The increase in the proportion of POS transactions may be attributed to the increased availability of POS machines as well as the very high limits which commercial banks have maintained for these transactions. A survey of the banking sector as at March 2009 revealed that the maximum value of a single POS debit card transaction that was permitted by the three largest banks was in the range of $40 000.00 to $150 000.00.

Table 3

Debit Card Transactions at ATMs & POS (% of total)		
	ATM	**POS**
April 03 - June 08	**77.1**	**22.9**
12-month ended June 04	79.3	20.7
12-month ended June 05	77.6	22.4
12-month ended June 06	75.6	24.4
12-month ended June 07	75.1	24.9
12-month ended June 08	77.4	22.6

ATM facilities are used primarily to access cash therefore an analysis of the relationship between ATM transactions and currency in circulation was conducted. Figure 6 shows that the value of debit card transactions at ATMs as a proportion of currency in circulation increased during the review period, which implies that an increasing proportion of the cash in the hands of the public was acquired through ATM facilities.

Figure 6

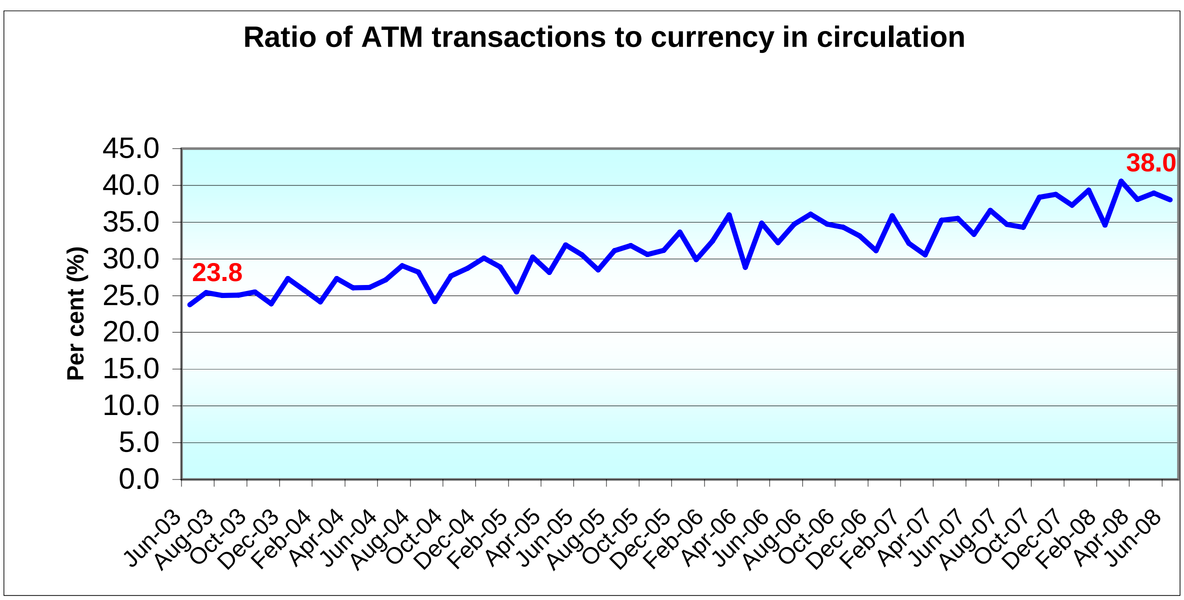


Figure 7 shows that the vault cash holdings of commercial banks increased from $2 500.6 million in June 2003 to 3893.6 million in June 2008, attributed mainly to the increased use of ATMs and the banks need to ensure that they are adequately stocked.

Figure 7

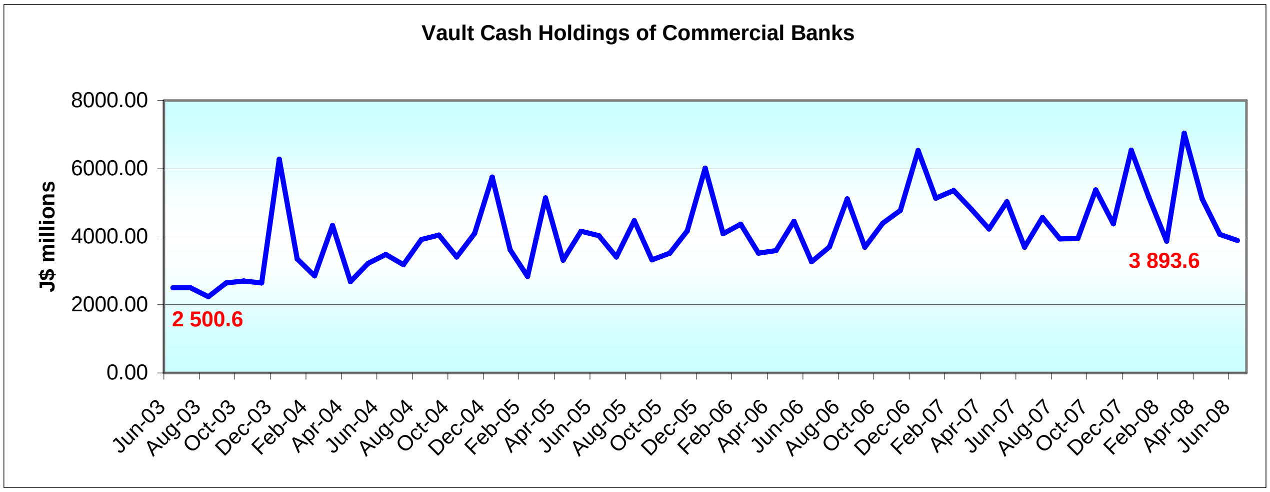
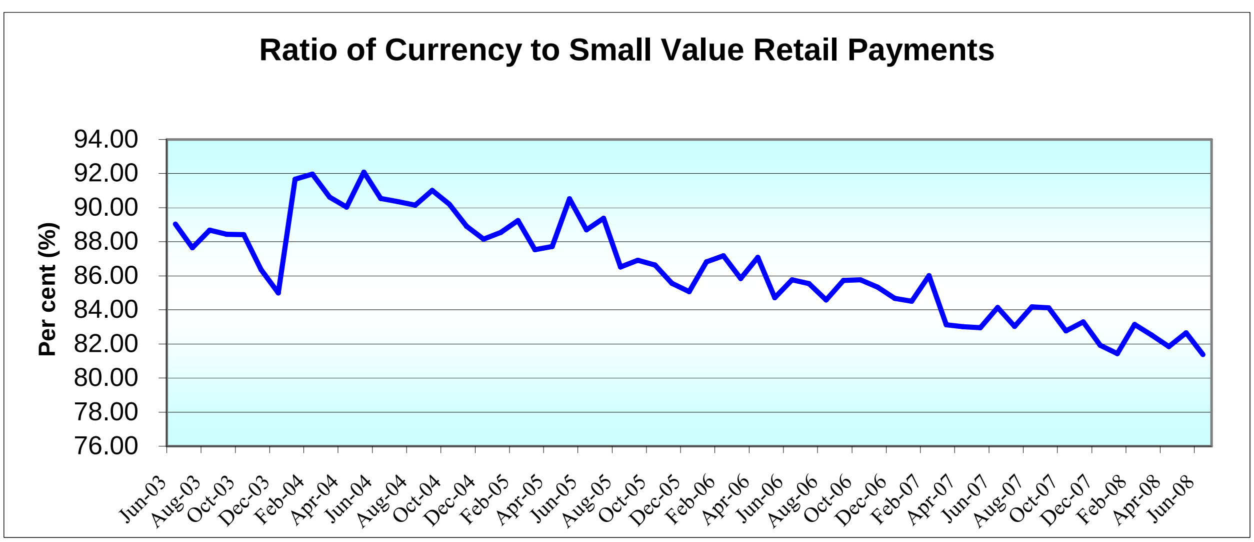


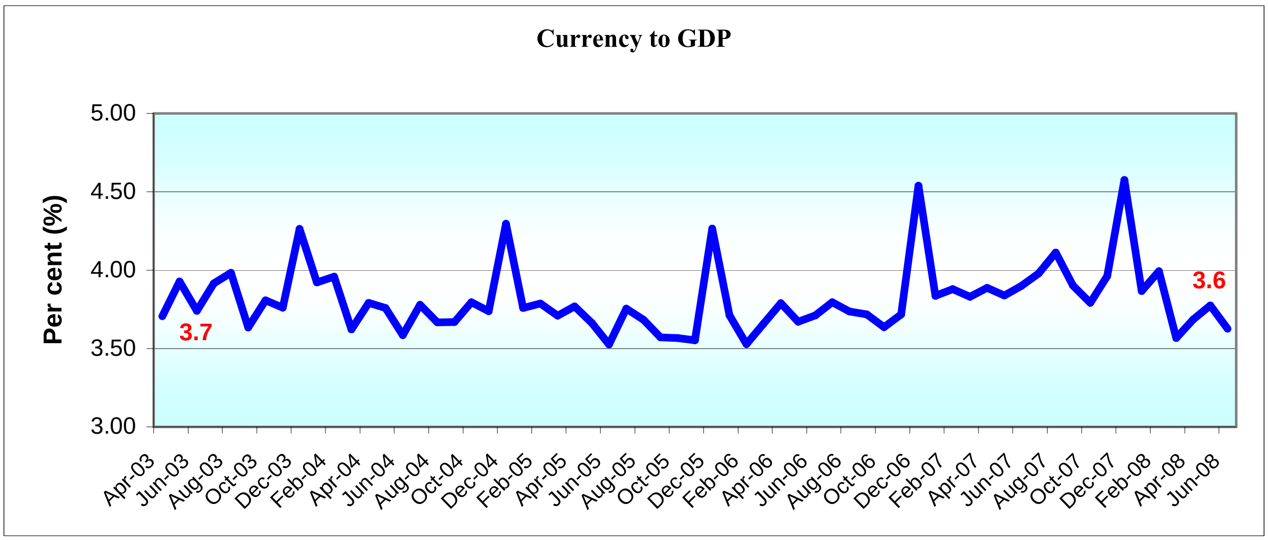
Figure 8 depicts the ratio of currency in circulation relative to small value transactions and shows that there was a reduction in the relative importance of currency as a means of payment. This resulted in an increase in the value of payments by means of alternative instruments during the review period.

Figure 8



A sustained reduction in the ratios of currency to GDP ratio and the currency to M1 balances may be regarded as evidence of cash substitution and lends support to the hypothesis that the use of currency as a payment medium is declining as a result of increased card use.[4] Figure 9 shows a marginal decline in currency as a percentage of nominal GDP to 3.63 per cent in June 2008 from 3.74 per cent in June 2003. The decline indicates that currency in circulation to GDP has remained relatively stable over the five year period.

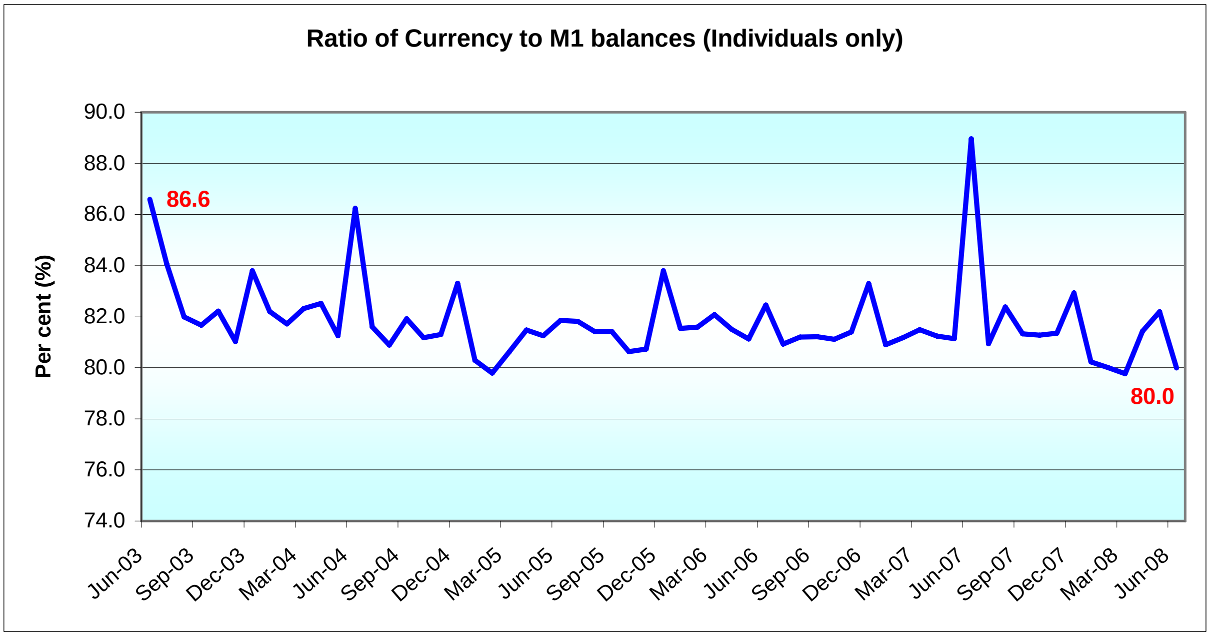
Figure 9



The ratio of currency in circulation to M1 balances revealed a trend decline to 80.8 per cent of M1 balances in June 2008 from 86.8 per cent in June 2003 (see Figure 10).[5]

[4] Cash balances may be held for prudential or speculative purposes. Observed levels of cash holdings only approximate the level of cash use.
[5] M1 balances include currency in circulation and the demand deposits of Individuals only.

Figure 10



The downward trend of this ratio of currency in circulation as well as the reduction in the ratio of currency as a percentage of GDP suggests that the use of currency declined during the period and provides evidence for the hypothesis that cash use declined during the review period.

4.0 Review of the Literature

In estimating the effect of alternative means of payment on the demand for currency, a log-linear specification of the form:

$$Log\ Y = \beta_o + \beta_1\ Log\ X + \beta_2\ R + \beta_3\ Log\ (Card) + e_t \qquad (1)$$

is assumed as a theoretical starting point whether a times series approach or cross-sectional specification is adopted. In the time series approach, *log Y* represents the log of currency in circulation while *log X* is an appropriate scale variable such as income, wealth or expenditure and *R* represents a measure of the opportunity cost of money holdings. The empirical model specifies money demand as a function of real balances such that price homogeneity is explicitly imposed in the model. *Card* typically consists of several variables measuring the impact of payment cards which is usually approximated by the number of outstanding credit and debit cards, the number of EFTPOS terminals or merchants and the number of ATMs. With regard to the number of ATM and EFTPOS terminals, Stix (2003) recommends the use of the volume of transactions conducted at these terminals instead rather than the number of machines.

Yilmazkuday (2006) analyzed the effects of credit and debit cards on the currency in circulation using GMM estimation. The model estimated nominal currency demand at the beginning of each period as a function of wealth, the price level, interest rates as well as credit and debit card usage. In particular, the effects of credit and debit cards on the demand for currency were estimated separately. Yilmazkuday found that as a consequence of the currency substitution feature of both credit and debit cards, the usage of these cards had a negative effect on currency demand. However, the usage of the debit cards had a larger impact on the currency demand than credit card usage. He postulated that this was probably due to the fact that debit cards were inevitably used to withdraw cash from ATMs. Yilmazkuday also found that the effect of debit cards was largely through withdrawals while that of credit cards occurred largely through purchases. Yilmazkuday hypothesized that the negative effect of credit cards on currency demand largely reflected a shift in individuals' demand for currency, whether transactional or precautionary in nature, to credit cards.

Stix (2004) analyzed the cash withdrawal habits of Austrians based on surveys from May 2003 to February 2004. The paper explored the effect of EFTPOS payments and ATM withdrawals on the demand for purse cash. Specifically, average purse cash is modeled as a function of personal net income and various socio-demographic factors including age, sex, education and kids below the age of 15 years. The results reveal that purse cash demand is significantly affected by debit card usage and that there were significant differences in cash demand for individuals with different debit card usage frequencies. Stix also noted that ATM transactions reduce the time-cost per withdrawal thereby increasing the number of withdrawals and reducing the average cash holdings. He argued that ATM transactions and cashless payments could affect the optimal cash holdings in two ways. ATM transactions could increase the velocity of cash in circulation as lower cash balances are held for a given value of transactions[6]. Additionally, the option of cashless payments could change the volume of cash transactions and as a consequence cash demand since card payments permit direct access to the payer's account; hence only part of the total transaction is carried out in cash. Markose and Loke (2003) showed that this decline in cash transactions had a proportional effect on optimal cash holdings.

Stix (2003) further noted that the empirical literature did not provide a clear result for the effect of ATM on cash demand as ATM usage was found to either have no effect or a negative effect on cash demand. Stix postulated that this result was possible because users of ATMs accessed these facilities with differing frequencies. He noted that if the share of infrequent ATM users dominated, then cash demand was likely to remain unaffected, however if the share of individuals who used the ATM frequently was high then a negative effect on cash demand was likely to occur. Stix also hypothesized that it may be possible that ATM transactions merely substituted bank counter withdrawals. In this case, the average cash holdings would remain the same and ATM use would have no effect on cash demand. Stix asserted that in a time series study, the observable aggregate effect would represent a weighted average of the effect of both frequent and infrequent ATM users that is, the magnitude of the change in cash balances caused by ATMs for each group multiplied by their relative size. He noted that if both effects cancel, then a macro-econometric study would not detect an effect even if it were present at the individual level. Stix argued that microeconomic studies, in contrast, noted the effects at the individual level and indicated that ATM transactions had a significant negative impact of on cash demand.

Seitz (2003) supported the view that the effect of ATM on cash demand is not definite. In a theoretical model of Euro currency demand, he asserted that the transaction demand for currency and the replacement of cash by other payments media, such as credit and debit cards was influenced by ATM and EFTPOS densities. Markose and Loke (2003) argued that the network effect of high densities as well as low user costs might foster cashless

[6] A higher velocity of circulation means that each dollar in circulation enables cash transactions of a correspondingly higher value. Hence, the velocity of cash in circulation measures the efficiency of cash as a means of payment.

payments in retail systems. However, Seitz noted that high ATM density could also imply high cash withdrawals and not cashless payments.

Rinaldi (2001) estimated a currency demand equation for Belgium to determine the extent to which currency had been substituted by alternative means of payment. The equation explicitly accounted for the financial innovations by including the number of debit and credit cards, the number of EFTPOS merchants as well as the number of ATM machines. She assumed that the currency in circulation, interest rates, real GDP as well as the card variables were non-stationary and subsequent tests revealed that these variables were cointegrated. Estimation of an error correction model revealed the existence of a long run relationship between currency in circulation and the other variables given that the error correction term was significant. In the long-run equilibrium relationship, POS merchant acceptance and the number of ATMs had a negative impact on currency in circulation while a weak positive effect was found for the number of credit and debit cards. Rinaldi noted that the strong negative impact of ATMs on currency demand was due to the improved ease of acquiring cash which reduced the need to hold large amounts of currency. She explained that this finding was consistent with the increased number of monthly withdrawals. In addition, currency demand was found to be negatively affected by an increase in short term interest rates.

Snellman, Vesala and Humphrey (2000) estimated a money demand equation using panel data for ten European countries and found that the number of debit and credit cards had an insignificant effect on currency demand. However, the effect of ATM and EFTPOS terminals on cash demand was found to be significantly negative. The negative effect of ATMs was found to be more than twice as large as the effect of POS terminals. Snellman, Vesala and Humphrey explained that the failure of earlier studies to detect the negative effect of ATM terminals on cash demand might be due to the time associated with behavioural adjustment required for frequent cash withdrawals to lead to lower value being withdrawn each time. They referred to the time required for consumers to make the behavioural change associated with the reduction in cash holdings as the "learning period". Snellman, Vesala and Humphrey contend that card payments have been the major cause of cash substitution by showing that the density of EFTPOS terminals had a significant and negative effect on currency outstanding. They further argued that the density of EFTPOS terminals was a key factor affecting the slope or speed of the cash substitution process and that after the initial learning period; ATM use had a negative effect on currency outstanding.

The findings of Snellman, Vesala and Humphrey (2000) were in line with the inventory theory presented in the Baumol-Tobin model of transaction demand for money, which predicts that ATM use lowers the transaction cost of cash withdrawals increasing the frequency of withdrawals and reducing the amount withdrawn each time thereby lowering the demand for cash holdings for transaction purposes. They contend that the cash substitution process is principally driven by the expanded use of credit and debit cards at the point of sale, and that cash is losing ground to various forms of non-cash payments, particularly plastic cards which are the strongest substitutes for cash. They argue that the reduction in cash use is evident in commonly employed indicators of the demand for currency use such as the share of currency in circulation to narrow money (M1) and the currency to GDP ratio. A sustained reduction in these indicators is regarded as evidence of cash substitution and lends support to the hypothesis that currency in circulation is declining as a result of increased card use.

The demand for money in Jamaica has received much attention in recent literature. However, currency demand has been estimated by few researchers, none of whom sought to determine the impact of the non-cash payment media on the demand for currency. Williams (1997) examined alternative approaches to forecasting the demand for currency in the Jamaican economy. The cointegration and error correction model (ECM) used in that research work described the adjustment path for currency demand relative to selected macroeconomic variables such as the consumer price index (CPI), the weighted average deposit rate, the exchange rate as well as consumer imports comprising food and non-durable items. The paper analyzed monthly data spanning the period 1990:12 to 1996:12 and found that the primary basis for holding cash balances in the short run was for transactions as suggested by the price and transaction proxies. The ECM term was negative and very significant implying that a long run relationship existed between currency demand and the various macroeconomic variables. However, given deficiencies in the structural specification, such as appropriateness of model specification and lagged data availability for variables, the use of the ARMA model was recommended for forecasting currency demand.

With regards to the choice of the scale variable, Williams noted that the correlation between currency and non-durable consumption and the relationship between currency and GDP were both significant. However, there was weak correlation between investment and currency which provided support for a model with disaggregated transaction data and not GDP. Despite the use of disaggregated transaction data by Williams, the variable did not have the expected sign. This was attributed to the selected transaction proxy, consumer imports not being an ideal estimate of transactions level. In addition, the exchange rate and interest rate were found to be statistically insignificant. Williams conjectured that the emphasis in the short run is not the relative shifting between cash balances and other assets such as foreign currency holdings though portfolio shifting may exist. Williams noted that in the Jamaican economy, the primary basis for holding currency balances in the short run is for transactions as is conjectured from the statistical significance of the price and transaction proxies.

5.0 Data and Econometric Methodology

Most studies on the demand for money in Jamaica have concentrated on the use of broad monetary aggregates; however this paper focuses on the narrowest measure, currency in circulation. While the primary objective of the paper is to determine the impact of alternative means of payment on the demand for currency, special attention is given to identifying the model which best forecasts the monthly movements in currency in circulation. Thus, the monthly demand for currency in circulation is forecasted using three different methodological processes. The first technique incorporates the theoretical and economic relationships between currency demand, various economic variables and alternative payment media. It uses an error correction framework to estimate the impact of the non-cash means of payment, particularly the use of debit and credit cards on the demand for currency in Jamaica. The forecasting ability of the model is analyzed by comparing its performance to that of a short run model and a univariate Autoregressive Integrated Moving Average (ARIMA) model.

5.1 Data

The data used in the derivation of the ECM included currency in circulation[7], consumer goods imports, in particular food and non-durable imports (c.i.f value), the consumer price index (CPI), the 3-month Treasury bill rate and the exchange rate (see Appendix for graphical representation of the series). The variables of special interest such as ATM volume, EFTPOS volume and the number if debit and credit cards in circulation were also included. The Treasury bill rate was used as it may be viewed as an alternative asset to holding money given that Treasury bills are very liquid and represent a risk free rate of return. In addition, Sriram (1999) noted that researchers adopting the transaction demand view of money generally employ short-term rates like the yields on government securities, commercial paper or savings deposits with a notion that these instruments are closer substitutes for money and their yields are especially relevant among alternatives that are forgone by holding cash.

Non-durable consumer goods imports were chosen as the scale variable approximating the demand for currency solely for transaction purposes given the absence of data on retail sales or private consumption expenditure which is used in similar studies for other countries. In contrast to other studies of money demand in Jamaica, the model does not include GDP since it is not available on a monthly frequency. The use of non-durable consumer goods imports as a reasonable proxy for the value of monthly transactions is supported by Sriram (1999) which indicated, that for an open economy, the disaggregation of the scale variable to appropriately reflect nature of international transactions might be important. Similarly, Mankiw and Summers (1986) supports the use of consumption proxies since this component tends to be much more money intensive than other components of GDP. The study also explored the use of data on total general

[7] The real demand for currency is estimated given that price homogeneity has been imposed. The CPI was used to deflate both the currency and income variables.

consumption tax (GCT), GCT collected locally and total consumer imports as proxies for the value of transactions however these variables did not yield better results. All variables used were collected on a monthly frequency for the period April 2003 to June 2008.

5.1.1 Model Techniques

To investigate the impact of alternative means of payment on currency demand, the study employed the use of a cointegration and error correction modeling framework to specify an appropriate long run currency demand function for Jamaica. The Augmented Dickey-Fuller (ADF) test was used to investigate the possibility of unit roots and to determine the order of integration. The number of cointegrating relationships among the variables was determined using the Johansen method.

Error correction models are useful because they reconcile short and long run behaviour of the variables involved. The long run relationship is incorporated by including the lagged co-integrating vector into the model and the short run dynamics are captured by including the variables in their differenced form.

The error correction model estimated can be represented as follows:

$$\Delta \mathbf{Z_t} = \beta_0 + \Pi \mathbf{Z_{t-1}} + \sum_{i=1}^{k-1} \Gamma \Delta \mathbf{Z_{t-I}} + \boldsymbol{\mu} \mathbf{X_t} + \varepsilon_t , \qquad (2)$$

where, $Z_t = (Y_t \; X_t)$ is the vector of I(1) variables and $\Pi = \alpha\beta'$ where α is the vector of adjustment coefficients and β the vector of cointegrating relation. X represents the deterministic variables such as seasonal dummies and the constant term which are often included to take account of short-run shocks to the system.

In this paper, the *Card* variable will be disaggregated to explicitly include ATM volume, POS volume as well as the number of cards in circulation to assess the impact of these alternative payment media on currency demand. In this regard, the functional form of the model used will be:

$$\textbf{\textit{Log (M/P)}} = \beta_o + \beta_1 \, \textit{Log (NOND)} + \beta_2 \, \textit{TBIL} + \beta_3 \, \textit{Log (ATMV)} + \beta_4 \, \textit{Log (POSV)} + \beta_5 \, \textit{Log (CARD)} + e_t \qquad (3)$$

where *M* is the currency in circulation, *P* is the price level, *NOND* represents consumer goods imports and *TBIL* is the interest rate on 3-month Treasury bill. The card variables ATM volume, EFTPOS volume and the number of debit and credit cards in circulation are represented by *ATMV, POSV* and *Card*, respectively. While the other variables typically enter in logarithms, the interest rate variable is used in levels. Consequently, estimates of the coefficients will provide the elasticity of the variables.

A priori, the demand for currency is expected to be positively influenced by the scale variable, NOND and negatively influenced by the opportunity cost variable, the 3-month Treasury bill rate, *TBIL*. The demand for currency is expected to decline as transaction technology improves thereby reducing the need for cash. In this regard, the number of credit and debit cards outstanding as well as EFTPOS terminals or volume is expected to be negatively related to currency demand while the number of ATMs or ATM volume may be positively or negatively related to the demand for currency. Currency demand is positively influenced by the number of ATMs if as the number of ATMs increase; individuals increase their demand for currency since it can be easily accessed. An alternative view suggests that the existence of ATMs reduces the demand for currency since individuals can minimize the opportunity cost of idle cash balances. In this case, ATMs would have a negative impact on currency demand.

5.1.2 Empirical Results

The results of the Augmented Dickey Fuller (ADF) tests with intercept only indicate that the level form of all the variables were non-stationary at the 5 per cent level of significance. Enders (1995) noted that visual inspection on the series provides useful information concerning outliers, missing values and structural breaks[8]. Visual inspection of the time series was therefore conducted to determine whether there were outliers, seasonality and or structural breaks present. These exogenous variables were then

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[8] See Enders, W. (1995), Applied Econometric Time Series, John Wiley & Sons Inc. pg 95

incorporated into the ADF test of the time series. Initially, the lag length was set to twelve and a constant, trend, seasonal dummies or dummies representing structural breaks identified were included. Insignificant lags were deleted until all remaining lags were significant.

The histogram normality residuals test was then applied and the equation for each variable was accepted only if the residuals were normal. A p-value greater than the level of significance, 0.05, indicated the null hypothesis of normality of residuals could not be rejected. The t-statistic of the first lag of each variable was compared to the ADF test statistic to determine whether the variable was stationary given the inclusion of constant, trend, seasonality or structural breaks. Table 4 shows the ADF test with intercept only as well as the results of tests which included seasonality and structural breaks which indicated that all the variables were non-stationary except the three-month Treasury bill rate[9]. The variables were also found to be stationary at the 5% level of significance in both their first differenced forms which suggest that they are integrated of order one, that is I(1). The Augmented Dickey Fuller test applied may be written as follows:

$$\mathbf{\Delta y_t = a_o + a_1 y_{t-1} + a_2 t + \mu D_j + \sum_{i=2}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t} \qquad (4)$$

where, t = time trend variable and D_j is a dummy variable representing structural break. The coefficient of interest is a_1 and if it equals zero then the entire equation is in first differences and so has a unit root. The t- statistic is calculated for the null hypothesis a_1=1 and this is compared with critical values given by the ADF test.

[9] The three-month Treasury bill rate was found to be I(1) with and without an intercept as well as when both trend and intercept were included.

Table 4

AUGMENTED DICKEY FULLER TESTS							
LEVELS						FIRST DIFFERENCES [2]	
	Intercept		Trend / intercept / dummy				
Variables	Test statistic	Lags	Test statistic	Lags	P-value [4]	Test statistic	Lags
LATMV	-0.342	4	2.612	3	0.172	-7.630*	3
LCARD	-0.334	1	-2.017	1		-16.034*	0
LPOSV	-1.954	1	-2.322	2	0.121	-8.677*	1
RCUR	-0.695	3	2.301	1	0.889	-6.826*	10
LP	0.517	1	-1.310	1		-4.554*	0
TBIL	-1.808	0	-1.725	0	0.054	-7.847*	0
RNOND	-0.610	3	2.981	1	0.683	-6.004*	3
1% level	**-3.542**		**-4.113**			**-3.544**	
5% level	**-2.910**		**-3.484**			**-2.911**	
10% level	**-2.593**		**-3.170**			**-2.593**	

1 Due to seasonality in these variables, the ADF test was conducted using seasonal dummies. The same critical values for the ADF test with trend are used.

2 Since differencing eliminates trend, unit root tests for the first differences are carried out and reported with intercept only.

3 * denotes rejection of the null hypothesis of a unit root at the 5% level of significance.

4 P-value refers to the histogram normality of residuals test.

The tests for the optimal lag order of the VAR indicated that either one or two lags could be used in the vector error correction model. The Likelihood Ratio (LR), Final Prediction Error (FPE) and the Akaike Information Criterion (AIC) indicated the use of two lags while the Schwartz (SC) and the Hannan Quinn (HQ) criteria indicated the use of one lag. The model selected was that with two lags given that Fischer, Köhlerand and Seitz (2004) noted that although theoretically the SC has advantages over the AIC; the latter tends to select the preferred model on more general grounds.

The existence of a long run relationship between real currency balances and the other variables was assessed using two lags. The Johansen maximum likelihood procedure was used to test for the presence of a co-integrating relationship. The trace and maximum eigen-value statistics indicated the presence of three co-integrating vectors and one co-integrating vector, respectively, at the 5% level of significance.

Table 5: VAR lag Order Selection Test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	464.7233	NA	7.11e-15	-15.54994	-15.33867	-15.46747
1	639.0561	307.2984	6.58e-17	-20.23919	-18.76026*	-19.66188*
2	685.1239	71.83457*	4.86e-17*	-20.58047*	-17.83390	-19.50832
3	713.0951	37.92710	7.04e-17	-20.30831	-16.29408	-18.74132
4	739.5186	30.45415	1.19e-16	-19.98368	-14.70181	-17.92185

* indicates the lag selected by the criterion

The long run cointegrating vector can be written in equation form as follows:

rcur* = 0.207 *rnond* – 8.119*tbil* + 1.766 *latmv* – 0.305 *lposv* -** 3.372 ***lcard –32.165

The long run coefficients all had the correct signs and were found to be statistically significant, with the exception of consumer goods imports and POS volume which were not significant. The small transactions elasticity of 0.253, being closer to 0.5 than one indicates that the scale variable real non durable imports, plays the role of transaction measure alone[10]. This could also be attributed to the selected variable not being an ideal estimate of transaction levels and highlights data limitation of the model. Sriram (1999) noted that there is no clear guidance from the theory or empirical studies regarding the acceptable magnitude on elasticity of the opportunity cost (interest rate) variables. Hence, the most relevant information will be the sign of the coefficient which should be negative for alternative return on money. The coefficients on the other variables suggest that the number of cards in circulation had a stronger negative effect on the demand for real cash balances than the volume of point-of-sale transactions. The positive effect of ATM

[10] See Sriram, S.S., (1999), "Survey of Literature on Money for Demand: Theoretical and Empirical Work with special reference to Error Correction Models", IMF Working Paper, # 64

volume on currency demand suggests that ATMs are used primarily for accessing cash thereby increasing real currency balances which is in line with the a priori expectations.

5.2 Adjustment coefficients

The adjustment coefficient of *rcur* is negative, very significant and in line with a priori expectations. It represents the speed at which the variable moves toward restoring the long run long run equilibrium. The results showed that real cash balances (*rcur*) have an adjustment of -0.076 which indicates that 7.6 per cent of the adjustment is achieved in the first month, a relatively slow adjustment process (see appendix for table A1). The negative sign implies that the lagged excess currency holdings induce smaller holdings in the current period.

5.3 Weak Exogeneity Tests and Other Tests

Given the identification of the co-integrating vector, weak exogeneity tests were conducted. If a variable is weakly exogenous, it is possible to condition the short-run model on that variable without any loss of information. The test results presented in Table 6 indicate that ATM volume, EFTPOS volume, the number of cards in circulation, and a combination of these variables were weakly exogenous.

Exclusion from the cointegrating vector was also tested individually for all the variables. These linear restrictions were imposed on the coefficients to determine whether these variables were in the long-run relationship. For the variables of interest, the restrictions were rejected for both *lcard* and *latmv* at the 5 per cent level significance. The restrictions

Table 6

Variables	Test statistic	p-value
RCUR	$\chi 2(1) = 5.313$	[0.021]*
RNOND	$\chi 2(1) = 7.976$	[0.005]**
TBIL	$\chi 2(1) = 35.088$	[0.000]**
LATMV	$\chi 2(1) = 4.063$	[0.044]*
LPOSV	$\chi 2(1) = 1.284$	[0.257]
LCARD	$\chi 2(1) = 0.178$	[0.673]
LATMV & LCARD	$\chi 2(1) = 4.093$	[0.129]
LPOSV & LCARD	$\chi 2(1) = 1.402$	[0.496]
LATMV & LPOSV	$\chi 2(1) = 8.175$	[0.017]
LATMV &LPOSV & LCARD	$\chi 2(1) = 8.177$	[0.042]*

* denotes significance at 95%, ** denotes significance at 99%

were not rejected at the 5 per cent level of significance for *lposv* however the exclusion of all three or any two of these variables from the long run equation was rejected at the 5 per cent level of significance. This implies that the variables *lcard*, *latmv* and *lposv* should be included in the co-integrating vector. Exclusion of the interest rate variable from the co-integrating vector was also rejected at the 5 per cent level of significance. These results indicate that a long run relationship exists between real currency balances and the other variables. This is further substantiated by the rejection of the joint test that both the long run and adjustment coefficients were zero at the 5 per cent level of significance for all the variables except EFTPOS volume.

5.4 Error Correction Model

Based on the cointegration analysis and the results of the weak exogeneity tests, an error correction model for real currency balances was derived in a single equation. To estimate the model, a new variable EC which represents the error correction term, was formed using the co-integrating vector estimated.

$$EC = rcur + 0.207\, rnond - 8.119\, tbil + 1.766\, latmv - 0.305\, lposv - 3.372\, lcard - 32.165$$

The single equation model was estimated with the first differences of the variables and the system is estimated with two lags. The results of the error correction model are presented in Table 7.

The diagnostic test statistics for the ECM money demand model presented in Table A4 reveals that the model is econometrically well specified. The model has 90.4 per cent explanatory power with standard error of 2.5 per cent. Further tests indicate that normality of the residuals is not rejected and there are no problems regarding autocorrelation or heteroscedasticity (see Table 8).

Table 7

Variables	Coefficient	Test statistic	p-value
EC	-0.076	-2.561	[0.013]*
DRCUR(-1)	-0.210	-2.730	[0.009]**
DRNOND(-1)	0.084	3.650	[0.001]**
DLATMV(-1)	-0.310	-4.413	[0.000]**
DLATMV(-2)	-0.158	-2.925	[0.005]**
DLPOSV(-1)	0.150	3.492	[0.001]**
@seas(12)	0.180	15.213	[0.000]**
@seas(1)	-0.100	-5.506	[0.000]**
DUMMYT	0.031	1.882	0.066

* denotes significance at 95%, ** denotes significance at 99%

5.5 Short-run model

A short-run model in first differences of the variables in various lags[11] was also estimated for the period April 2003 to June 2007. The short run dynamics are described by an equation whose exact specification is chosen on the basis of a general to specific procedure, in which insignificant lags are dropped until the most satisfactory and parsimonious representation is found. The period from July 2007 to June 2008 was not included in the model as the model was estimated mainly to determine the forecasting ability of the ECM model. The seasonal dummies for January and December are included in the model as well as the impulse dummy for the Treasury bill rate. In addition, the model was used to determine the proportion of change in the dependent variable that is explained by changes in the independent variables and the exogenous variables. The model obtained was:

Table 8: Results of the short run model

Variables	Coefficient	Test statistic	p-value
DRCUR(-3)	0.150	3.339	[0.002]**
DTBIL	1.100	4.521	[0.000]**
DTBIL(-1)	-0.728	-3.305	[0.002]**
DTBIL(-3)	0.508	1.993	[0.055]
DTBIL(-5)	0.491	2.081	[0.045]*
DLATMV(-3)	0.115	2.697	[0.011]*
DLATMV(-4)	0.185	4.439	[0.000]**
DLPOSV(-1)	0.101	3.774	[0.001]**
DLPOSV(-5)	-0.069	-2.841	[0.008]**
DLCARD(-3)	-0.344	-3.454	[0.002]**
@SEAS(1)	-0.152	-13.717	[0.000]**
@SEAS(12)	0.202	22.366	[0.000]**

* denotes significance at 95%, ** denotes significance at 99%

[11] Given that the frequency of the data was monthly, 12 lags should be included for each variable. However given the small sample only six lags for each variable could be estimated. Following a general to specific approach, all insignificant lags were then deleted.

The short-run model had 96.0 per cent explanatory power with standard error of 1.7 per cent. Further tests indicated that normality of the residuals was not rejected and there were no problems regarding autocorrelation or heteroscedasticity of the as shown in Table 14.

Table 9: Diagnostic Tests of the short run model

Diagnostic Tests	
Test	**p-value**
Normality	0.580
Serial correlation	0.133
Heteroscedasticity	0.776

5.6 ARIMA model

The Autoregressive Integrated Moving Average (ARIMA) model is a time series methodology which uses past and current values of the dependent variable to generate forecasts of the variable. The forecast is generated by modeling the correlation between the series and its past values and assumes this identified correlation will continue into the future. The main premise on which the ARIMA model is generated is the stationarity of the series, which is the tendency of the series to revert of to its mean value in the long run. One advantage of this model is that it does not rely on a priori specification of economic hypotheses and so possible problems which might arise in estimating a structural model are avoided.

Given that the stationarity tests indicated that currency in circulation was I(1), the series was differenced to generate a stationary series for use in the analysis. The ARIMA model was identified using the autocorrelation and partial autocorrelation functions of the differenced currency series. Observations from the sharp decline in the autocorrelation function after the first lag indicated an AR(1) process while the spikes at the 12-month lag indicated that seasonality was present in the data. Examination of the partial autocorrelation function revealed a slow decline as well as spikes at lags 12 and 24. Since monthly data was used a seasonal factor, MA(12) was included at lag 12 to model the seasonality of the currency series. Addition of other AR or MA terms did not improve the model therefore an AR(1) model was chosen with a MA(12) component as well as seasonal dummies for December and January. The results of the ARIMA model are presented in Table 10:

Table 10

Variables	Coefficient	T-statistic	p value
@SEAS(12)	0.193	11.063	[0.000]**
@SEAS(1)	-0.151	-8.585	[0.000]**
AR(1)	-0.335	-2.416	[0.020]*
MA(12)	0.907	35.007	[0.000]**

* denotes significance at 95%, ** denotes significance at 99%

The estimated coefficients of the model were all significant and had the expected signs. The AR(1) term captures the monthly changes in the demand for currency, which was negative indicating a decline in demand in the current month relative to the previous month. The MA(12) term indicates the yearly changes in the stock of currency. The positive coefficient indicates an increase in currency holdings year-over-year. The seasonal dummies included for December and January suggest an increase in currency holdings in December followed by a decline in these holdings in January. In addition, on average, the growth in currency in circulation in December is not entirely reversed in January. In terms of goodness of fit, the ARIMA model chosen had the lowest Akaike and Schwartz Bayesian criteria. In addition, the model explained 92.0 per cent of the change in the dependent variable and had a sum of squared residuals of 0.0215. Further tests indicated that there were no problems with regard to the normality of the residuals, autocorrelation or heteroscedasticity.

6.0 Forecast Evaluations

An analysis of the forecasting ability of each model was conducted using the accuracy measures such as the root mean square error (RMSE), the mean absolute error (MAE) and the Theil U forecast statistics. The RMSE and MAE statistics are relative measures which depend on the scale of the dependent variable and are used to compare forecasts for the same series across different models. A small error indicates better forecasting ability of the model according to that criterion. While the MAE measures the average magnitude of the errors in a set of forecasts, without considering their direction the RMSE is the square root of the squared differences between forecast and corresponding observed values averaged over the sample. Given that the errors are squared in calculation of the RMSE before they are averaged, it gives a relatively high weight to large errors. Therefore the RMSE is most useful when large errors are particularly undesirable. In contrast, the Theil U statistic[12] is scale invariant and measures how well the model predicts against a 'naive' model. Its coefficient lies between zero and one, where zero indicates a perfect fit. A Theil statistic in excess of one suggests that the simple 'naive' model performs better on average and hence such a model should be re-estimated.

The prediction capability of all three models was evaluated using in-sample and out-of-sample forecasts. The in-sample specification was done for the period April 2003 to June 2007. The purpose of forecasting within the sample was to test for the predictive power of the model. If the magnitude of the difference between the forecasted and actual values is low then the model has good forecasting power. The in-sample forecast performance statistics are shown below:

[12] Theil's U statistic calculates the ratio of the RMSE of the chosen model to the RMSE of the 'naive' (i.e., assuming the value in the next period is the same as the value in this period - no change in the dependent variable) forecasting model. Thus, a value of one for the Theil statistic indicates that, on average, the RMSE of the chosen model is the same as the 'naive' model.

Table 11: Forecast Evaluation for In- Sample Forecasts (2003:04 – 2007:06)

MODELS	CRITERIA		
	RMSE	MAE	Theil U
Error correction model	0.038	0.029	0.003
Short-run model	0.042	0.035	0.003
ARIMA	0.110	0.097	0.009

In terms of the in-sample performance of the models, the error correction model had the lowest RMSE and MAE statistics (see Table 12). This indicates that over the period 2003: 04 to 2007:06, the out-performed the short run model and the ARIMA models. This result is not surprising since over long horizon the structural relationships represented in the ECM should exert more influence on the data than the simple ARIMA or short-run models. However, the performance of the error correction and short run models may be adjudged to be the same using the Theil U statistic. Based the values of the three statistics used to judge the forecasting power of the models, the forecasted series were very close to the actual series.

Table 12: Forecast Evaluation for Out-of-Sample Forecasts (2007:07 – 2008:06)

MODELS	CRITERIA		
	RMSE	MAE	Theil U
Error correction model	0.310	0.237	0.027
Short-run model	0.184	0.160	0.016
ARIMA	0.107	0.094	0.009

To generate the out-of sample forecasts, the models were re-estimated excluding data for the last twelve months of the sample. These data points were retained for use in forecasting values for the period which were then compared to the actual values. An evaluation of the out-of-sample forecasts using all three statistics implies that the ARIMA model demonstrated superior forecasting performance relative to the short-run and error correction models given all statistics were lower for this model. Since the currency demand function's in-sample forecast out-performs that of the other two models, this suggests that the estimated parameters in the demand function are strongly influenced by the observations in this period. In spite of this, the Theil U coefficient for all three models was relatively close to zero, indicating good forecasting performance. It also shows that the error correction process, though relatively slow is very important in explaining the demand for currency.

A graphical evaluation of the out-of sample forecasts is presented below in Figures 11 to 13. The illustrations show that the forecasts all three models demonstrated a relatively high correlation between the actual and forecasted currency values in the first six months of the forecasting period. The models identified the turning points in the data correctly however there was some degeneration in the predictive powers of the models in the last six months of the forecasting period. The ARIMA model which exhibited superior out-of-sample forecasting performance had the least deviation between the actual and forecasted vales in the period January to June 2008. For the error correction model this divergence of forecasts from actual values, suggest that the macroeconomic and payments variables included in the model did not adequately explain the movement of currency in circulation in this period. The failure of the error correction model to display superior out-of-sample forecasts may be due to changes in the structural relationships during the last twelve months of the review period. More specifically, the impact of the fall-out of the alternative investment schemes on the economy and consequently the demand for currency. This graphical analysis supports the findings of the criteria used to judge the forecasting performance of the models. In this regard, it is recommended that the ARIMA model be used for forecasting currency demand over short horizons while the ECM model is recommended for use over a longer horizon. However, one could conclude that all models, used with the observed deficiencies, should provide adequate forecasts for the Bank's operating targets.

Figure 11

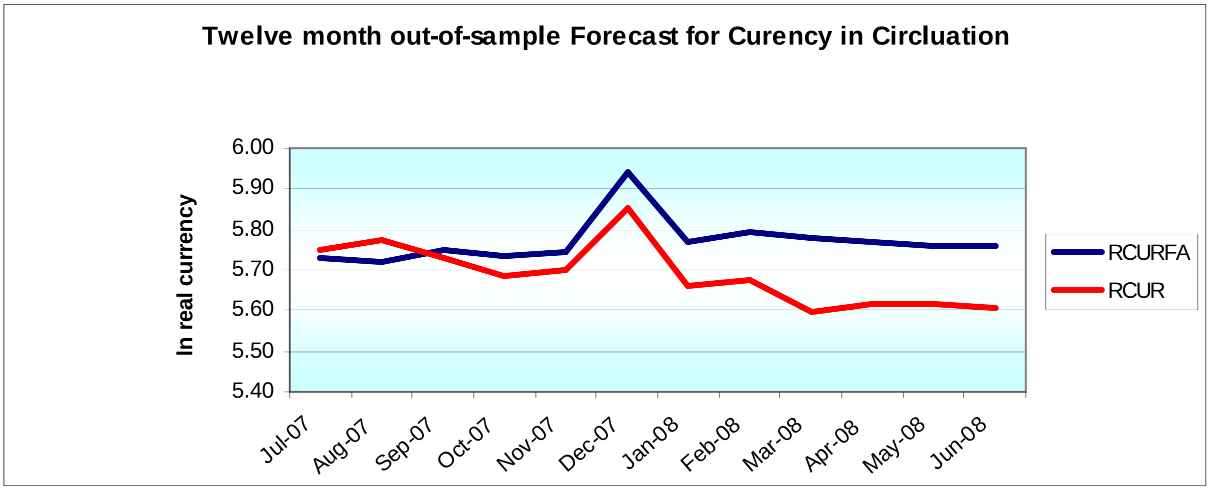


Figure 12

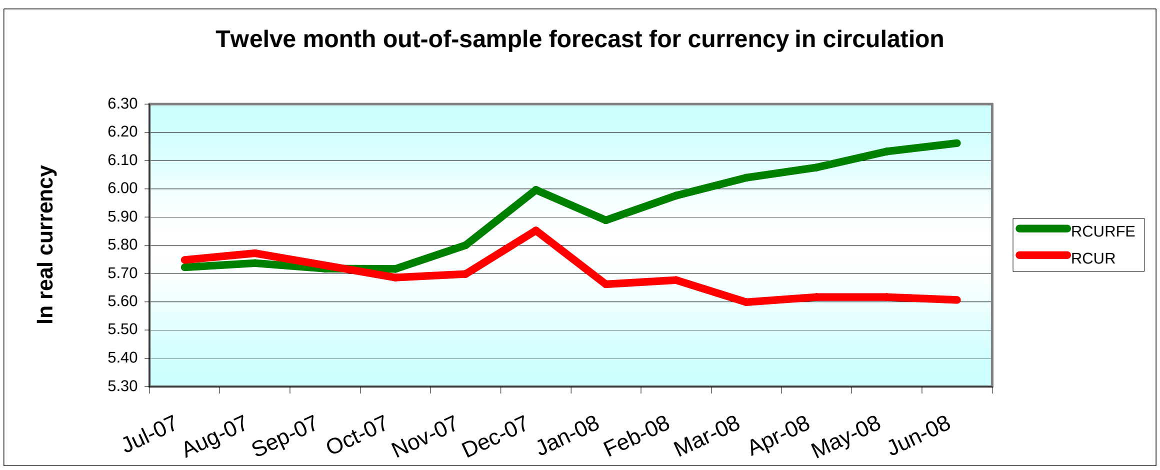
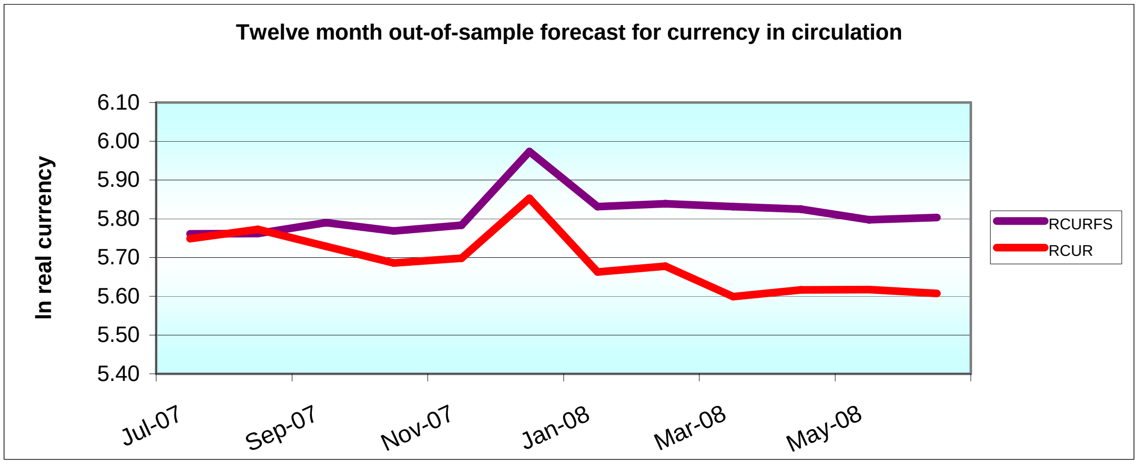


Figure 13



7.0 Conclusion

The increased number of EFTPOS terminals in in Jamaica has expanded significantly the use of debit and credit cards use in retail payments and contributed to a decline in the use of cash. This decline has been evident in the ratio of currency in circulation to small value retail payment methods and currency to narrow money (M1) ratios. Nevertheless, notes and coins are still the preferred and most used instrument for low-value retail transactions.

In this paper an error correction model was used to estimate the impact of the use of these alternative means of payment on the demand for currency in Jamaica during the period April 2003 to June 2008. The results suggest that the volume of ATM transactions increases the currency stock while both the volume of EFTPOS transactions and the number of cards negatively influence the demand for currency, consistent with expectations. The results also suggest that the effect of ATM usage on the currency demand was larger than the effect of EFTPOS usage during the review period.

A comparison of the forecasting power of the ECM model with that of a short-run and an ARIMA model indicated that the ECM demonstrated statistical superiority in-sample while the ARIMA model performed better in out-of-sample forecasting. The failure of the error correction model to display superior out-of-sample forecasts may be due to changes in the structural relationships during the last twelve months of the review period. More specifically, the impact of the fall-out of the alternative investment schemes on the economy and consequently the demand for currency.

Given the findings, it could be argued that currency is being substituted by various alternative payments media. However, the impact is not as great as previously anticipated. An explanation could be that both consumers and merchants adapt their payment habits rather slowly. As a consequence, payments media such as EFPOS machines are not readily available in some areas of the country and where they are available some consumers might still chose not to use them given the associated charges. In addition, the anonymity of cash transactions is still preferred by some individuals. Nevertheless, the change towards a more convenient and efficient retail payment system is gradually occurring.

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Appendix

Graph A1: Graphs of the variables in natural logs

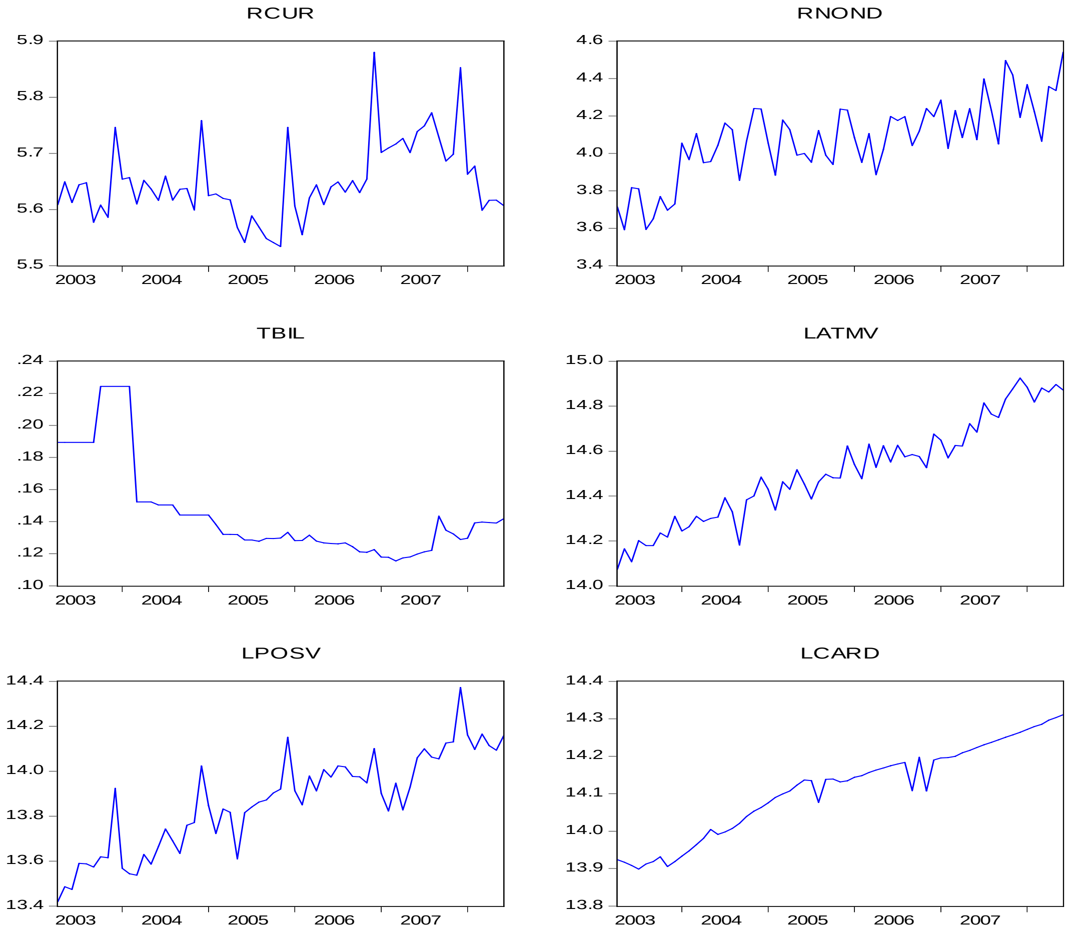

Table A1: Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 01/09/09 Time: 17:19
Sample (adjusted): 2003M07 2008M06
Included observations: 60 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
RCUR(-1)	1.000000
RNOND(-1)	-0.206636 (0.19949) [-1.03583]
TBIL(-1)	8.119053 (1.00639) [8.06753]
LATMV(-1)	-1.766196

	(0.37825)
	[-4.66934]
LPOSV(-1)	0.304937
	(0.17976)
	[1.69635]
LCARD(-1)	3.372257
	(0.66457)
	[5.07431]
C	-32.16512

Error Correction:	D(RCUR)	D(RNOND)	D(TBIL)	D(LATMV)	D(LPOSV)	D(LCARD)
CointEq1	-0.093559	0.670460	-0.093222	0.188244	-0.135908	0.012446
	(0.04557)	(0.24330)	(0.01291)	(0.09584)	(0.12343)	(0.03376)
	[-2.05287]	[2.75575]	[-7.21845]	[1.96414]	[-1.10106]	[0.36862]
D(RCUR(-1))	-0.195926	0.262811	0.028963	0.252028	0.495875	0.000181
	(0.12683)	(0.67709)	(0.03594)	(0.26672)	(0.34351)	(0.09397)
	[-1.54474]	[0.38815]	[0.80585]	[0.94490]	[1.44354]	[0.00193]
D(RCUR(-2))	-0.013260	-0.223411	-0.012302	-0.310337	-0.211877	0.012862
	(0.09379)	(0.50071)	(0.02658)	(0.19724)	(0.25403)	(0.06949)
	[-0.14138]	[-0.44619]	[-0.46285]	[-1.57337]	[-0.83407]	[0.18509]
D(RNOND(-1))	0.086381	-0.478407	-0.005192	0.021965	-0.113476	-0.022949
	(0.02705)	(0.14440)	(0.00766)	(0.05688)	(0.07326)	(0.02004)
	[3.19349]	[-3.31311]	[-0.67741]	[0.38616]	[-1.54898]	[-1.14516]
D(RNOND(-2))	0.000834	-0.502086	-0.006714	-0.058787	-0.087381	-0.006525
	(0.03223)	(0.17207)	(0.00913)	(0.06778)	(0.08730)	(0.02388)
	[0.02589]	[-2.91789]	[-0.73509]	[-0.86727]	[-1.00094]	[-0.27323]
D(TBIL(-1))	-0.325139	-0.415402	0.177488	-0.606125	-0.695139	-0.333149
	(0.33591)	(1.79323)	(0.09519)	(0.70640)	(0.90977)	(0.24887)
	[-0.96793]	[-0.23165]	[1.86463]	[-0.85805]	[-0.76408]	[-1.33866]
D(TBIL(-2))	-0.033391	0.091715	0.100570	0.030095	1.444084	-0.449520
	(0.33916)	(1.81058)	(0.09611)	(0.71324)	(0.91858)	(0.25127)
	[-0.09845]	[0.05066]	[1.04643]	[0.04219]	[1.57209]	[-1.78896]
D(LATMV(-1))	-0.322099	0.297695	-0.127213	-0.351666	-0.041970	0.171010
	(0.10475)	(0.55919)	(0.02968)	(0.22028)	(0.28370)	(0.07761)
	[-3.07496]	[0.53237]	[-4.28581]	[-1.59645]	[-0.14794]	[2.20360]
D(LATMV(-2))	-0.149030	-0.229254	-0.063946	-0.113271	0.006052	0.081705
	(0.09241)	(0.49334)	(0.02619)	(0.19434)	(0.25029)	(0.06847)
	[-1.61263]	[-0.46470]	[-2.44190]	[-0.58285]	[0.02418]	[1.19335]

D(LPOSV(-1))	0.132240	0.157773	0.028660	-0.047826	-0.308676	-0.092944
	(0.05321)	(0.28405)	(0.01508)	(0.11190)	(0.14411)	(0.03942)
	[2.48527]	[0.55544]	[1.90082]	[-0.42742]	[-2.14194]	[-2.35771]
D(LPOSV(-2))	-0.035430	0.245083	0.033227	0.107861	-0.177275	-0.058871
	(0.05417)	(0.28917)	(0.01535)	(0.11391)	(0.14671)	(0.04013)
	[-0.65407]	[0.84752]	[2.16467]	[0.94686]	[-1.20834]	[-1.46692]
D(LCARD(-1))	0.220642	-0.617554	0.258866	-0.586707	0.707440	-0.899298
	(0.24677)	(1.31734)	(0.06993)	(0.51893)	(0.66833)	(0.18282)
	[0.89413]	[-0.46879]	[3.70202]	[-1.13060]	[1.05851]	[-4.91898]
D(LCARD(-2))	0.099549	-0.280488	0.121869	-0.193166	0.391477	-0.172073
	(0.20789)	(1.10978)	(0.05891)	(0.43717)	(0.56303)	(0.15402)
	[0.47886]	[-0.25274]	[2.06879]	[-0.44185]	[0.69530]	[-1.11724]
C	-0.012092	0.060164	-0.007348	0.030717	0.004708	0.010575
	(0.00559)	(0.02986)	(0.00158)	(0.01176)	(0.01515)	(0.00414)
	[-2.16191]	[2.01497]	[-4.63614]	[2.61149]	[0.31077]	[2.55200]
@SEAS(1)	-0.094667	-0.120205	0.004905	-0.075519	-0.259701	0.020339
	(0.02341)	(0.12498)	(0.00663)	(0.04923)	(0.06341)	(0.01734)
	[-4.04366]	[-0.96181]	[0.73931]	[-1.53394]	[-4.09585]	[1.17263]
@SEAS(12)	0.184409	0.094041	-0.000342	0.096818	0.243227	0.003682
	(0.01418)	(0.07570)	(0.00402)	(0.02982)	(0.03841)	(0.01051)
	[13.0041]	[1.24224]	[-0.08509]	[3.24658]	[6.33291]	[0.35050]
DUMMYT	0.044711	-0.255299	0.043914	-0.072758	0.074690	-0.006360
	(0.02240)	(0.11956)	(0.00635)	(0.04710)	(0.06066)	(0.01659)
	[1.99637]	[-2.13536]	[6.91961]	[-1.54484]	[1.23136]	[-0.38330]
R-squared	0.913402	0.521816	0.681569	0.612845	0.761342	0.596252
Adj. R-squared	0.881180	0.343887	0.563083	0.468788	0.672540	0.446020
Sum sq. resids	0.028902	0.823656	0.002321	0.127814	0.212003	0.015864
S.E. equation	0.025926	0.138401	0.007346	0.054520	0.070216	0.019207
F-statistic	28.34675	2.932718	5.752322	4.254167	8.573407	3.968875
Log likelihood	144.0092	43.51409	219.6701	99.40940	84.22871	162.0053
Akaike AIC	-4.233642	-0.883803	-6.755669	-2.746980	-2.240957	-4.833511
Schwarz SC	-3.640244	-0.290406	-6.162271	-2.153582	-1.647559	-4.240113
Mean dependent	-8.97E-05	0.012073	-0.000792	0.012745	0.011412	0.006706
S.D. dependent	0.075212	0.170863	0.011114	0.074803	0.122704	0.025806
Determinant resid covariance (dof adj.)		1.92E-18				
Determinant resid covariance		2.60E-19				
Log likelihood		772.9462				
Akaike information criterion		-22.16487				
Schwarz criterion		-18.39505				

Table A2: Error Correction Estimates

Dependent Variable: D(RCUR)
Method: Least Squares
Date: 01/09/09 Time: 17:18
Sample (adjusted): 2003M07 2008M06
Included observations: 60 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
EC6	-0.076006	0.029679	-2.560955	0.0134
DRCUR(-1)	-0.209742	0.076829	-2.729997	0.0087
DRNOND(-1)	0.084096	0.023041	3.649803	0.0006
DLATMV(-1)	-0.310126	0.070279	-4.412765	0.0001
DLATMV(-2)	-0.157584	0.053872	-2.925137	0.0051
DLPOSV(-1)	0.150118	0.042992	3.491765	0.0010
@SEAS(12)	0.179760	0.011816	15.21298	0.0000
@SEAS(1)	-0.099656	0.018099	-5.506162	0.0000
DUMMYT	0.030885	0.016407	1.882497	0.0655

R-squared	0.904798	Mean dependent var	-8.97E-05
Adjusted R-squared	0.889864	S.D. dependent var	0.075212
S.E. of regression	0.024960	Akaike info criterion	-4.405584
Sum squared resid	0.031774	Schwarz criterion	-4.091432
Log likelihood	141.1675	Hannan-Quinn criter.	-4.282702
Durbin-Watson stat	1.947767		

Table A3: Diagnostic Tests for the ECM model 2003:04 to 2008: 06

Diagnostic Tests	
Test	p-value
Normality	0.190
Serial correlation	1.000
Heteroscedasticity	0.827

Table A4: Cumulative Sum of Squares of Recursive residuals: ECM specification 2003:04 to 2008:06

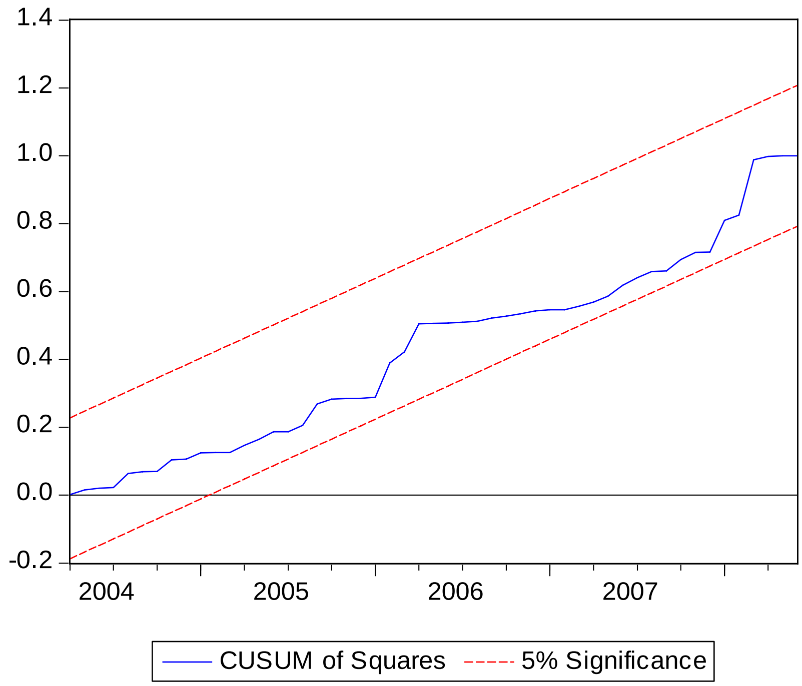

Table A4: Short run model 2003:04 to 2007:06

Dependent Variable: D(RCUR)
Method: Least Squares
Date: 02/23/09 Time: 14:19
Sample (adjusted): 2003M10 2007M06
Included observations: 45 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
DRCUR(-3)	0.150011	0.044928	3.338905	0.0021
DTBIL	1.100040	0.243296	4.521403	0.0001
DTBIL(-1)	-0.728143	0.220331	-3.304762	0.0023
DTBIL(-3)	0.507607	0.254691	1.993034	0.0546
DTBIL(-5)	0.491374	0.236077	2.081415	0.0452
DLATMV(-3)	0.115320	0.042759	2.696951	0.0109
DLATMV(-4)	0.184761	0.041623	4.438972	0.0001
DLPOSV(-1)	0.100878	0.026728	3.774247	0.0006
DLPOSV(-5)	-0.069205	0.024358	-2.841223	0.0076
DLCARD(-3)	-0.344067	0.099618	-3.453861	0.0015
@SEAS(1)	-0.152466	0.011115	-13.71694	0.0000
@SEAS(12)	0.201591	0.009013	22.36582	0.0000

R-squared	0.960223	Mean dependent var	0.003585
Adjusted R-squared	0.946964	S.D. dependent var	0.076277

S.E. of regression	0.017566	Akaike info criterion	-5.022501
Sum squared resid	0.010183	Schwarz criterion	-4.540724
Log likelihood	125.0063	Hannan-Quinn criter.	-4.842899
Durbin-Watson stat	1.638118		

Table A5: Short run model 2003:04 to 2007:06

Diagnostic Tests	
Test	**p-value**
Normality	0.580
Serial correlation	0.133
Heteroscedasticity	0.776

Table A6: ARIMA model 2003:04 to 2007:06

Dependent Variable: D(RCUR)
Method: Least Squares
Date: 02/23/09 Time: 14:36
Sample (adjusted): 2003M06 2007M06
Included observations: 49 after adjustments
Convergence achieved after 10 iterations
MA Backcast: 2002M06 2003M05

	Coefficient	Std. Error	t-Statistic	Prob.
@SEAS(12)	0.193015	0.017447	11.06269	0.0000
@SEAS(1)	-0.151299	0.017624	-8.584717	0.0000
AR(1)	-0.334861	0.138597	-2.416075	0.0198
MA(12)	0.907163	0.025914	35.00686	0.0000

R-squared	0.920949	Mean dependent var	0.001823
Adjusted R-squared	0.915679	S.D. dependent var	0.074121
S.E. of regression	0.021523	Akaike info criterion	-4.761258
Sum squared resid	0.020846	Schwarz criterion	-4.606824
Log likelihood	120.6508	Hannan-Quinn criter.	-4.702666
Durbin-Watson stat	2.161167		

Inverted AR Roots	-.33			
Inverted MA Roots	.96+.26i	.96-.26i	.70-.70i	.70+.70i
	.26-.96i	.26+.96i	-.26+.96i	-.26-.96i
	-.70-.70i	-.70-.70i	-.96-.26i	-.96+.26i

Diagnostic Tests	
Test	p-value
Normality	0.305
Serial correlation	0.396
Heteroscedasticity	0.596