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# Simulating the Effects of an Instant Payments System on the Volume of Money

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RESEARCH DEPARTMENT

### ABSTRACT

This study investigates the ex-ante implications of implementing an instant payment system (IPS) in Trinidad and Tobago using a monetarist framework. The paper assumes that an IPS primarily affects the money system with the IPS application being directly linked to individuals' banking accounts. Therefore, drawing from the quantity theory of money, a Vector Error Correction Model (VECM) is used to assess the impact of an IPS on the velocity of money, inflation expectations and the growth of broad money. The findings, using impulse response functions, reveal that implementing an IPS created sustained increases in money velocity and accelerations in broad money growth, indicating enhanced transactional efficiency. The inflation expectations response exhibits a U-shaped pattern, with initial deflationary pressures followed by eventual inflationary effects. Managing liquidity demand pressures and inflation is recommended via routine surveillance and tailoring stress testing scenarios to include an IPS environment.

**JEL Classification Numbers:** H20; H24; H25; H26

**Keywords:** Instant Payments System, Quantity Theory of Money, Vector Error Correction Model, Trinidad and Tobago.

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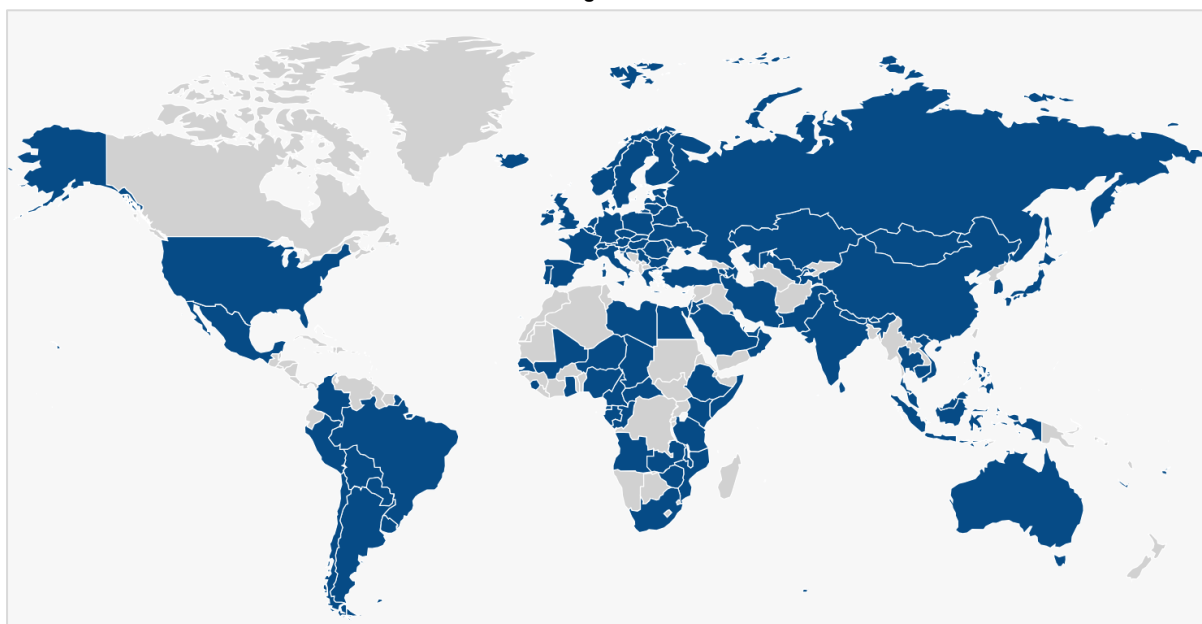
## Simulating the Effects of an Instant Payments System on the Volume of Money

**Natalie Thomas, Latrell Miguel and Alon Dhanessar**

## 1. INTRODUCTION

The shift towards faster, cheaper and more secure transactions continues to foster transformation in the digital payments market. An increasingly popular revolution in this area, globally, is account-to-account instant payments (IPs), that is real-time fund accessible (via real-time payment clearing and settlement), nearly-instantaneous, 24/7, secure payment transactions between bank accounts or payment providers. Compared to traditional payment systems, such as credit card networks and wire transfers, which rely on intermediaries, batch processing and structures around business hours, weekdays and other factors, IPs are a ground-breaking addition to the retail payment market. Facilitated via new technologies and/or changes to existing settlement infrastructure (such as the Automated Clearing House (ACH) system) and regulation, major strides have been accomplished in the payments landscape due to IPs.<sup>1</sup> As depicted in **Figure 1**, the spread and use of IPs are considerable.

### Figure 1



Source: (World Bank 2026)

IP transactions represent a structural transformation in the payments landscape. With less payment and settlement frictions, assuming a relatively high adoption rate, IPs are likely to effect the circulation of liquidity in the system, transactional transparency, activity traceability, financial inclusivity and policy transmissivity. However, IPs are vulnerable to issues such as cyberattacks and regulatory fragmentation.

As of 2025, the global IP market roughly stood at US\$34.2 billion and is expected to reach US\$ 47.1 billion in 2026 and US\$ 499.0 billion by 2034.<sup>2</sup> The leading countries with the most advancements in IPs reside in the Asia-Pacific region<sup>3</sup>, in particular, India with its Unified Payments Interface (UPI)<sup>4</sup>. Other examples include the FedNow Service

<sup>1</sup> The World Bank Group. 2026. Project FASTT: Global Tracker. Accessed 2026. <https://fastpayments.worldbank.org/data#block-homenav>.

<sup>2</sup> Fortune Business

<sup>3</sup> The top countries globalising IP payments include India (UPI), Brazil (Pix), Thailand (PromptPay) and China (Alipay and WeChat Pay).

<sup>4</sup> In 2016, the National Payments Corporation of India established the UPI, a real-time, instant payment system that allows users to transfer money between multiple bank accounts.

(US), the Single Euro Payments Area initiative (EU), PromptPay (Thailand), and, a regional initiative in Barbados<sup>5</sup> (aided by the World Bank)<sup>6</sup>.

In India, prior to the launch of the UPI in 2016, cash transactions dominated the payments landscape. UPI (mobile application software) has expanded the system, integrating various third-party applications (notably Google Pay), which allow for functions such as fund routing, recurring payments, bill splitting, QR code-based transactions and cross-border transactions.

Regionally, Barbados provides one of the most relevant Caribbean examples of an IPS development through BIM Pay. It is a real-time payments platform introduced under the Barbados Payments System Modernisation Project. BIM Pay allows users to transfer funds instantly between participating financial institutions using mobile devices, facilitating 24/7 account-to-account payments and supporting broader objectives of financial sector modernisation. The initiative forms part of a wider strategy by the Central Bank of Barbados to strengthen digital payment infrastructure, reduce reliance on cash, and improve payment efficiency within the economy. The system has demonstrated rapid initial uptake, processing over 1.3 million transactions valued at approximately BDS\$2.2 billion within weeks of its launch in June 2026.

Domestically, Trinidad and Tobago has made (and is making) several steps in modernising the payments ecosystem. The Central Bank of Trinidad and Tobago (CBTT) reaffirmed intentions to shift to a full digital payments system by 2035, including plans to advance the Draft Payment Systems and Services Bill, operationalise UPI-based instant payments and rollout the CARICOM Payment and Settlement System.<sup>7</sup> The National Payment and Innovation Company of Trinidad and Tobago (NPICTT) was also launched (August 2025) as a unified, secure digital payment gateway for all public-sector financial transactions.

Theoretically, the introduction of an instant payments system (IPS) represents a fundamental technological change. Irving Fisher recognised that the velocity of money can change on account of technological and institutional changes. Hence, consistent with monetarist theory, greater adoption and use of an IPS should increase the velocity of money by reducing transaction costs, improving payment efficiency, and accelerating the substitution away from cash holdings. In this light, the IPS should create measurable effects on the circulation of money—particularly on deposit money—that can be observed using the Quantity Theory of Money among others.

From the Quantity Theory of Money, it is well understood that a change in velocity has other macroeconomic effects that are important to understand. Changes to velocity may be accompanied by changes to price levels (inflation), money supply and output. Hence, knowing the magnitude of these changes is crucial for monetary policymakers. Based on this and the recent domestic interest in IPs, this paper investigates the implications of an IPS for Trinidad and Tobago from the monetarist's Quantity Theory of Money perspective. This is simulated using the Quantity Theory of Money, which assessed the potential effects of IPs on money velocity, inflation expectations and the growth rate of money. Understanding these dynamics are significant for policymakers seeking to adapt monetary frameworks in an ever-evolving financial landscape.

<sup>5</sup> Via the Barbados Payments System Modernisation Project, which was launched in October 2024 (Central Bank of Barbados 2024).

<sup>6</sup> The Payment Systems Development Group of the World Bank has assisted more than 120 countries in modernising their payment systems over the years and, more recently, has played a leading role in global research and technical assistance to countries on fast payments. (The World Bank Group 2025)

<sup>7</sup> Daily Express. 2026. Howai: Fully digital payments system by 2035.

## 2. LITERATURE REVIEW

The rapid advancements of digital technologies have revolutionised the financial landscape of many countries, creating new forms of money and modernising payment systems. The advancement of real-time payments (IPS) are among the popular examples of these innovations. Given its capabilities, an IPS could have implications for the velocity of money, impacting other variables such as liquidity, economic activity and affect monetary and financial stability policymaking. Hence, the monetarist school of thought offers a useful framework for assessing these effects.

According to American economist and statistician Milton Friedman, money plays a crucial role in explaining the short-term cyclical fluctuations in economic activities. Under the monetarist view, economies are stable when money supply growth is managed. As such, it is assumed that the mismanagement of money in circulation thus contributes to issues concerning price levels and economic activity (Friedman 1968). A key concept advanced under monetarism is the Quantity Theory of Money, which posits that the product of the money supply ( $M$ ) and the velocity of circulation of money ( $V$ ) equates to the product of general price levels ( $P$ ) and real output of goods and services transacted ( $Y$ )<sup>8</sup>.

The Quantity Theory of Money hinges on several key assumptions, including the relative stability of the velocity of money and the economy operating at full employment (Friedman 1968; Fisher 2006). Meaning that  $M$  is the main determinant of  $PY$  [nominal gross domestic product (GDP)]. However, numerous criticisms about the stability of  $V$  have arisen (Fisher 2006; Jung 2024). In general, the critiques have emphasised the theory's oversimplification of economic dynamics as it neglects factors such as changing economic conditions and behavioural patterns, technological advancements and by extension financial innovations. Nonetheless, the basic equation of exchange (overlooking specific proponents), still holds merit in assessing the impact of payment innovations. Importantly, Lucas (1980) demonstrates that money velocity is not constant, showing that it can shift in response to monetary and financial shocks, which temporarily disrupt the proportional link between money growth and inflation. He illustrates that such shocks alter the joint dynamics of money, prices, and interest rates, underscoring velocity's role as an important transmission channel in monetary economies.

Understanding how the implementation of an IPS can affect monetary policy and financial stability is critical. On the financial stability front, an IPS could introduce significant liquidity risks for depository institutions (Goldberg, Vall-Llobera and Canova 2024). According to the authors, IPs are processed and settled continuously, requiring institutions to maintain adequate balances to settle transactions at any time. Since payments are being settled continuously, the IPS could move payment activity away from systems that settle payments at specific times, impacting financial institutions' available liquidity throughout the day. Given this, it is best practice to develop and enact an appropriate liquidity risk management framework. One such instance of this, developed by the Federal Reserve, is the Federal Reserve Policy on Payment System Risk<sup>9</sup>.

Khiaonarong, Leinonen and Rizaldy (2021) also highlighted several operational risks associated with IPS. One of the primary concerns was fraud risk, as the irrevocable nature of an IPS could increase the potential for fraudulent activities, necessitating enhanced fraud detection and prevention strategies, including coordination among operational stakeholders and comprehensive staff training. Compliance risk was another significant consideration, with institutions needing to adhere to relevant regulations and ensure that anti-money laundering (AML) and fraud controls were appropriately tailored for IPS. Authors emphasised that these risks can significantly impact financial stability by undermining trust, causing liquidity shortages, and disrupting payment systems. In terms of monetary policy, the authors explained that the rapid movement of funds can influence the velocity of money and the

<sup>8</sup>  $MV=PY$

<sup>9</sup> [Federal Reserve Policy on Payment System Risk](#)

transmission of policy changes, requiring central banks to consider these implications when designing and implementing monetary policy.

Following the establishment of the Single Euro Payments Area (SEPA) and the SEPA-wide instant payment platform, Hartmann et al (2019) evaluated the potential of the IPS to become mainstream among six Euro economies. They found that a combination of regulatory support, mobile payment integration, and collaboration among financial institutions facilitated rapid adoption. Specifically, the United Kingdom and Sweden witnessed a substantial shift from traditional payments to IPS, supported by these factors. The study also noted that faster payment availability leads to a moderate increase in money velocity by reducing the transactional delays typically associated with cash and card payments.

Alternatively, Otoakhia (2023) examined the impact of digital payment systems on the velocity of money in Nigeria. Using a range of payment instruments, the study constructed an index for payment system adoption and employed an unrestricted error correction model to simulate how shocks to payment instruments affect money velocity, inflation expectations, and monetary growth. The study found that increased adoption of digital payments initially slows velocity, likely due to a tendency for cash hoarding amid economic uncertainty. However, this deceleration in money velocity was determined to be long-run outcome, while in the short-run, increased digital payment adoption increased money velocity. Overall, the study suggests that digital payment systems exert different effects on money velocity across time horizons, increasing velocity in the short run but reducing it in the long run, possibly reflecting the use of payment channels to facilitate cash withdrawals and liquidity hoarding during periods of uncertainty. However, the study's conclusions regarding cash hoarding and monetary policy effectiveness are not directly tested within the empirical model, limiting the strength of its inference; among other estimation challenges such as small sample size.

In a study focused on money velocity, Mattsson et al (2022) developed a novel approach to estimate the velocity of money by calculating the 'transfer velocity'<sup>10</sup>, which measures the rate at which money moves across accounts within a specific payment system. The method was applied to a community currency in Kenya (Sarafu), leveraging transaction data to determine average holding times in accounts. The analysis revealed that transfer velocity varies significantly across users and communities, indicating substantial heterogeneity in how money circulates. Specifically, the authors determined that a significant amount of account balances remained largely static, while the smaller active portion showed faster circulation. Key findings include evidence that economic disruptions, such as the COVID-19 pandemic, increased transfer velocity. For small, open economies, this method underscores the importance of understanding micro-level circulation patterns for effective policy-making.

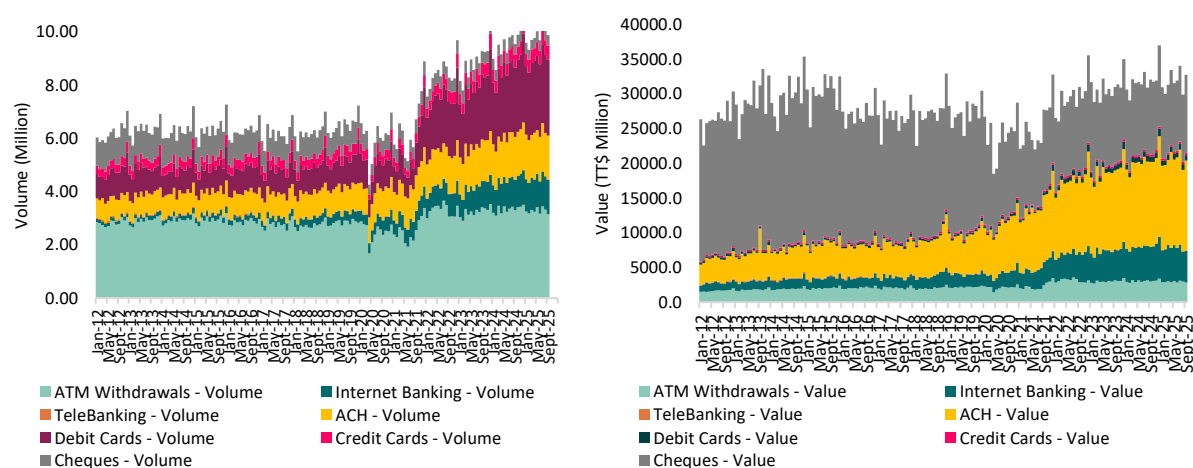
Last, Ocansey et al. (2023) investigate the relationship between mobile money usage, digital banking services, and the velocity of money in Ghana. The study analyses time series data from 1992 to 2022 using principal component analysis, impulse response function, and vector error correction model. The findings reveal that mobile money and digital banking services positively impact the velocity of money both in the short and long term. Specifically, an increase in mobile money usage and digital banking services leads to a higher velocity of money, indicating more frequent and efficient transactions. The study concludes that promoting mobile money and digital banking services can enhance the velocity of money and reduce reliance on physical currency, but it also poses some degree of inflationary pressure.

<sup>10</sup> This is calculated as the ratio of total transaction volume over a period to the average total balance of the payment system during that period. Transfer velocity is computed using micro-level transaction data. See Mattsson et al (2022) for more information.

### 3. STYLISTED FACTS

Domestically, cash and cheques still play a large role in the retail payment system. The volume of cash transactions, suggested by ATM withdrawals, remains a top choice in the retail payment market (**Figure 2**). The 2019 demonetisation exercise also showcased Trinidad and Tobago's heavy dependence on cash for transactions and as a store of value. The exercise was also pivotal in on-boarding unbanked individuals. Meanwhile, for cheques, its use for higher-valued retail payments continues to dominate. Nonetheless, the digitisation of payments has progressed. Alongside an active point of sale (POS) system<sup>11</sup> and automated clearing house (ACH)<sup>12</sup> system, online banking, mobile banking (e.g. EndCash) and newer e-money services have been introduced<sup>13</sup>. Hence, commercial banks are major players in the payments landscape, as deposit accounts mainly facilitate payment transfers via traditional payment rails as well as new e-services. A key driver for the changes observed in the payments landscape was the COVID-19 pandemic, necessitating the use of contact-less payment options and winning over a portion of the digitally-hesitant consumers. Since then, cashless payment options have grown in popularity. Several other factors, such as crime (largely evidenced by the growth in non-cash options), higher internet and mobile penetration, have also contributed to changes.

**Figure 2**



Source: Central Bank of Trinidad and Tobago

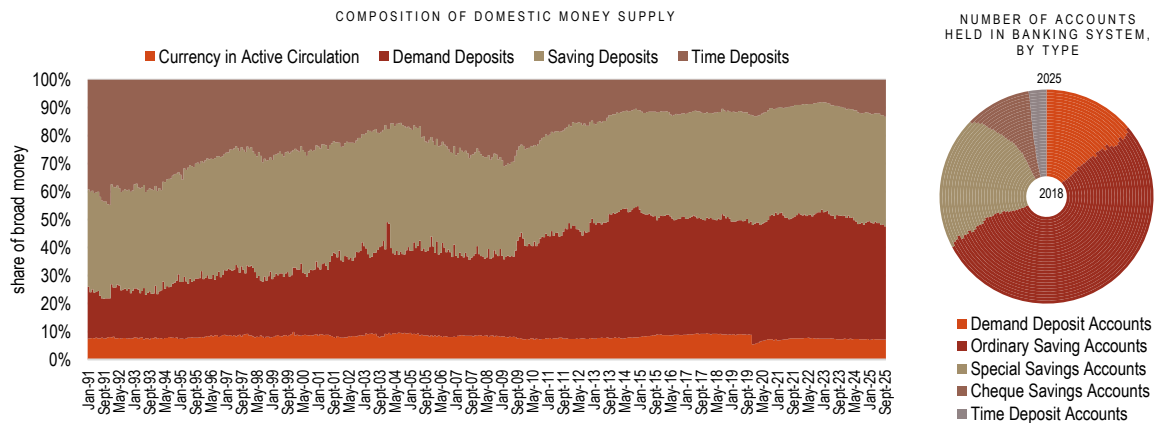
Regarding the composition of money supply aggregates, changes in demand and savings bank deposits, in comparison to currency in active circulation have also demonstrated a growing preference for non-physical forms of money, **Figure 3**.

<sup>11</sup> Reflecting the credit and debit card networks.

<sup>12</sup> Trinidad and Tobago's Interbank Payments System.

<sup>13</sup> Six registered E-Money Issuers (EMIs), PayWise, PESH, TSTT PAYPR, WIDIT, WAM and Convenience Pay Wallet (Central Bank of Trinidad and Tobago 2026).

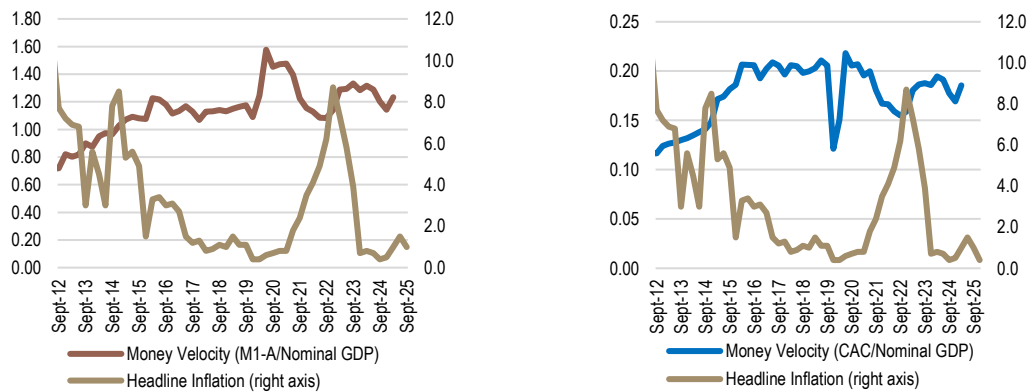
Figure 3



Source: Central Bank of Trinidad and Tobago

An initial review of money velocity suggests that circulation has been increasing since 2012 (**Figure 4**). Using the most liquid forms of money used in transactions (narrow money)<sup>14</sup>, velocity maintained an uptrend, speeding up over 2020 and most of 2021, during the COVID-19 pandemic. The shift from cash to digital payments was also evident during the pandemic. A similar trend is observed when currency in active circulation is used as the numerator for calculating money velocity. Periods of higher inflation also correlated to slower money circulation, noticeably over the post-pandemic period that saw sharp steady increases in price levels.

Figure 4



Source: Central Bank of Trinidad and Tobago

## 4. DATA AND METHODOLOGY

Using Irving Fisher's identity of exchange (Fisher 1911), the effects of an IPS is assessed. Importantly, for the purpose of this study, the impact on velocity is anticipated to occur within the digital payment system. Therefore, the key variables of the equation of exchange as seen below will be adjusted:

$$MV = PY \quad (1)$$

$M$  is the aggregate supply of money,  $V$  is the velocity of money,  $P$  captures price level and  $Y$  is real output. Using equation (1) the variables are modified so that  $(PT)$  is the total value of digital transactions<sup>15</sup> and  $(M)$  is the supply

<sup>14</sup> Paper money and coin in active circulation, demand deposits and travellers' cheques.

<sup>15</sup> This includes the sum of the values of ATM Transactions, Internet Banking Transactions, Telephone Banking Transactions, RTGS Transactions and ACH (Credits). Due to the unavailability of e-money and mobile banking transaction data, these variables are not included in the transaction volume variable.

of deposit money<sup>16</sup>. This transformation ascertains the velocity of money ( $V$ ) which indicates the frequency with which an average unit of money is exchanged for goods and services within a specific timeframe. Thus, the following equation is obtained:

$$V = PT/M \quad (2)$$

Furthermore, foundational work on modelling money velocity involved using the demand for money, general equilibrium approaches and cash-in-advance models. In the foundational settings, money velocity was theorised as being variable (Svensson 1985; Hodrick, Kocherlakota and Lucas 1991; Palivos, Wang and Zhang 1993). Additionally, recent empirical literature draws from the theoretical foundations mentioned to assess the nexus between money velocity and payment systems (see Ardakani 2022; Otoakhia 2023; Ocansey, Dadzie and Nambie 2024). Following the theoretical foundations and recent empirical literature, the money velocity over time ( $V_t$ ) can be empirically defined as a function of the following variables:

$$V_t = f(\text{inflation expectations, transaction volume, growth rate of broad money}) \quad (3)$$

which aims to examine the estimated impact of the introduction of an IPS on the velocity of money for Trinidad and Tobago<sup>17</sup>. Transaction volume captures digital payment activity and serves as a proxy for the channel impacted by instant payments technology. Instant payments enable transactions to occur at any time without delay. This delay-free payments innovation should increase money velocity as the IPS is expected to increase the volume of transactions. Inflation expectations capture the expected level of inflation and is taken from Ramlogan, Persad and Nelson (2023)<sup>18</sup>. Greater anticipated inflation is expected to increase the velocity of money as discussed in the literature. The growth rate of broad money is expected to be positively correlated with money velocity.

The data used covers the period 2012Q1 to 2024Q1 and is sourced from the CBTT and the Central Statistical Office of Trinidad and Tobago. The sample data was selected based on data accessibility. The unrestricted Vector Autoregressive (VAR) model is initially employed for this study as postulated by Sims (1980) and Lutkepohl (2001). Before estimating this model, pre-estimation stationarity testing is critical to determine the order of integration of the various time series (DeJong et al 1992). If the variables are found to be integrated of an order one,  $I(1)$ , they must be differenced before estimating the VAR model. Conversely, (Johansen 1988, 1991; Hall 1989) proposed that in the presence of a long-run or cointegrating relationship and the underlying eigenvalues within the companion matrix of the VAR model are stable, the Vector Error Correction Model (VECM) is most appropriate. The VECM is an econometric model used to simultaneously model the long-run relationship and short-run dynamics through the error correction term (ECT) in addition to providing impulse response functions and variance decomposition (Lutkepohl 2004).

Using equation (3), the unrestricted VAR model to be estimated is denoted below:

$$Y_t = A_0 + \sum_{p=1}^n A_p y_{t-p} + \varepsilon_t \quad (4)$$

<sup>16</sup> This is the sum of demand deposits and savings deposits. Saving deposits are included due to the high prevalence of saving accounts used for daily transactions based on anecdotal data, see **Figure 3**.

<sup>17</sup> A logarithmic transformation of this model is also done and presented in Appendix C and briefly discussed in the results section.

<sup>18</sup> Inflation Expectations provides an indication of economic agents' perception of price movements in the future. The measure of Inflation Expectations is derived from a news-based index constructed from web-scraped text data published in the Trinidad Express newspaper and captures a time horizon of 2 months ahead. For details on the methodology, refer to: Ramlogan, A., Persad, N. and Nelson, A. September 2023. "Developing a News-Based Index of Inflation Expectations for Trinidad and Tobago." Research Review Seminar 2023.

Where  $Y_t$  represents the vector of endogenous variables, money velocity (MVD), growth rate of broad money (M2G), inflation expectation (INF\_E) and transaction volume (TVOL) also see **Table 1** for descriptive statistics.  $A_0$  represents the vector of corresponding coefficient matrices to be estimated,  $\varepsilon_t$  is the vector of error terms assumed to be white noise,  $n$  is the number of lags in the VAR system and  $t$  denotes time. The optimal lag length is determined using the Akaike Information Criterion (AIC) as a less parsimonious specification is preferred given the frequency of the data used (also see Emiliano, Vivanco and Menezes 2014). The lag length criterion are presented in **Table 2A** in Appendix A.

**Table 1: Descriptive Statistics of the Variables**

|                     | <i>MVD</i> | <i>M2G</i> | <i>INF_E</i> | <i>TVOL</i> |
|---------------------|------------|------------|--------------|-------------|
| <i>Mean</i>         | 0.864322   | 4.381473   | 6.166667     | 4376204     |
| <i>Median</i>       | 0.848559   | 3.149847   | 5.35         | 3703731     |
| <i>Maximum</i>      | 1.095852   | 14.08498   | 20           | 8077195     |
| <i>Minimum</i>      | 0.680583   | -2.28394   | 0            | 2782837     |
| <i>Std. Dev.</i>    | 0.104652   | 4.696159   | 4.350169     | 1560472     |
| <i>Observations</i> | 49         | 49         | 49           | 49          |

Source: Authors' own work using EViews 14

If cointegration exists among the variables, we can apply algebraic manipulation to equation (4) to specify the VECM as follows:

$$\Delta Y_t = B_0 + \sum_{p=1}^n A_{p-1} Y_{t-(p-1)} + \alpha_t ECT_{t-1} + \varepsilon_t \quad (5)$$

Where  $ECT$  denotes the error correcting terms and  $\alpha_t$  are the associated coefficients, which captures the speed of adjustment to the long run equilibrium. The stability of this coefficient is conditioned on its significance and it should be negatively signed which would indicate the models convergence back to its long run equilibrium following short run fluctuations. Furthermore, after estimating the model, post-estimation diagnostic tests are required to ensure the validity of the model (Lutkepohl 2004). These tests are the traditional VAR/VECM diagnostic tests for normality, the absence of serial correlation and homoscedastic residuals. Once these diagnostics hold, impulse response function and variance decomposition can be estimated.

## 5. RESULTS AND DISCUSSION

**Table 1A** presents the order of integration of the variables using the standard unit root tests. All variables are integrated of an order  $I(1)$ , with the exception of TVOL which is integrated of an order  $I(2)$ . This means all the variables in the model exhibit stochastic behaviour, whereby shocks to the series have permanent effects, in other words, the series are non-mean reverting. Particularly, TVOL is difference-stationary of order two, with DTVOL being  $I(1)$  and stationary only after second differencing. **Tables 2A** also shows the optimal lag length recommended by the various information criteria. For this study, an optimal and maximum lag length of four is adopted as recommended by the LR, FPE and AIC to preserve degrees of freedom in the estimated model.

Since all variables are now integrated of order one, the potential for cointegration exists as outlined in the previous section. **Table 3A** presents the Trace and Max-Eigen values statistic from the Johansen test (Johansen 1988) based on a VAR model estimated in levels. Both statistics indicate that there is a cointegrating relationship among

the variables and therefore a VECM<sup>19</sup> model becomes the appropriate estimator as seen in equation (5). Where  $n$  is the number of lags of the underlying VAR model and  $r$  is the rank.

**Table 2** presents the VECM estimates for the system comprising money velocity (MVD), inflation expectations (INF\_E), the first difference of transaction volume (dlog T\_VOL), and broad money growth (M2G), estimated under Johansen's Case 3 with one cointegrating relationship and four lags. The normalised long-run vector indicates that equilibrium movements in MVD are driven primarily by transaction volume dynamics, as evidenced by the large and statistically significant coefficient on transaction volume, while the coefficients on inflation expectations and broad money growth are comparatively weak. This pattern suggests that long-run variations in money velocity are more strongly shaped by structural changes in transaction activity than by monetary growth or inflation expectations.

Turning to the short-run adjustment parameters, the error-correction term enters most strongly in the inflation expectations equation with a negative and statistically significant coefficient, indicating that inflation expectations play the primary role in correcting deviations from the long-run equilibrium. Although the magnitude of this adjustment coefficient is large<sup>20</sup> in absolute value relative to common heuristics from single-equation error-correction models, such bounds are not strictly imposed in a multivariate Johansen framework. Given that system-level diagnostics confirm dynamic stability, the estimated cointegration rank, and well-behaved residuals, the error correcting coefficient is interpreted as reflecting rapid adjustment through expectations rather than model instability. By contrast, the adjustment coefficient in the MVD equation is only marginally significant, and the ECTs in the broad money growth and transaction volume equations are statistically insignificant. Consistent with established cointegration methodology, these results suggest that the burden of restoring long-run equilibrium falls on inflation expectations rather than on velocity itself, reflecting the system-wide adjustment structure emphasized in the cointegrated VAR literature<sup>21</sup>.

These empirical results also offer an important perspective on the Quantity Theory of Money (QTM). The classical formulation of QTM assumes a stable velocity, under which persistent money growth translates proportionally into inflation. However, the significance of transaction volume dynamics in the long-run velocity equation, combined with the weak adjustment of M2G, implies that velocity is not stable in this environment. Consequently, the proportional money–inflation relationship predicted by the traditional QTM may not hold uniformly. This interpretation aligns with evidence that the strength of the money–inflation link varies across monetary regimes: Lucas (1980) study of the 1953–1977 US experience illustrates periods where the QTM relationships hold strongly, while later research demonstrates that policy shifts and changes in velocity behaviour can generate both breakdowns and revivals of QTM-type proportionality. The present VECM results therefore suggest that while the long-run logic of QTM remains conceptually relevant, its empirical validity is conditional on the behaviour of money velocity, which appears increasingly sensitive to technological and structural changes in modern payments systems. Last, the relevant diagnostic tests for serial correlation, heteroscedasticity, stability, and normality for the VECM can be found in **Appendix 1B**<sup>22</sup>.

<sup>19</sup> See Pesaran, Shin and Smith (2000) and Lutkepohl (2004).

<sup>20</sup> The adjustment coefficient falls outside the commonly cited  $-2$  to  $0$  range, likely because expectations react very quickly to shocks and the way the long-run relationship is scaled. Importantly, this does not affect the model's usability, as an ECT less than negative two reflects oscillatory adjustments to the long-run equilibrium. The oscillatory adjustment dynamics is not investigated further.

<sup>21</sup> Since the ECT is primarily statistically significant in the inflation expectations equation and not in the others, the standard interpretation is that inflation expectations adjust to close long-run gaps, while the other variables behave as (at least locally) weakly exogenous with respect to the long-run parameters.

<sup>22</sup> The VECM model is estimated using 4 lags to address observed autocorrelation at 3 lags. In this regard, the  $n-r$  lags rule is ignored as addressing autocorrelation is more critical to avoid inflated standard errors which can bias  $t$ -statistics.

**Table 2: VECM Long-run Equation and Error Correction Terms**

| <b>COINTEGRATING EQUATION</b> |                  |                          |                |          |
|-------------------------------|------------------|--------------------------|----------------|----------|
| <b>MVD(-1)</b>                | <b>INF_E(-1)</b> | <b>D(LOG(T_VOL(-1)))</b> | <b>M2G(-1)</b> | <b>C</b> |
| <b>1</b>                      | -0.010           | -13.8995                 | 0.00624        | 0.48322  |
|                               | (0.017)          | (3.658976)               | (0.012328)     |          |
|                               | [-0.58098]       | [-3.79873]               | [0.50613]      |          |
| <b>ERROR CORRECTION TERMS</b> |                  |                          |                |          |
| <b>MVD</b>                    | <b>INF_E</b>     | <b>D(LOG(T_VOL))</b>     | <b>M2G</b>     |          |
| <b>-0.12305</b>               | -4.90122         | 0.020726                 | -1.78326       |          |
| <b>(0.065618)</b>             | (1.513294)       | (0.03084)                | (1.703812)     |          |
| <b>[-1.87522]</b>             | [-3.23877]       | [0.67205]                | [-1.04663]     |          |

Source: Authors own work using EViews 14

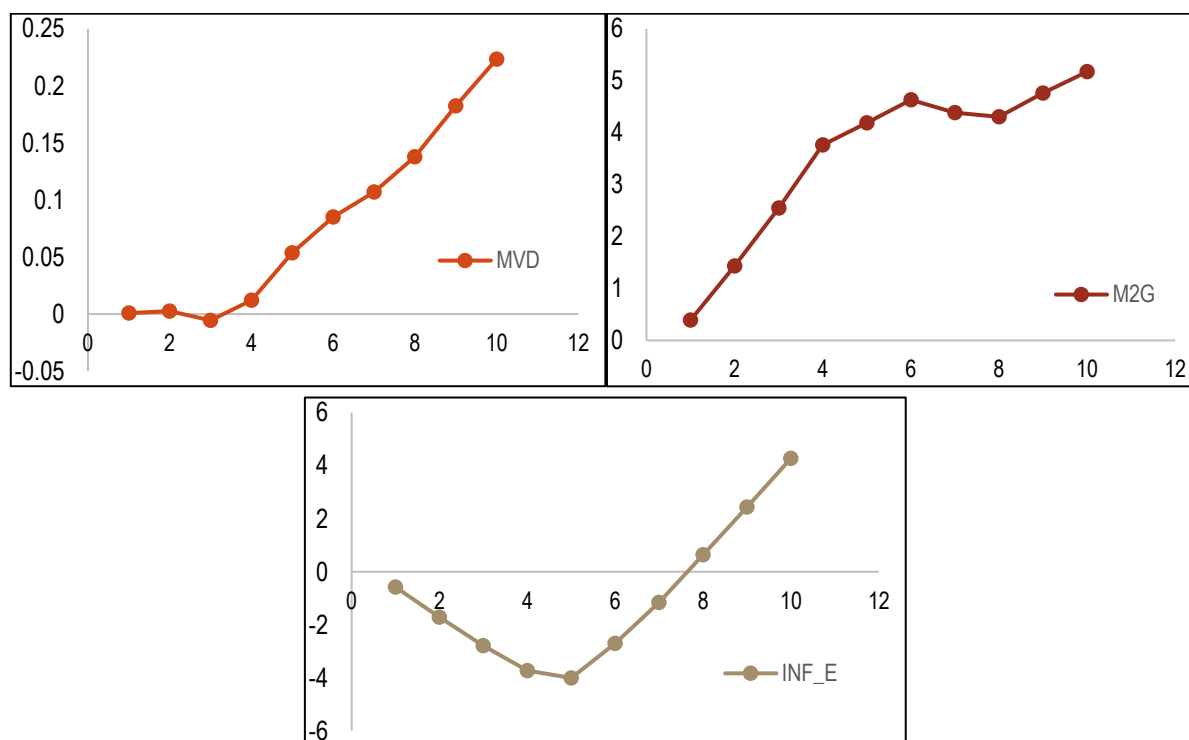
Note: Standard errors in (parentheses) &amp; t-statistics in [brackets]

Most importantly, impulse responses from the VECM can be used to estimate that impact of the introduction of an IPS in Trinidad and Tobago. The establishment of an IPS directly affects money velocity by allowing funds to circulate faster within the economy as transaction speed increases.

Prior to an examination of the impulse response functions (IRFs), ordering of the variables is necessary. Cholesky orthogonalisation requires a pre-specified causal ordering of the endogenous variables where a variable ordered first in the ordering is viewed to respond to other variables with lags while a variable ordered second responds contemporaneously to the first-ordered variable and with lags to the remaining variables (Ibrahim 2011). In this analysis, the ordering: transaction volume to money velocity to money growth to inflation, is assumed to mimic the flow of effects initiated by the establishment of an IPS. Increased transaction volume is expected to stimulate economic activity hence impacting money velocity. This stimulated economic activity through increased transaction volumes will then create inflationary pressures. This sequence best reflects the transmission of impacts in an economy adjusting to the adoption of a payment innovation such as an IPS.

Moreover, the IPS is assumed to increase the efficiency and frequency of transactions, leading to a higher volume of transactions. This is assumed because businesses and consumers are able to transact more efficiently, which can lead to increased consumption, production, and investment. This increase in transactions boosts the circulation of money. In response to the higher velocity, CBTT could adjust the money supply, resulting in money growth. However, if the money supply grows faster than the volume of transactions, it could lead to an increase in price levels, causing inflation. Moreover, price pressure can also be initiated by efficiency gains from the IPS if demand for retail goods and services grow faster than supply.

**Figure 6: Response of various variables to a one standard deviation shock to transaction volume bootstrap confidence intervals at 5000 bootstrap repetitions**



Source: Generated using EViews 14

**Figure 6<sup>23</sup>** presents the impulse response functions to a one standard deviation shock to transaction volumes, intended to mimic the implementation of an IPS, which is expected to increase transaction volumes through substitution away from cash. The shock is applied to the error term/innovation associated with the transaction volume equation. Based on the mean value of the transaction volume residual, the estimated standard deviation of this innovation is 0.0259. Since transaction volumes enter the model in log differences, this corresponds to an approximate 3 per cent increase in transaction volume. Accordingly, the introduction of the IPS is simulated as a 3 per cent positive shock to transaction volumes. **This shock can be scaled proportionally by any arbitrary real value to examine larger or smaller increases.** Importantly, this simulation does not imply an anticipated adoption or substitution rate of 3 per cent; rather, it serves as a *counterfactual* disturbance to analyse the dynamic responses of the system to the transaction volume shock. Nonetheless, one may scale transaction volumes with payment system innovations to assume an adoption as a simplifying assumption<sup>24</sup>, without interpreting the magnitude of the shock as a direct estimate of the actual substitution rate.

The IRF for money velocity reveals a positive and progressive response to the one standard deviation shock in transaction volume. After the second period, the response exhibits a small but monotonically increasing trajectory. This pattern provides compelling evidence supporting the theoretical framework established in the literature regarding the relationship between digital payments and monetary circulation speed (see Otoakhia 2023). Further, the sustained positive response aligns with empirical findings from Chen (2021), who documented that digital payment transaction size has a positive and significant effect on money velocity, noting that a 1 per cent increase in digital payment transactions leads to a 2.13 per cent increase in money velocity in China. This monotonic nature

<sup>23</sup> A sensitivity analysis including various orderings is also performed, one being a generalised ordering. The results across all permutations of orderings are similar, hence, not presented in the paper.

<sup>24</sup> However, this simplifying assumption is not directly adopted in this paper as such an assumption in an ex-ante environment can lead to biased conclusions. It is also critical to recognise that transaction volumes may also respond to other contemporaneous factors that cannot be accounted for using the QTM.

of the money velocity variable is also consistent with the findings from Shao (2022). This author found that increased digital currency exhibits a 'network effect' thereby the velocity of money in circulation accelerated leading to greater growth in the circulation of money.

The impulse response of M2G to a shock in transaction volume demonstrates a substantial acceleration pattern. This pattern reflects the instantaneous liquidity demand effects that digital payment systems create within the banking sector, as documented by Gonzalez, Ma, and Zeng (2023) who found that instant payment systems immediately increase banks' demand for liquid assets and alter their balance sheet composition. Additionally, these findings are consistent with that of Nizam (2022) who showed that electronic money has a positive correlation with broad money measure through improved financial intermediation. Those aside, the underlying data generating process of M2G generally maintains positive values over the horizon.

The impulse response of inflation expectations (INF\_E) displays a pronounced U-shaped pattern following a shock to transaction volume. The initial negative response is consistent with short-run adjustment dynamics implied by the VECM, in which inflation expectations bear the primary burden of restoring equilibrium after deviations in money velocity. From an economic perspective, this short-term decline may also reflect deflationary pressures associated with increased payment system efficiency. As highlighted by Gonzalez, Ma, and Zeng (2023) the adoption of instant payment technologies can raise precautionary liquidity demands for banks and temporarily constrain credit supply, dampening inflation expectations in the short run. As the system adjusts and these transitional frictions dissipate, the influence of the error-correction mechanism wanes and longer-run dynamics dominate. From approximately the sixth quarter onward, inflation expectations rise in tandem with money velocity and monetary expansion, indicating that once equilibrium is re-established, higher digital transaction intensity translates into stronger effective velocity. In the long-run, this co-movement is consistent with the quantity theory intuition. That is, sustained increases in velocity amplify the inflationary impact of money growth, leading to higher inflation expectations despite the absence of immediate inflationary pressure following the initial shock which is attributed to the underlying model.

Impulse responses display considerable persistence and do not fully re-converge within the horizon shown. In a cointegrated VAR that is dynamically stable, shocks to transitory components should eventually decay and the system should return to its long run manifold. Having verified that the companion matrix roots lie inside the unit circle except for the unit roots associated with cointegration, no residual serial correlation and the adequacy of the deterministic specification. The observed persistence likely reflects near unit root dynamics and regime sensitive velocity behaviour documented in the literature; hence, we interpret the persistent responses as features of the underlying data generating process rather than model failure.

## 6. POLICY RECOMMENDATIONS

The IRF results reveal that a shock to transaction volume produces an acceleration in the growth rate of broad money that continues throughout the observation period. This finding suggests that implementing an IPS could alter the composition of money measures within Trinidad and Tobago's macro-financial system and, depending on uptake, may marginally expand the money supply. Enhanced real-time monitoring systems specifically designed to track transmission channels after the implementation of the IPS system. Managing liquidity surges and slumps will also be pivotal. The literature demonstrates that instant payments affect liquidity demands, with implications for banks' liquidity management and stability, household and corporate liquidity preferences and system-wide liquidity conditions.

The U-shaped response pattern in inflation expectations, characterised by initial negative effects followed by positive longer-term responses, highlights the complex dynamics requiring sophisticated assessments of changes

to the inflation dynamics due to the IPS. If necessary, CBTT can intervene using monetary actions—such as monetary policy instruments—to control inflationary pressures.

In general, Trinidad and Tobago should implement continuous monitoring systems to detect unusual payment flows that could indicate market stress, particularly given the 24/7/365 operational nature of instant payments. Stress testing frameworks specifically designed for instant payment environments, incorporating scenarios such as system failures over a period of time would also be beneficial (also see Edwards and Garcia-Singh 2018).

## 7. CONCLUSION

Instant payments have the potential to enhance the efficiency and convenience of financial transactions, but their widespread adoption may pose some macroeconomic implications that warrant careful assessment.

This study aimed to estimate the impact of implementing an instant payments system in Trinidad and Tobago using a monetarist framework. The paper assumed that the impact of the instant payments is most likely to affect the volume of money that are kept within banks given that the system's application would be directly linked to an individual's banking account. As such, the paper uses the velocity of money to estimate the impact of instant payments domestically. Further, it takes from the literature surrounding the quantity theory of money to establish a model for the velocity of money using inflation expectations, the growth rate of broad money and the total volume of transactions. It was found that the variables in the model were integrated of an order one and cointegration existed between them. In this light, a Vector Error Correction Model (VECM) was used to account for observed cointegration as well as to assess the impulse response functions (IRF) drawn from the model.

The IRFs highlighted important dynamic effects associated with the introduction of an instant payments system in Trinidad and Tobago. The sustained, progressive increase in money velocity following a shock to transaction volumes indicates that digital payments through the IPS will continuously enhance the speed of monetary circulation over time. This finding suggests that the planned instant payments system has the potential to drive greater transactional efficiency within Trinidad and Tobago's financial ecosystem, reinforcing the need to support infrastructure capable of managing higher transaction speeds reliably and securely. Meanwhile, the immediate and sustained acceleration in broad money growth (M2G) emphasises that the financial system will experience liquidity demand pressures as digital transactions expand. Such pressures necessitate robust real-time monitoring and liquidity management frameworks by the Central Bank of Trinidad and Tobago to effectively manage the increased money supply and mitigate risks of financial instability during the rollout and scaling phases of the instant payments system. Furthermore, implementing stress testing scenarios tailored to the instant payments environment—such as system outages or liquidity shocks—will be essential to safeguard financial stability, particularly given the round-the-clock operations and systemic importance of the new payment system.

Moreover, the observed U-shaped response in inflation expectations underscores the complexity of macroeconomic adjustment to an IPS. The initial decline in inflation expectations likely reflects short-term efficiency gains and transient reductions in credit availability due to liquidity shifts, while the eventual rise after the sixth quarter suggests that once the economy fully integrates the new payment technology, sustained monetary effects from velocity and money growth dominate, exerting upward pressure on inflation expectations.

A key limitation of this study is the absence of a strong proxy variable for instant payments—such as e-money or mobile transactions data—making it necessary to rely on assumptions. Therefore, further work in this area should seek to establish a causal link between instant payments and economic growth going beyond the monetarist perspective. For example, future work can take the form of an ex-ante general equilibrium or agent-based models (ABM). To evaluate the long-term impact of an instant payment system, a Dynamic stochastic general equilibrium model could be employed to quantify aggregate welfare gains and shifts in the steady-state GDP by modelling a

reduction in transaction frictions. On the other hand, an ABM would capture the complex transition dynamics and adoption blockages triggered by individual/firms switching costs<sup>25</sup>, adversity to embrace technological shifts and network effects. Nonetheless, these approaches require long time-series data and micro-level firm/agent data in the case of the ABM. Moreover, when the IPS is implemented, control group or instrument methods can be used to look at how the IPS affects various macroeconomic and financial variables, allowing for more robust causal inferences to be drawn.

In conclusion, these findings highlight that while the IPS promises to modernise payment flows and promote efficiency, its effects—based on the quantity theory of money—will be multifaceted and persistent. Trinidad and Tobago's policymakers must continuously monitor monetary and inflation dynamics and maintain adequate liquidity buffers. These capacities will be critical to harness the benefits of instant payments while maintaining monetary and financial stability in the evolving digital payments landscape.

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<sup>25</sup> The tangible and indirectly-tangible costs associated with transitioning from traditional payment methods to digital payments like the IPS. This includes the time it takes to download the IPS app, the fear of fraud related to using the digital interface, and the "Wait-and-See" approach often adopted by agents in society.

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## APPENDIX A – TECHNICAL APPENDIX

**Table 1A: Standard Unit Root and Stationarity Tests**

|             | MVD                   | ΔMVD                     | TVOL                  | ΔDTVOL                   | INF_E                   | ΔINF_E                   | M2G                   | ΔM2G                     |
|-------------|-----------------------|--------------------------|-----------------------|--------------------------|-------------------------|--------------------------|-----------------------|--------------------------|
| <b>ADF</b>  | -0.098055<br>(0.9434) | -9.705049***<br>(0.0000) | -0.854982<br>(0.9521) | -4.546465***<br>(0.0006) | -3.095389**<br>(0.0339) | -3.364498**<br>(0.0178)  | -1.666359<br>(0.4409) | -4.825973***<br>(0.0003) |
| <b>PP</b>   | -2.303790<br>(0.1749) | -11.36512***<br>(0.0000) | -0.731326<br>(0.9647) | -6.956027***<br>(0.0000) | -2.244141<br>(0.1940)   | -5.151250***<br>(0.0001) | -2.199262<br>(0.2092) | -5.151250***<br>(0.0001) |
| <b>KPSS</b> | 0.262434***           | 0.229745***              | 0.865230              | 0.309663***              | 0.142639***             | 0.063651***              | 0.446597              | 0.115201***              |

Source: Generated using EViews 14

Note: The Akaike information criterion is used for ADF. Bartlett kernel is used for the PP with Newey-West Bandwidth. Bartlett kernel is used for the KPSS with Newey-West Bandwidth. A max of 4 lags are used when estimating unit roots for the ADF test. P-value in (parentheses). \*\*\*, \*\* and \* denotes significance at the 1 per cent, 5 per cent and 10 per cent level of significance.

**Table 2A: Lag Length Criterion**

| LAG      | LR        | FPE       | AIC       | SC        | HQ        |
|----------|-----------|-----------|-----------|-----------|-----------|
| <b>0</b> | NA        | 0.00347   | 5.687758  | 5.849958  | 5.74791   |
| <b>1</b> | 115.1008  | 0.000377  | 3.463728  | 4.274723* | 3.764484* |
| <b>2</b> | 27.09688  | 0.000367  | 3.416804  | 4.876595  | 3.958165  |
| <b>3</b> | 16.03777  | 0.000475  | 3.626729  | 5.735317  | 4.408695  |
| <b>4</b> | 38.84780* | 0.000257* | 2.915194* | 5.672578  | 3.937765  |

Source: Generated using EViews 14

Note: LR - sequential modified LR test statistic (each test at 5% level). FPE - Final prediction error. AIC - Akaike information criterion. SC - Schwarz information criterion. HQ - Hannan-Quinn information criterion. \* indicates lag order selected by the criterion.

**Table 3A: Johansen Cointegration Test**

| H <sub>0</sub>   | TRACE<br>STATISTIC                                | 5% CRITICAL<br>VALUE | P-VALUE | MAX-EIGEN<br>STATISTIC                                    | 5% CRITICAL<br>VALUE | P-VALUE  |
|------------------|---------------------------------------------------|----------------------|---------|-----------------------------------------------------------|----------------------|----------|
| <b>NONE</b>      | 60.579                                            | 47.856***            | 0.002   | 30.575                                                    | 27.584               | 0.020*** |
| <b>AT MOST 1</b> | 30.004                                            | 29.797**             | 0.047   | 17.648                                                    | 21.132               | 0.144    |
| <b>AT MOST 2</b> | 12.356                                            | 15.495               | 0.141   | 10.258                                                    | 14.265               | 0.196    |
| <b>AT MOST 3</b> | 2.098                                             | 3.841                | 0.147   | 2.098                                                     | 3.841                | 0.147    |
| <b>INFERENCE</b> | Trace test indicates<br>2 cointegrating equations |                      |         | Max-eigenvalue test indicates<br>1 cointegrating equation |                      |          |

Source: Generated using EViews 14

Note: \*\*\*, \*\* and \* denotes significance at the 1 per cent, 5 per cent and 10 per cent level of significance

APPENDIX B – MODEL DIAGNOSTICS

Table 1B: VECM Residual Serial Correlation LM Tests

| Lag | LRE* stat | df | Prob.  | Rao F-stat | df         | Prob.  |
|-----|-----------|----|--------|------------|------------|--------|
| 1   | 17.43126  | 16 | 0.3582 | 1.115766   | (16, 55.6) | 0.364  |
| 2   | 21.57649  | 16 | 0.1574 | 1.430021   | (16, 55.6) | 0.1619 |
| 3   | 9.599094  | 16 | 0.8867 | 0.575894   | (16, 55.6) | 0.8886 |
| 4   | 15.97965  | 16 | 0.4544 | 1.010544   | (16, 55.6) | 0.46   |

Source: Generated using EViews 14

Table 2B: VECM Residual Heteroscedasticity Tests

| Chi-sq  | df  | Prob. |
|---------|-----|-------|
| 324.978 | 340 | 0.712 |

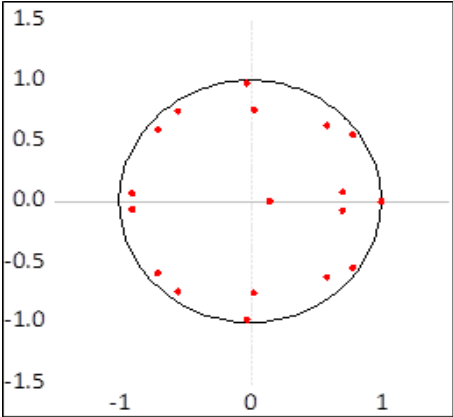
Source: Generated using EViews 12.

Table 3B: VECM Residual Normality Tests

| Test        | Prob.  |
|-------------|--------|
| Skewness    | 0.6046 |
| Kurtosis    | 0.2379 |
| Jarque-Bera | 0.4097 |

Source: Generated using EViews 14

Figure 1B: Roots of VECM Characteristic Polynomial



Source: Generated using EViews 14