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Mobile Money Use, Digital Banking Services and Velocity of Money in Ghana

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ABSTRACT

Investigating the correlation between digital financial services, mobile money usage, and money velocity in Ghana, the study analysed time series data spanning from 1992 to 2022. A composite index was constructed by principal component analysis using data extracted from the world development indicators, with the components mobile money usage, digital financial services, and velocity of money. The estimation utilised an impulse response function and vector error correction model; the results indicated that mobile money, digital financial services, and money velocity are related in both the short and long term. Furthermore, the application of a standard deviation innovation to the velocity of money produced increases of both positive and negative magnitude for all the variables. This suggests that mobile money, digital banking services, and velocity of money in Ghana are interdependent in an asymmetric manner. In order to facilitate an increase in the velocity of money, the research concluded that policymakers should guarantee that a greater proportion of the population has access to mobile money and digital banking services. In addition to promoting mobile money, online banking services, and digital payment methods on purpose, the government should reduce reliance on physical currency and expedite the circulation of money. It is recommended that future longitudinal studies involving African nations employ diverse estimation techniques.

Keywords: Velocity of Money, Digital Banking, Supply of Money, Inflation, Policy rate, Mobile Money
JEL Classifications: M2, G3, G1, G4, D0, G0

1. INTRODUCTION

Historical trajectory of money's growth is a captivating narrative that encompasses several centuries and mirrors the progression of human civilizations, economic structures, and commercial networks (Hyden, 2024). Throughout history, the concept of money has undergone significant transformations, evolving from basic commodities to intricate digital representations. During ancient times to the emergence of the monetary system, individuals participated in a practise known as barter, which involved the direct exchange of goods and services. Nevertheless, the practise of barter was not without its limitations, primarily due to the necessity of a fortuitous alignment of desires between trading parties and its inherent inefficiency when dealing with intricate transactions (Kosmetatos, 2023). In response to the difficulties posed by barter systems, civilizations initiated the utilisation of goods possessing inherent worth as a means of facilitating exchange (Al-Jabra and AlNuhait, 2023). The acceptance of commodities such as grain, animals, and precious metals like gold and silver was widespread owing to their intrinsic utility or scarcity. As economies expanded and the transportation of substantial amounts of physical commodity money became unfeasible, nations implemented the use of representational money (Ron, 2023; King, 2023). This monetary system entailed the utilisation of tangible tokens, such as coins or paper notes, which could be traded for a predetermined quantity of a valuable item held in a centralised repository. Fiat money, which is declaration by governments or authoritative body, designating it as legal tender was introduced. In contrast to commodity money, fiat money has inherent value and instead depends on the faith and confidence bestowed upon it by individuals. Governments have the ability to exercise control over the supply of fiat currency, hence facilitating more efficient management of economies (Mushaddik and Nori, 2023).

The advent of technology has given rise to the emergence of electronic money, encompassing transactions that are executed using electronic means, such as banking systems and digital payment mechanisms. The advent of credit and debit cards, online banking, and mobile wallets has revolutionised the accessibility and utilisation of financial resources (Hanif, 2020; Perkins, 2020). In the contemporary day, the notion of currency has undergone a broadening to encompass digital forms such as crypto-currencies, and exemplified by Bit coin. Crypto currencies refer to digital assets that employ cryptographic techniques to ensure secure transactions and function on a decentralised block chain infrastructure (Ahamad and Gupta, 2022). Crypto currencies symbolise a deviation from conventional forms of government-issued currency and have attracted considerable interest due to their capacity to disrupt financial systems (Agarwal and Agarwal, 2021). With the progression of technology, some central banks in Africa are currently investigating the concept of introducing their own digital currencies. The proposed central bank digital currencies (CBDCs) would derive their value and authority from the government and central bank, thereby integrating the advantages of digital transactions with the stability inherent in a national currency. The evolution of currency serves as a manifestation of advancements in the realms of economics, society, and technology across many historical periods (Daraojimba and Abioye, 2023). Throughout history, the concept of money has undergone significant transformations, ranging from its rudimentary form as a means of exchanging products to the complex financial systems that exist in contemporary society. This on-going evolution of money has not only allowed for its adaptation to changing circumstances, but also exerted a profound influence on the manner in which societies engage in commerce and interact within the global economy (Elhajjar and Yacoub, 2022).

The utilisation of traditional physical payment systems has been fundamental to commercial activities for an extended period. However, the advent of digital payment systems has brought about a significant transformation in the manner in which transactions are carried out. The selections of these strategies frequently relied on variables such as individual inclinations, technical framework, and the requirement for ease and safeguarding (Khalifa and Ali, 2023). The on-going progress of technology is anticipated to have a significant impact on the future of financial transactions, with digital payment systems assuming a more prominent role. Digital payments utilise a variety of technologies to enhance the security and encryption of transaction data, as well as provide multi-factor authentication (Aburbeian and Fernández-Veiga, 2024). These measures serve to increase the complexity for malicious individuals attempting to conduct fraudulent transactions (Behera and Bala, 2023). Furthermore, the use of digital payment methods such as virtual credit cards has the advantage of making a singular payment exclusively allocated to a specific vendor for a predetermined amount. This serves to safeguard the primary credit card from any hacking incidents. According to Montreuil and Foucher (2023) a significant majority of organisations, namely 92% of them, acknowledge paper cheques as a means of receiving incoming payments. Similarly, 86% of these companies also recognise paper cheques as a method for making outgoing payments (Schlatt and Sedlmeir, 2023). The act of sending and receiving cheques can result in substantial expenses associated with processing, such as bank charges, printing fees, postal fees, and the secure disposal of cheques. The implementation of digital payment systems enables organisations to enhance their ability to consistently and punctually settle debts. Upon the occurrence of a payment, the account balance promptly shows the alteration, and any currency conversions are executed instantaneously at the time of the transaction (Jindal and Chavan, 2023).

The use of digital payments in Ghana is facilitated by a robust internet access, levels of financial inclusion, extensive networks of mobile money agents, well-established payments infrastructure, and on-going regulatory enhancements led by the Bank of Ghana (Pérez-Arriaga and Nagpal, 2021). The Bank of Ghana (BoG), which serves as the central bank, assumes a pivotal role in the regulation of the money market with the objectives of preserving stability, managing inflation, and facilitating the efficient operation of the financial system. The money market refers to the exchange of short-term debt instruments and other financial assets. The advent of digital payment systems however has disrupted the longstanding dominance of banks in currency issuance and payments, leading economic actors have gradually shifted their practises in holding and utilising money (Sarkissian, 2024; Gill, 2024). Agents also have the ability to conveniently deplete their future fortunes by utilising third-party digital payment providers. Rather than individuals' financial assets circulating mostly within traditional banking institutions, there is a growing trend of utilising third-party digital payment businesses for personal transactions and storing funds. The emergence of third-party digital payment companies in the money market has had a notable impact on the established position of traditional banks, leading to a certain degree of disruption. Consequently, the money supply system is gradually being influenced by the presence of these new market participants, resulting in modifications to the existing money supply model (Pedram, 2024; Yao and Alexiou, 2024).

Velocity of money is a fundamental economic concept that resonates within Ghana's borders, influencing the financial landscape's dynamics; the velocity of money in Ghana represents the rate at which the Ghanaian cedi circulates through transactions, which influences economic vitality and price levels. The velocity of money in Ghana tells a tale of consumer habits, technological advancements, government policies, and global economic situation, which are rooted in the complex interaction between economic factors and societal behaviours (Morosan and Dursun-Cengizci, 2024). This concept provides a lens through which the economic pulse of Ghana is examine, revealing how its currency travels through the veins of trade, investment, and consumption, thereby influencing the economic trajectory of the nation.

Abramova and Böhme (2023) contend that the distribution of velocity of money in digital currencies exhibits significant heterogeneity and is closely linked to individual agents' behaviours, thus posing a challenge to the notion of complete decentralisation in these systems. According to Kuriyama and Hashimoto (2023) the utilisation of inverse estimation methodology exhibits heterogeneity and facilitates the ability to make comparisons across different subgroups of individuals who spend money. In a study conducted by Koomson and Martey (2023) the focus was on examining the regulation of digital services and its implications for financial inclusion in East Africa. The findings of the research revealed that digital financial services regulation has a notable and consequential influence on both traditional banking services and the utilisation of mobile money. Setyadharma and Iskandar (2023) conducted a study to examine the correlation between digital and electronic transactions and the velocity of money. The findings of their investigation indicate that electronic transactions, as assessed by credit cards, exhibit a noteworthy negative influence on the velocity of money. Alsmadi and Moh'd Al-Hazimeh (2023) conducted a study examining the economic fundamentals of digital banking services provided by a FinTech companies in a smart city. The study concluded that the activities of the FinTech Companies in the realm of digital banking are economically justified, and have an influence on the velocity of money, the findings helped in bridging the gap between the intuitive understanding of the need for implementing smart solutions in practise and the economic rationale behind the move. In their study Mohamed and Nor (2023) analysed the impact of electronic money utilisation on the velocity of money. Their findings indicate that, over an extended period, electronic money transactions, income levels, and interest rates exhibit a significant positive relationship. However, the influence of electronic money transactions on the velocity of money is observed to be relatively minimal.

The current body of research lacks clarity about the impact of mobile money usage and digital banking services on the velocity of money in Ghana. This highlights the necessity of investigating the relationship between mobile money, digital banking, and the velocity of money in Ghana through the analysis of time series data. The subsequent sections of the paper are denoted as sections 2, 3, 4, and 5. The second section of this paper provides an overview of the literature and the quantity theory of money. In the third section, the vector error correction model or Autoregressive Distributed Lag (ARDL) method will be explained. The fourth section will present an analysis and discussion of the empirical results. Finally, the fifth section will present the conclusions and recommendations.

2. LITERATURE REVIEW

The beginnings of the standard quantity theory of money analysis can be traced back to the turbulent price fluctuations of the fourteenth century, the time period spanning the sixteenth and seventeenth centuries (Plakandaras and Gupta, 2023). During this specific era, there was a notable occurrence of currency debasement, which took the form of government devaluations and fraudulent clipping perpetrated by people (Abdullah, et al., 2023). Additionally, there was a significant import of gold and silver from a across the word. These trends were further exacerbated by the quick expenditure of these additional monetary units on wars, which in turn disrupted the industrial process (Stiglitz and Regmi, 2023; Muthusamy and Kannan, 2023). The convergence of these elements resulted in the emergence of a notable occurrence for economic analysts, characterised by a substantial escalation in prices.

The historical underpinnings of the quantity theory encompassed a hypothesis positing that the supply of money is equivalent to the product of price and real income, in conjunction with the notion of velocity. Nevertheless, these components can be attributed many interpretations that need to be aligned. Multiple definitions of the money supply emerged, taking into account factors such as the inclusion or exclusion of demand deposits (Salerno, 2023). Likewise, real income can encompass all economic interactions, alternatively, only transactions involving income payments and expenditures on consumer products are included. The aforementioned form of the quantity theory may be traced back to the preceding analysis, with Irving Fisher emerging as its prominent advocate (Tobin, 2005). The equation is commonly denoted as mv = pt. The terminology of this concept indicates its foundation in the monetary transactions, where the right-hand side of the equation represents the exchange of products. Services or securities are exchanged for a commensurate transfer of funds. The concept can be seen as a tautology, where the amount of money spent is equal to the monetary worth of commodities exchanged, and the velocity is determined in a manner that preserves this equivalence (Schmitt, 1996; Fine and Lapavitsas, 2004; Foley, 2005; Shaikh, 1979). In the present perspective, the economists belonging to this tradition are perceived to have established two overarching assumptions. To begin with, the assumption of constant velocity in the short-run is made based on the premise that it is influenced by habitual behaviour. None of these factors will see significant short-term impacts, additionally, the proposition of a future characterised by full employment assumes that the level of transactions remains relatively stable, and this results in a positive correlation between the money supply and the price index. The extent to which economists during the period considered velocity to be constant is a subject of inquiry (Rubin and Colliot-Thélène, 1979). Kemmerer and Langton (2023) depicted velocity as a function of the overall economic environment and also noted that the level of money hoarding exhibited significant variation in the short-term. According to Fisher and Barber (1907) the price level is the sole passive component in the equation of exchange. Additionally, he argued that in most cases of significant price level changes, it is primarily the money supply (M) that varies to a sufficient extent, rather than the velocity of money (v) or the volume of transactions (T), making it the explanatory variable. Therefore, it is reasonable for us to infer that the quantity equation of transactions was derived from an underlying assumption of the constant velocity.

One potential critique of the transactions approach is its tendency to treat all forms of transaction as homogeneous (Hobbs, 1996; Johanson and Mattsson, 1987). Indeed, transactions can be classified into various types. The payment intervals in question may be anticipated to vary. In a general sense, it can be posited that this phenomenon is likely to occur in the context of capital transactions including the acquisition of end products and services, acquisition of intermediate goods and the remuneration for the use of resources. In light of this, an alternate methodology has emerged and gained traction. This pertains mostly to the examination of payments related to the acquisition of end products and services. Therefore, the equation representing the quantity theory of money can be expressed as mv = pY, where Y represents the national income at constant prices, and v is the average frequency with which money is utilised in income transactions within a specific period. The distinguishing aspect of this method is that it solely considers the net value-added in each exchange. In accordance with the principles of national income accounting, this stands in opposition to the transactional approach, this encompasses all intermediary transactions at their full value. The income approach can be regarded as a modification and potentially an enhancement of the transactions approach. The observation of changes in prices and quantities pertains to the real production of the economy, as opposed to a conceptual estimate of the overall number of transactions conducted. The debatability of whether it is desirable as a measure of the desire for money remains uncertain. If alterations in the proportion of intermediate and capital transactions relative to income have an impact on the demand for money, then the transactions approach seems to be more favourable as it considers these elements, but the income approach does not, and therefore, the evaluation of the transactions and revenue approach is largely subjective (Allais, 1966; Laughlin, 1924).

The many iterations of the quantity theory are founded upon distinct methodologies, with notable disparities observed between the transactions and cash balance versions. Differences may develop when considering the delineation of the money stock, since one emphasises money as a means of trade and the other as a store of value. In a similar vein, one perspective will place emphasis on the mechanical components of the payments process, whereas the other will prioritise the examination of issues that influence the appropriateness of money as an asset. It is worth acknowledging that the components under consideration exhibit interdependence, so mitigating the impact of the apparent dichotomy (Swaney, 1987). However, it remains evident that they possess distinct perspectives. Given this fact, it is quite remarkable that these various formulations of quantity equations provide comparable theoretical outcomes, together referred to as the quantity theory. Therefore, according to the conventional quantity theory, the sole alternative for surplus money holdings was goods and services, thereby largely disregarding the significance of the financial market (Graziani, 2003). This phenomenon resulted in the formation of the notion that an expansion of the money supply would result in heightened spending on goods and services, with the primary impact being observed in price changes rather than changes in quantity. It was hypothesised that the demand for real money balances had a reasonably consistent pattern, leading to a corresponding tendency for velocity to remain constant. This assumption was validated based on two reasons. Initially, the need for money was primarily understood as a transactional demand, with an expectation of relative stability. Furthermore, in accordance with the concept of full employment equilibrium, the rise in expenditure resulted in price inflation rather than an increase in quantity, thereby maintaining a constant actual quantity available for holding. Therefore, the conventional quantity theory successfully addressed the issue of a fluctuating money supply with an unchanging money demand and a passive price mechanism.

The Keynesian revolution exerted a dominant influence over the conventional quantity theory, leading to its widespread acceptance and rendering it largely impervious to questioning for an extended period (Marglin, 2020; Kicillof and Odriozola, 2017). The dissolution of this elevated position occurred during the 1970s, as a result of the confluence of swift monetary expansion and heightened inflation. Friedman (1970) adopted an empirical approach to the quantity theory and he expresses his conclusions as, Quantity Theory has increasingly become the generalization that changes in desired real balances if the demand for money tend to proceed slowly and gradually or to be the result of events set in train by prior changes in supply. Substantial changes in the supply of nominal balances can and frequently do occur independently of any changes in demand. The conclusion is that substantial changes in prices or nominal income are almost always the result of changes in the nominal supply of money. This approach has tended to be labelled as the modern quantity theory and indeed it is evident from the quote above that its conclusions are similar even if the reasoning differs.

The concept of velocity of money pertains to the movement of a currency within a specified time period due to a transaction (Simmons and Dini, 2021). Moreira and Hick (2021) assert that while velocity is constant, its value can vary significantly; for instance, a reduction or increase in payment activity will result in an immediate and substantial change in velocity. This will continue to fluctuate in accordance with government monetary policy and economic conditions. Velocity of Money is an element of monetary theory in which the distinction between monetary and non-monetary values has evolved in tandem with market strategies and eras. The underlying philosophy concerning the qualities of Velocity of Money differs significantly from that of conventional transactions (Roy and Rochaida, 2021). According to Sarsembayev (2021) the liquidity level that was previously determined solely by the circulation of money as a medium of exchange has now undergone a significant transformation. In opposition to the level of acceptability, the liquidity standard posits that the essence of natural benefits should constitute the fundamental nature of money.

Berger and Vavra (2019) employed a dataset spanning 21 years of monthly data and utilised 8-month volatility of M1 growth as a metric to gauge the volatility in money growth. Friedman's hypothesis was corroborated through the identification of a Granger causation relationship between the standard deviation of money growth and velocity. Research conducted by Fisher Jr (2023) has made substantial contributions to the existing body of knowledge. The utilisation of credit cards as a payment method provides every financial transaction with the utmost convenience. Nevertheless, customers ought to be mindful of the potential hazards and expenditures associated with its utilisation (Amin, 2013; Guseva and Rona-Tas, 2014). The proliferation of credit cards issued by a variety of financial service providers is intended to facilitate the consumers' consumption. It is crucial to emphasise that credit cards carry the greatest risk for wasteful users in comparison to other forms of payment transactions. The primary allure of credit cards lies in their dual functionality as practical payment methods and sources of credit. Cherif and Imine (2023) illustrate the analogy by comparing credit card spending to the prediction that this form of payment will eventually become routine and have ramifications for VoM. Undoubtedly, each economic transaction contributes positively to the acceleration of the Velocity of Money (Dalal and Chawla, 2023). The direct incorporation of credit cards into the payment system by consumers has significantly enhanced the convenience of all monetary transactions (Taherdoost, 2023). Occasionally, special promotions are offered in the form of discounts and other incentives.

The correlation between the velocity of money circulation and inflation diminishes as the availability of payment methods increases (Anwar and Fattah, 2023). Moreover, endogenous fluctuations in the velocity of money circulation may result in a mismatch between the money supply and the price level. The increase in the money supply will result in a general price increase if the rate of money circulation remains sluggish for an extended period of time; therefore, monetary authorities should maintain a relatively stable rate of money circulation. Dasaklis and Malamas (2023) examined the correlation between the velocity of money circulation and local digital payments utilising the actual cash balance method. They contend that the implementation of digital payments will diminish individuals' inclination to retain cash and that the advent of digital currency will affect the cash demand function that existed previously. Therefore, the adoption of digital payment systems will accelerate the circulation of currency.

Godana (2023) examines the influence of digital payment on money demand using the Fisher equation theory, the Keynesian money demand theory, and the Friedman demand theory, respectively. While no empirical investigation is performed, the formula's conclusions are largely consistent with expectations. Anakpo et al. (2023) further categorises the various payment methods in society by employing this to construct a general equilibrium model for the purpose of examining the monetary policy implications of digital stored value cards. On the basis of related evidence, he argues that digital stored value cards serve as both a payment method for consumers and a financing method for issuers.

Anakpo et al. (2023) contend that digital stored value cards provide issuers with financing and customers with a method of payment. Therefore, the flexibility of the currency is influenced not solely by the intervention of the central bank but also by private sector-issued digital payment stored value cards. The volatility of the currency is influenced not solely by the central bank's intervention, but also by private sector-issued digital payment card-related factors.

Chen and Fortunati (2023) investigate monetary policy initially through the lens of the expansive notion of Internet finance, and subsequently employ digital payments to illustrate the potential ramifications on the velocity of money circulation. The article solely examines the consequences of broad money's velocity of circulation; while it does reach the conclusion that the velocity will decline, it makes no case for currency or narrow money. However, it is possible that the effect on the velocity of circulation for currency and narrow money would differ from that of broad money. This is due to the potential contribution of digital payments' low-cost and high-efficiency features, which could expedite the circulation of cash. Nevertheless, this hypothesis warrants additional investigation.

As digital payments have continued to advance in China over the past few years, an increasing number of academics have begun to investigate the connection between digital payments and currency circulation. Alhassan and Islam (2021) discovered a positive and long-lasting relationship between the velocity of money circulation and third-party payment growth rate by constructing a co-integration model between the two variables. In their study, Maulayati and Herianingrum (2020) employ the co-integration model, Granger causality test, and impulse response function in the VAR model to examine the relationship between third-party internet payment and the acceleration of money circulation at all levels. They argue that this acceleration would impede the degree of monetization and financial modernization of China's economy. To this end, the authors recommend that the government enhance its oversight of the third-party payment industry and rigorously prevent the risk issues associated with third-party payment systems. According to Hofmann (2020) the emergence of third-party Internet payments has a significant impact on the monetary hierarchy and substitutes for cash and demand deposits. This, in turn, influences the money supply at every level and, ultimately, the Fisher equation-calculated velocity of money circulation.

The velocity of money in developed and developing economies was investigated by Ardakani (2023) using a dynamic general equilibrium model. The observed rate of money growth is found to have an adverse impact on the velocity of money. Kayongo and Muvawala (2020) use an ARDL framework to analyse the stability of the velocity of money in Uganda. The results obtained by the authors suggest that financial innovation ultimately contributes to an increase in the velocity of money. Moreover, money velocity is positively impacted by inflation expectations. Mata and Roldão (2021) analysed the income velocity of money in Portugal. According to the results obtained from the vector autoregressive model, there exists a cointegration between the velocities of money, macroeconomic indicators including interest rates, and institutional variables.

Electronic money is defined by the Bureau of Indian Standards (BIS) as a prepaid payment instrument product where the value of money is stored in a consumer-owned electronic device. The worth of the currency that consumers acquire is what they retain in their electronic devices; when used for transactions, the value of electronic money depreciates. Electronic money is distinguished from debit and credit cards by the fact that online authorization is required and, upon use, funds are debited from the consumer's bank account. Prepaid cards, in which the value of the money is stored on a microprocessor device embedded in a plastic card, and prepaid electronic money products that utilise computer networks and store the value of the money in an installed software or application, are both examples of electronic money.

As defined by Tennant and Brody (2020) a debit card is a payment method that authorises the holder to charge purchases directly to the funds in their account. The debit card holder is an institution client who maintains a savings or current account and utilises the card to conduct transactions at ATMs or at online retailers that employ Electronic Data Capture devices. The utilisation of the debit card for payment results in a deduction from the balance held in the savings or checking account of the cardholder. Debit cards are characterised similarly by Bank Indonesia as one of the

Payment Instruments Using Cards utilised to conduct economic transactions, such as purchasing transactions. In accordance with the relevant regulations, the cardholder's obligations are promptly repaid through the direct deduction of the cardholder's deposits from accounts at authorised banks and financial institutions that accept deposits.

3. DATA AND METHODOLOGY

Using vector autoregression or vector error correction models, this study attempts to ascertain whether mobile money usage, digital banking, and velocity of money in the Ghanaian economy have a long-run relationship. The data used is extracted from the World Bank's World Development Indicators (WDI) for the period 1992-2022. The selection of the research sample is determined by data accessibility and the desire to comprehend the enduring consequences of mobile money, digital banking, and velocity of money within the designated time period, while also delving further into the underlying causes of these trends. Vector Error Correction Models are a subset of vector autoregressive models (VAR). In order to specify the VECM model, an error correction term is incorporated into the VAR model. If the variables in the system are co-integrated, or have a long-run relationship, then VECM methodology is applied. By differencing the variables and introducing an error correction term, each VAR model can be converted to VECM. VECM, on the other hand, is only applicable in the presence of co-integrating or long-run relationships; the VAR model should be utilised instead if there is no cointegration.

Several factors influenced the direction of this study; for instance, the velocity of money, which measures the number of times the average currency changes hands in a single year, approximates the circulation of money within an economy. A higher velocity of money signifies a thriving economy characterised by robust economic activity, whereas a low velocity suggests a general aversion to spending money. However, in the age of mobile money and digital banking, where the majority of economies are transitioning to a cashless system, the theory employed to assess the efficiency of economies may appear to be at odds with the declining use of physical cash (m1). Hence, mobile money and digital banking possess the capacity to impact business models and the theory of velocity of money. In academia, the impact of mobile money and digital banking on the velocity of money is not well understood. Notwithstanding the abundance of scholarly literature concerning the velocity of money, the correlation between mobile money and digital banking and its impact on velocity of money in Ghana has been explored by a limited number of researchers.

The objective of the empirical inquiries is to examine the correlation or validity between digital banking and mobile money, both of which are extensively utilised in Ghana for routine financial transactions. The velocity of money is assessed through the utilisation of broad money as a percentage of gross domestic product and broad money growth (annual %), both of which are derived from the World Bank's development indicators. Mobile money is additionally assessed through mobile cellular subscriptions and account ownership at a financial institution or with a mobile money service provider (percentage of the total population). Indicators of world development conclude the evaluation of digital banking based on the proportion of the total population aged 15 and older that engages in digital payments, receives digital payments, or conducts digital merchant payments.

3.1. Data

The information is obtained from the World Bank's world development indicators and is presented in the following Table 1.

4. DATA PRESENTATION, ANALYSIS, AND DISCUSSION OF RESULTS

Prior to estimating the VAR/VEC model as delineated in the preceding section, it is essential to conduct a stationarity test on the time series data (Stock and Watson, 2001). Stationarity of the data is therefore determined using the following procedure.

Table 1: Descriptive statistics

Variable indications	Measurement	Notation	Data Source	Scale
Velocity of money	(i) Broad money (% of GDP) is the category of the amount	VOM	WDI	Natural logarithm
Mobile money	(i) Account ownership at financial institution or with a mobile money-service provider (% of population age 15+), (ii) mobile cellular subscriptions, (iii) Number of persons age 15+who made digital in-store merchant payment using mobile phone	Momo	WDI	Natural logarithm
Digital banking	Number of persons who made digital online merchant payment for an online purchase (% of age 15+), made or received digital payment (% age 15+)	Digit	WDI	Natural logarithm
M2 Money Supply Growth Rate	(i) Broad money growth (annual %) of money circulation in the economy, (ii) Borrowed any money from a formal financial institution or using a mobile money account (% age 15+), (iii) Saved any money (% age 15+) (iv) Broad money to total reserves ratio, (v) Claims on other sectors of the domestic economy (annual growth as % of broad money), (vi) Claims on private sector (annual growth as % of broad money)	M2G	WDI	Natural logarithm
Monetary Policy Rate	(i) Monetary Sector credit to private sector (% GDP), (ii) Real interest rate (%)	MPR	WDI	Natural logarithm
Inflation Expectation	Inflation, GDP deflator (annual %)	Infindex	WDI	Natural logarithm

Author's computations, (2024)

The outcomes of the stationarity tests using the Perron (1988), Dickey and Fuller (1979) and Lee and Schmidt (1996) tests are displayed in Table 2. The null hypothesis that a time series sample does not contain a unit root is examined using the ADF test statistics. Depending on the version of the test employed, the alternative hypothesis may vary; however, it is typically stationary or trend stationary. Comparable to the ADF test, the Phillip Perron test determines whether or not data points change in a predictable fashion; this allows the researcher to determine whether or not the data are stationary. The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test was an additional examination performed to validate the stationarity of the data. In addition to examining the alternative hypothesis, this test evaluates the null hypothesis that the time series exhibit trend stationarity. The rationale behind implementing these three tests is to guarantee the reliability of the unit root results.

VOM, MOMO, Digit, M2G, MPR, and Infidex are not stationary at level according to the augmented dickey-fuller test statistics; however, following the initial difference, the variables became integrated at order one I(1). Similarly, at order one I(1), in both the Phillips Perron and KPSS tests, every variable is integrated. Hence, in light of the variables being integrated at order one (I(1)), it becomes necessary to examine the variables for cointegration in order to determine whether a long-run relationship exists subsequent to the determination of the lag length selection.

In Table 3 of the time series analysis, choosing the ideal lag duration is essential, particularly when using autoregressive models such as VAR (Vector AutoRegressive) or ARIMA (AutoRegressive Integrated Moving Average). A model's lag length is the total amount of historical observations that it incorporates. Achieving precise and trustworthy findings requires choosing suitable lag duration. ACF plots illustrate the relationship between the series and its lag values, while PACF plots shed light on the autocorrelation structure of the time series. In contrast, PACF accounts for correlations with shorter delays by displaying the correlation between the series and its lag values. The ideal lag duration can be inferred from the lag at which ACF and PACF values decrease or become negligible. Model selection can be done using criteria such as the Hannan-Quinn Information Criterion (HQIC), the Bayesian Information Criterion (BIC), and the Akaike Information Criterion (AIC). These standards strike a compromise between the model's complexity and goodness of fit. A better trade-off is indicated by lower values. Select the model that minimises the chosen information criterion by fitting it with varying lag lengths. A statistical test called the Ljung-Box test determines whether any of a set of autocorrelations of a time series deviates from zero. It facilitates the testing of the independent distribution of the data, which is the null hypothesis. The Ljung-Box test is used to identify the lag length where the test statistic is not significant and to search for various lag lengths, divide the time series into sets for training and validation, then fit the model using various lag times. To determine which lag length yields the best out-of-sample performance, use Mean Squared Error on the validation set. Fit models with varying lag times and assess each model according to a selected criterion (e.g., AIC, BIC) to conduct a grid search. Choose the lag length that, when applied to the selected criterion, yields the best model performance. For the purpose of this research AIC is selected with a lag length of 3 in view of the fact that it has the least figure of 2.022157 as compared to FPE (5.23), SC (5.513), HQ (3.766), and LR (53.36).

In Table 4 shows Johansen's co-integrating test which is used in a multivariate framework. To find out how many co-integrating relationships there are between the dependent and independent variables, we must first determine whether the variables are I(0) or I(1) variables. If all of the variables used in this study are I(1) variables, then the number of co-integrating relationships between the dependent and independent variables can be found using the Johansen's co-integration test.

Johansen's methodology takes its starting point in the Vector Autoregression (VAR) of order P given by;

$$Y_t = \tau + \delta_i Y_{t-1} + \text{---} + \delta_P Y_{t-P} + \varepsilon_t \text{---} \qquad (1)$$

Table 2: Data stationarity test

Unit root test											
Augmented Dickey-Fuller test				Philip-Perron-test				KPSS-test			
Variable	In level	First Diff	Status	Variable	In level	First Diff	Status	Variable	In level	First Diff	Status
VOM	−2.551212	−4.212403***	I (1)	VOM	−2.642296	−4.355488***	I (1)	VOM	0.340569	0.394391***	I (1)
MOMO	−2.213559	−3.986584***	I (1)	MOMO	−2.125088	−3.986584***	I (1)	MOMO	0.169030	0.163381***	I (1)
Digit	−2.381359	−4.265420***	I (1)	Digit	−2.143096	−3.430177***	I (1)	Digit	0.138395	0.204195***	I (1)
M2G	−0.436121	−5.308303***	I (1)	M2G	−0.748906	−5.308442***	I (1)	M2G	0.651885	0.234624***	I (1)
MPR	−2.494888	−4.548227***	I (1)	MPR	−2.494888	−4.544479***	I (1)	MPR	0.230839	0.190056***	I (1)
Infidex	−2.491577	−5.157966***	I (1)	Infidex	−2.513463	−5.157966***	I (1)	Infidex	0.236816	0.200334***	I (1)

Author's Computation, 2023

Table 3: Determination of optimal lag length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−209.0494	NA	0.002481	11.02818	11.28411	11.12000
1	−30.57553	292.8803	1.71e-06	3.721822	5.513350*	4.364607
2	22.53235	70.81050	8.12e-07	2.844495	6.171618	4.038238
3	74.56793	53.36983*	5.23e-07*	2.022157*	6.884876	3.766859*

Author's Computation, 2024

Table 4: Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE (s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.903063	232.0433	95.75366	0.0000
At most 1 *	0.828431	143.3629	69.81889	0.0000
At most 2 *	0.753847	76.37762	47.85613	0.0000
At most 3	0.309509	23.10921	29.79707	0.2407
At most 4	0.177853	9.035796	15.49471	0.3621
At most 5	0.041080	1.594009	3.841466	0.2068

Trace test indicates 3 cointegrating eqn (s) at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) *P* values

Where Y_t is an nx1 vector of variables that are integrated of order one-commonly denoted by I(1) and ε_t is an nx1 vector of innovations written as;

$$\Delta Y_t = \theta + \pi Y_{t-1} + \sum_{i=1}^{P-1} \gamma_i \Delta Y_{t-1} + \varepsilon_t -- \qquad (2)$$

$$\text{Where; } \pi = \sum_{i=1}^{P} \forall_i - I \text{ and } \gamma_i = \sum_{j=i+1}^{P} \forall_i -- \qquad (3)$$

If the coefficient matrix π has reduced rank r < n, then there exist n×r matrice α and β each with rank r such that $\pi = \alpha\beta'$ and $\beta' Y_t$ is stationary r is the number of cointegrating relationships, the elements of α are known as the adjustment parameters in the vector errorcorrection model and each column of β is a cointegrating vector. Furthermore, the null hypothesis is rejected since the maximal eigenvalue results supported the trace statistics results using three (3) cointegration equations. This suggests that the variables have a long-term causal link with one another. Modelling a vector error correction is possible if cointegration is present.

4.1. Model for Vector Error Correction (VECM)

When variables are stationary, the conventional VAR model is estimated, and differentiating the series is the first step in the traditional removal of the unit root model. This would, however, result in overdifferencing and the loss of information provided by the long-term comovement of variable levels in the case of cointegrated series, and therefore the cointegrated VAR model is constructed as a result. The Vector Error Correction Model (VECM) concept, as proposed by Medvedev and Fedchenkov (2015) is comprised of an error-correction term generated from the known cointegration connection and a VAR model of order p - 1 on the differences of the variables. VECM model intuitively creates a short-term link among variables and corrects for deviations from long-term comovements.

4.2. Model Specification

Using differences and error correction terms, each VAR model can be represented in the form of VECM, as stated previously. Moreover, this suggests that each VECM model is supported by an underlying VAR model. To comprehend the VECM specification, the following analysis of the underlying VAR model specification is necessary:

$$Y_t = \tau + r_1 Y_{t-1} + r_2 Y_{t-2}) + - + r_p Y_{t-p} + \mu_t \qquad (4)$$

Where Y_t is a vector of K parameters (Kx1), τ is a vector of constant (kx1), r_2 and r_p are matrices of parameters (KxK) at different lags (lag1 + p) and μ_t is a vector of impulse (Kx1). In VAR and VECM terminology, the error terms are referred to as impulses or innovations.

In order to incorporate short-term dynamics, VECM models are delineated in differences. Furthermore, to account for long-term cointegration relationships and short-term adjustments, VECM models incorporate error correction terms and cointegration equations. The general form of a VECM models are specified as follows:

$$\Delta Y_t = \tau + \pi Y_{t-1} + \sum_{j=1}^{k-1} \delta_i \Delta Y_{t-1} + \mu_t \qquad (5) \text{ or}$$

$$\Delta Y_t = \tau + \pi Y_{t-1} + \vartheta_1 Y_{t-1} + \vartheta_2 \Delta Y_{t-2} + --- + \vartheta_{p-1} \Delta Y_{t-(p-1)} + \mu_t \qquad (6)$$

$$\begin{aligned} \Delta l_n VOM_t = \alpha &+ \sum_{j=1}^{K-1} \beta_j \Delta l_n VOM_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n Digit_{t-1} \\ &+ \sum_{m=1}^{K-1} \gamma_m \Delta l_n MOMO_{t-1} + \\ &\sum_{j=1}^{K-1} \beta_j \Delta l_n M2G_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n MPR_{t-1} + \\ &\sum_{i=1}^{K-1} \varnothing_t \Delta l_n INfindex_{t-1} + \lambda_1 ECT_{t-1} + \mu_{it} \end{aligned} \qquad (7)$$

$$\begin{aligned} \Delta l_n MOMO_t = \alpha &+ \sum_{j=1}^{K-1} \beta_j \Delta l_n MOMO_{t-1} + \\ &\sum_{i=1}^{K-1} \varnothing_t \Delta l_n Digit_{t-1} + \sum_{m=1}^{K-1} \gamma_m \Delta l_n VOM_{t-1} + \\ &\sum_{j=1}^{K-1} \beta_j \Delta l_n M2G_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n MPR_{t-1} + \\ &\sum_{i=1}^{K-1} \varnothing_t \Delta l_n Infindex_{t-1} + \lambda_1 ECT_{t-1} + \mu_{it} \end{aligned} \qquad (8)$$

$$\begin{aligned} \Delta l_n Digit_t = \alpha &+ \sum_{j=1}^{K-1} \beta_j \Delta l_n Digit_{t-1} + \\ &\sum_{i=1}^{K-1} \varnothing_t \Delta l_n MOMO_{t-1} + \sum_{m=1}^{K-1} \gamma_m \Delta l_n VOM_{t-1} + \\ &\sum_{j=1}^{K-1} \beta_j \Delta \ddot{u}\ddot{u}\ddot{u}\ddot{u}_n 2 \quad {}_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta \; {}_n \quad {}_{t-1} + \\ &\sum_{i=1}^{K-1} \varnothing_t \Delta l_n Infindex_{t-1} + \lambda_1 ECT_{t-1} + \mu_{it} \end{aligned} \qquad (9)$$

$$\Delta l_n M2G_t = \alpha + \sum_{j=1}^{K-1} \beta_j \Delta l_n M2G_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n MOMO_{t-1} + \sum_{m=1}^{K-1} \gamma_m \Delta l_n VOM_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n Digit_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n MPR_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n Infindex_{t-1} + \lambda_1 ECT_{t-1} + \mu_{it} \quad (10)$$

$$\Delta l_n MPR_t = \alpha + \sum_{j=1}^{K-1} \beta_j \Delta l_n MPR_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n MOMO_{t-1} + \sum_{m=1}^{K-1} \gamma_m \Delta l_n VOM_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n Digit_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n M2G_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n Infindex_{t-1} + \lambda_1 ECT_{t-1} + \mu_{it} \quad (11)$$

$$\Delta l_n Infindex_t = \alpha + \sum_{j=1}^{K-1} \beta_j \Delta l_n Infindex_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n MOMO_{t-1} + \sum_{m=1}^{K-1} \gamma_m \Delta l_n VOM_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n Digit_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n M2G_{t-1} + \sum_{i=1}^{K-1} \varnothing_t \Delta l_n MPR_{t-1} + \lambda_1 ECT_{t-1} + \mu_{it} \quad (12)$$

K-1 is the lag length reduced by one, β_j, $\varnothing_t$, and γ_m are the short-run dynamic coefficients of the model's adjustments in the long-run, λ_1 is the speed of adjustment which also carries negative sign, ECT_{t-1} is the error correction term of the lagged value of the residuals obtained from the cointegrating regression of the dependent variables on the regressors, μ_{it} is the impulse or the stochastic error term. Also, velocity of money, mobile money, digital banking services, M2 money supply growth, Monetary Policy Rate, and Inflation Expectation index are denoted by VOM, MOMO, Digit, M2G, MPR, and Infindex respectively.

$$\Delta l_n Vom_t = -0.189745ECT_{t-1} + 0.194471VOM_{t-1} + -0.539902MOMO_{t-1} + -0.127707Digit_{t-1} + 0.142485M2G_{t-1} + 0.312530mpr_{t-1} + -0.320745Infindex_{t-1} + 0.024256 ----- \quad (13)$$

4.3. Vector Error Correction Estimates

Table 5 shows the vector correction estimates which are critical concepts in Vector Error Correction Models (VECMs), the speed of adjustment describes the rate at which a system returns to its long-run equilibrium following a disturbance or disruption. A correlation exists between the adjustment coefficient in a VECM and the rate of adjustment. The error correction term (ECT) in a VECM represents the transient forces that motivate the system's variables to adapt in the direction of their long-term equilibrium. The coefficient that is linked to the error correction term within a particular equation signifies the rate at which the long-term equilibrium is restored to its initial state. Long-term estimates in Table 3 indicate that mobile money usage and velocity of money are significantly and positively correlated; an increase in mobile money usage results in a corresponding increase of 15% in velocity of money, all things being equal. This correlation is consistent with the results reported by Takyi (2024) and is in opposition to the findings discussed by Essien and Henrietta (2024). Mobile money services enable users to transmit and receive funds via their mobile devices in an expedient manner, thereby decreasing the time required for currency to exchange hands. Additionally, mobile money services are frequently more accessible than traditional banking services, particularly in regions where banking infrastructure is scarce. This enhanced accessibility may result in an increase in transaction volume, thereby accelerating the flow of money. Additionally, mobile money diminishes the dependence on tangible currency by facilitating electronic transactions rather than requiring the physical exchange of banknotes; this leads to transactions that are executed more quickly and efficiently.

Additionally, a substantial correlation exists between digital banking services and the velocity of money over an extended period of time; specifically, an expansion in digital banking corresponds to a 48.3% increase in the velocity of money. This concept facilitates immediate transactions, enabling users to conduct financial transactions, transfer funds, and make payments in real time. This instantaneity increases the velocity of money by decreasing the completion time of transactions. As stated by Muksalmina and Ahmadsyah (2024), bill payment functionalities are frequently provided by digital banking platforms, which enhance convenience. By resolving their financial obligations and debts online, users can significantly save time and effort that would otherwise be spent on manual processes like toiling with and mailing checks. Additionally, Mohamed and Faisal (2024) stated that digital banking enables and simplifies customers' access to their bank accounts by providing a banking service that is available around the clock. This constant accessibility encourages financial activity, which increases the velocity of money due to the fact that transactions can transpire at any moment. Additionally, a noteworthy correlation exists between the growth of M2 and the velocity of money. Supply and velocity of money are two essential elements of quantity theory of money, a fundamental concept in microeconomics. Spending habits can be influenced by the cost and accessibility of credit. In situations where credit is readily accessible and affordable, individuals might resort to borrowing funds more frequently, which could potentially accelerate the flow of money. In essence, the interplay between the velocity of money and M2 growth is dynamic and contingent upon an assortment of economic variables. Variations in the magnitude and direction of the influence of M2 on the velocity of money are contingent upon the wider economic environment.

Long-term correlations also exist between monetary policy rate and velocity of money; for instance, an increase in the policy interest rate by the central bank results in a corresponding rise in the cost of borrowing, which tends to deter business investment and consumer expenditure. The opportunity cost of retaining money may also increase in tandem with higher interest rates. There is a possibility that organisations and individuals would be more inclined to lend or invest money as opposed to retaining it, which could accelerate the flow of money. As posited by Bachri and Rosyadi (2024) elevated interest rates might induce a dearth of borrowing, investment, and expenditure, thereby potentially

Table 5: Vector Error Correction Estimates

Cointegrating Eq:	CointEq1			
VOM(-1)	1.000000			
MOMO(-1)	-0.153693			
	(0.05330)			
	[-2.88355]			
DIGIT(-1)	-0.483841			
	(0.15640)			
	[-3.09355]			
M2G(-1)	-1.818440			
	(0.31221)			
	[-5.82434]			
MPR(-1)	-1.766590			
	(0.58511)			
	[-3.01924]			
INFINDEX(-1)	-1.033664			
	(0.18883)			
	[-5.47381]			
	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
CointEq1	-0.189745	0.069472	-2.731227	0.0106
VOM	0.194471	0.066619	2.919006	0.0056
VOM	0.058643	0.157603	0.372095	0.7125
VOM	-0.022940	0.165245	-0.138826	0.8905
VOM	-0.058472	0.155967	-0.374899	0.7105
MOMO	-0.539902	0.073630	-7.281934	0.0000
MOMO	0.112017	0.082360	1.360083	0.1843
MOMO	0.110213	0.011974	9.204368	0.0000
MOMO	0.059952	0.068767	0.871806	0.3905
DIGIT	-0.127707	0.015365	-8.311552	0.0000
DIGIT	-0.241819	0.046386	-5.213189	0.0000
DIGIT	0.253270	0.140825	1.798471	0.0825
DIGIT	-0.057932	0.129423	-0.447618	0.6578
M2G	0.142485	0.019154	7.438916	0.0000
M2G	-0.248911	0.278093	-0.895064	0.3781
M2G	0.091494	0.250722	0.364923	0.7178
M2G	-0.550494	0.117970	-4.666380	0.0005
MPR	0.312530	0.110017	2.840742	0.0015
MPR	0.048726	0.142298	0.342420	0.7345
MPR	0.256864	0.105509	2.434522	0.0008
MPR	-0.253809	0.100115	-2.535174	0.0000
INFINDEX	-0.320745	0.100025	-3.086313	0.0037
INFINDEX	-0.029278	0.142907	-0.204873	0.8391
INFINDEX	0.227643	0.100350	2.368470	0.0000
INFINDEX	0.399813	0.131190	3.047587	0.0002
C(26)	0.024256	0.035439	0.684441	0.4991
R-squared	0.637075	Mean dependent var		0.024949
Adjusted R-squared	0.324208	S.D. dependent var		0.287872
S.E. of regression	0.236650	Akaike info criterion		0.260947
Sum squared resid	1.624091	Schwarz criterion		1.209868
Log likelihood	18.82397	Hannan-Quinn criter.		0.627902
F-statistic	2.036252	Durbin-Watson stat		2.080990
Prob(F-statistic)	0.003471			

impeding the flow of money. According to Musthafa and Suardi (2024) credit conditions in the economy may be influenced by monetary policy rates. This is because credit becomes more accessible and affordable with reduced interest rates, which could incentivize borrowing and spending and subsequently increase the velocity of money. Long-term inflation can also be impacted by alterations in monetary policy rates. For instance, when a central bank increases interest rates in an effort to rein in inflation, it could result in a greater emphasis on price stability, which in turn could affect the velocity of money and spending patterns.

4.4. Short Run Relationship

Negative and statistically significant values of the cointegrating equation in Table 5, also known as the speed of adjustment, indicate convergence from short-run dynamics to long-run equilibrium. The adjustment coefficient of 18.9% signifies that the model will revert to equilibrium at a rate of 18.9% in the event of any disturbance. An increase in money velocity will result in a 19.4% increase in money velocity in the short term, all other things being equal. An increase in mobile money usage has a favourable association with the velocity of money, as indicated by the positive coefficient. Ogboye and Kwarbai (2022) assert that mobile money transactions are frequently distinguished by their expediency and convenience. Consequently, individuals may be more inclined to utilise mobile money for a variety of transactions, which could increase the frequency of exchanges. Temporarily, the facilitation of transaction execution may contribute to an acceleration of money velocity. Ahmad and Green (2020) posit that mobile money has the potential to replace cash transactions should individuals transition from physical cash to mobile money. Such a transition could potentially accelerate the flow of currency. Inan and Hidayanto (2023) postulated that the short-term security of mobile money could impede or dissuade users from utilising the service. The velocity of money in the mobile money system could be adversely affected if individuals revert to conventional currency transactions due to scepticism regarding the security of their transactions. According to Zeng and Li (2023) a lack of comfort and familiarity with digital platforms for financial transactions exists among some individuals. Insufficient digital literacy can impede the broad implementation of digital banking services, thereby restricting the user base engaged with digital banking systems.

Additionally, a positive and statistically significant short-term correlation exists between digital banking services and money velocity. According to Shin and Cheng (2023), digital banking enables expedited and more effective transactions in the short term when compared to conventional banking approaches. Using smart phones and computers, individuals can manage their finances, make payments, and conduct transactions from the convenience of their own residences. This increased velocity of money may result from the increased frequency of financial transactions prompted by this convenience. In contrast to the claim that mobile money acceptance is universal, the authors of Sarangi (2023) suggest that infrastructure deficiencies in certain regions and challenges users face when attempting to access mobile money services or encounter a scarcity of acceptance points can impede the flow of funds. Additionally, Setiadi and Nurhayati (2023) noted that the majority of individuals, particularly in less technologically advanced regions, may lack the digital literacy skills required to use mobile money platforms effectively. This could potentially impede the progress of mobile money adoption and diminish the flow of funds as individuals continue to rely on conventional methods.

A significant positive relationship exists between money supply and velocity of money; this indicates that businesses and consumers may be more inclined to spend during economic expansion, thereby increasing the velocity of money. It has been verified by Akaliyski and Taniguchi (2023) that in times of economic recession or uncertainty, individuals might exhibit a propensity to accumulate funds in an effort to reduce the velocity of money. Additionally, an increase in lending activities by banks in response to a growing money supply may stimulate economic activity and accelerate the velocity of money. But the impact of M2 growth on the velocity of money might be mitigated if financial institutions adopted more prudent lending practices. Short-term correlation analysis reveals a significant and positive relationship between the inflation index and velocity of money; the existence of inflation incentivizes businesses and individuals to engage in rapid spending in order to prevent the depreciation of their currency. This increased expenditure contributes to a greater money velocity. According to a study by Adeosun et al. (2023) it is critical to have an accurate inflation index in order to comprehend fluctuations in the general price level. Misconceptions regarding economic conditions may result from inaccuracies or biases in inflation measurement. Insufficient representation of fluctuations in the cost of living by the inflation index could lead to suboptimal spending and investment decisions by businesses and individuals, thereby influencing the circulation of money.

To provide a more comprehensive simulation-based analysis of the VOM response to the right-hand variables, I illustrate a simulation of a one standard deviation shock to said variables.

Figure 1 shows the impulse response function conducted for the variables, velocity of money is subjected to an impulse of one unit standard deviation in Figure 1, mobile money usage will decrease in period one, increase progressively in period three, and then continue to decline until period six. The decrease in popularity may be attributed to individuals' inclination towards conventional banking infrastructure. In a similar vein, a velocity of money impulse of one standard deviation will cause digital banking services to increase from period 5 onwards, before declining from period 5 onwards. A greater velocity of money could potentially stimulate greater adoption of digital banking if these services are perceived as more convenient and efficient. Moreover, an economy that expands at a speedier rate could potentially generate greater consciousness regarding digital banking services. As more individuals become acquainted with the advantages of these services including online transfers, mobile payments, and round-the-clock access to financial data they are more likely to embrace them. Furthermore, an elevated velocity of money may not invariably result in greater adoption of digital banking if the digital infrastructure lacks resilience and is not broadly available. A barrier may consist of restricted access to technology or the internet. As a consequence, an increase in the velocity of money from period four to period six was caused by an impulse, which subsequently decreased beginning in period six. Advancement in the velocity of money will result in an initial escalation of the monetary policy rate and the inflation index from periods 1 to 8, followed by a subsequent decline. There are both positive and negative correlations observed among the variables in all the responses. Consequently, the relationship between innovation and velocity of money and mobile money, digital banking services, money supply, monetary policy rate, and inflation index is asymmetric.

Figure 2 also shows stability and diagnostic results, stability and diagnostic testing are critical components of VECM modelling. To assess the dependability of the estimated relationships, identify structural breaks or parameter changes, and maintain the model's validity for policy analysis and forecasting, the research employed the following tests: serial correlation, heteroscedasticity, normality, Cusum and Cusum of Squares, as illustrated in Figures 1-3, and Tables 5 and 6, respectively. Results from table 6 indicates that there is no serial correlation in the model as the probability value

Figure 1: Impulse response functions

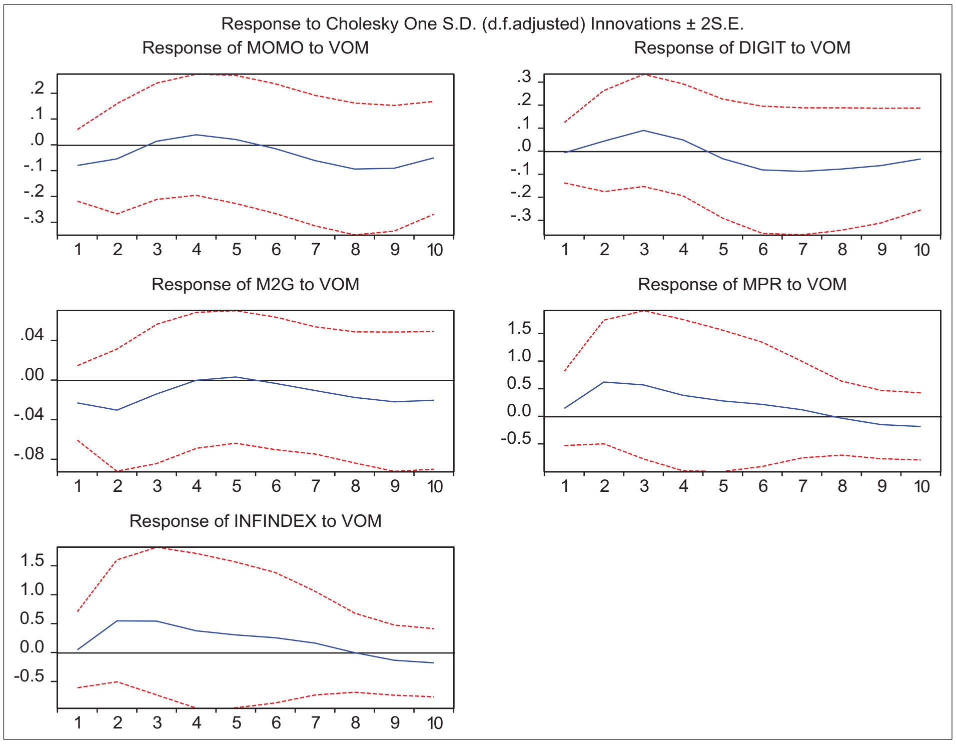
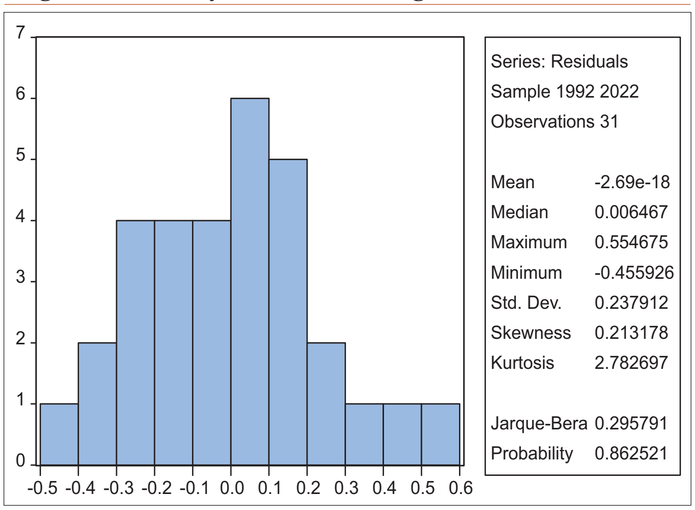


Figure 2: Stability and residual diagnostic test



is more than the threshold, also table 7 shows that there is no heteroscedasticity in the model as its probability value is more than 0.05. The Cusum test revealed that the blue line, which corresponds to the 5% critical line, is situated between the two red lines in Figure 1. This indicates that there is no indication of a structural break in the VECM coefficients, and it is possible to conclude that the relationships between the variables remain stable over time and that the model adequately describes the data. Figure 2's Cusum of Squares results further validate the model's stability, indicating that it has not experienced any substantial alterations. Furthermore, the findings presented in Figure 1 indicate that the residuals conform to a normal distribution. This conclusion is supported by the Jarque-Bera value of 0.295791 and the probability value of 0.862521 both of which surpass the 5% significance threshold. Additionally, the

Table 6: Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.895481	Prob. F (2,23)	0.4222
Obs*R-squared	2.239519	Prob. Chi-Square (2)	0.3264

Table 7: Heteroacedasticity

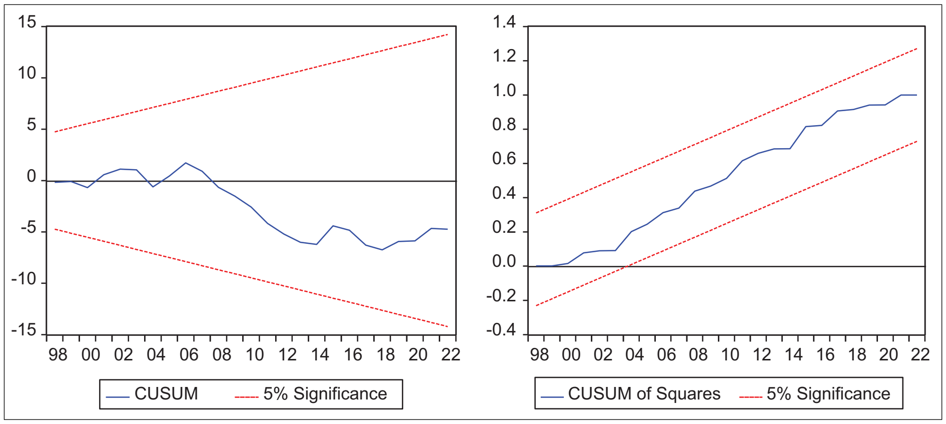
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.101290	Prob. F (5,25)	0.3846
Obs*R-squared	5.595537	Prob. Chi-Square (5)	0.3476
Scaled explained SS	3.243739	Prob. Chi-Square (5)	0.6625

findings presented in Tables 5 and 6 indicate the absence of serial correlation and heteroscedasticity within the model. The P-values for both the heteroscedasticity and serial correlation tests are substantial high, preventing us from rejecting the null hypothesis and indicating that there is insufficient evidence to conclude that the residuals exhibit serial correlation. It is possible that the assumption of independent errors is reasonable.

5. CONCLUSION, RECOMMENDATIONS, AND POLICY IMPLICATIONS

A significant indicator of a nation's overall economic activity is the velocity of money. A greater velocity typically signifies a more dynamic and prosperous economy, given that there is greater frequency of money exchange. When combined with the quantity of money (as measured by the money supply), the velocity of money helps to determine the overall price level in an economy. Volatility of money fluctuations has the potential to impact inflationary or deflationary pressures. The velocity of money is a metric employed by central banks to devise and evaluate monetary

Figure 3: Cusum



policy. Gaining insight into the velocity of money circulation facilitates policymakers' deliberations concerning money supply and interest rates. The equation of exchange (MV = PY), in which M represents the money supply, V denotes the velocity of money, P signifies the price level, and Y signifies real output (GDP), includes the velocity of money as a component. Explanation of the relationship between money and economic activity is facilitated by this equation. Financial analysts and investors may take the velocity of money into account when formulating investment strategies. An increasing velocity might be interpreted favourably in terms of economic expansion, whereas a decreasing velocity might give rise to apprehensions. The efficiency with which the financial system facilitates transactions is reflected in the velocity of money. An increased velocity is indicative of a financially liquid and operational system. Variations in consumer and business confidence have the potential to impact the velocity of money. People may retain currency, resulting in a decrease in velocity, during economic downturns, for instance. The velocity of money can be employed by policymakers as a metric to assess the efficacy of their policies. An illustration of the efficacy of monetary authorities' efforts to stimulate the economy could be observed through a surge in the velocity of money.

Using data from 1992 to 2022, the primary objective of this paper is to examine the short and long term relationship between money velocity, mobile money usage, and digital banking service in Ghana. The article presents a range of economic and financial conclusions and recommendations derived from empirical research. Table 4 presents the findings that indicate a positive correlation between velocity of money and the following variables over the long term: mobile money, digital banking services, money supply, monetary policy rate, and inflationary index. The proliferation of digital financial services and mobile money has the potential to influence the velocity of money through streamlined and expedited transactions. Additionally, the proliferation of digital financial services may encourage individuals to conduct transactions more frequently, which could ultimately result in a faster flow of money. As stated by Faza and Hakim (2023) the velocity of money can be impacted by the money supply, which includes demand deposits, physical currency, M1, savings deposits, and time deposits. In the long-term, an increase in money supply that is not accompanied by a corresponding rise in money demand may result in a higher velocity due to increased spending. Moreover, central banks employ monetary policy instruments including reserve requirements, open market operations, and interest rates to exert control over the money supply and, by extension, the velocity of money. For instance, a reduction in interest rates could incentivize expenditure and borrowing, thereby potentially augmenting the velocity of money over an extended period of time. The findings suggest that, over time, inflation can significantly augment the velocity of money. The data indicates that there is a statistically significant positive correlation between the velocity of money and the other variables in the model in the short run. This indicates that there are significant relationships between money supply, monetary policy rate, mobile money usage, digital banking services, velocity of money, and inflation index in both the short and long run. This result is consistent with the findings of Fernandes and Borges (2023) that investigated the effect of mobile money on money velocity and concluded that the variables are causal in both the short and long run. The impulse response function in Figure 1 further validated the findings of this research. It demonstrated that a one-unit standard deviation increase in the velocity of money induces both positive and negative shocks across all model variables. This suggests that there exists an asymmetric relationship in the long and short run among the velocity of money, mobile money usage, digital banking services, money supply, monetary policy, and inflationary index.

Policy makers should ensure that greater proportion of the populace have access to banking and financial services in order to advance financial inclusion. Such endeavours encompass programmes aimed at integrating unbanked or under banked individuals into the established financial system. There should be deliberate efforts to promote the utilisation of online banking services, mobile money, and digital payment methods, these technologies have the potential to accelerate money circulation, reduce reliance on physical currency, and streamline transactions. Financial infrastructure, including networks and payment systems, should be improved and invested in. Interest should be demonstrated in building a resilient digital infrastructure that is dependable and efficient and can enable more rapid and secure transactions, advocate for increased financial awareness and literacy among the populace. Educated consumers are more likely to conduct transactions more frequently and at a quicker rate in order to better inform their financial decisions. Government should strive to establish and sustain a stable monetary policy, since policies that are stable and predictable have the capacity to foster an atmosphere of assurance and dependability, thereby stimulating spending and investment. There should also be attempts to reduce the transaction costs that are linked to financial activities. Elevated transaction costs have the potential to deter users and impede the flow of money. Policy makers should also create and maintain an environment that is conducive to economic expansion, a greater velocity of money is frequently the result of increased business activity, employment, and consumer spending that accompanies an expanding economy. Prompt and dependable banking services incentivize businesses and individuals to engage in more active money transfers and therefore government should consider enforcing public policies that promote and facilitate economic activities. Aiming strategically, fiscal expenditures by the government on education, infrastructure, and other sectors can augment the velocity of money and foster economic expansion, reduce political and economic unpredictability, which may induce stockpiling or a reluctance to spend. The presence of future certainty motivates economic agents to engage in financial transactions actively. Subsidies, tax incentives, and other similar policies can motivate economic actors to invest their funds in productive endeavours, preserve a regulatory setting that fosters competition and innovation within the financial industry. This has the potential to facilitate the creation of novel and enhanced financial products and services. Future research on the impact of mobile money, digital financial services, on velocity of money in Africa, using longitudinal data is encouraged.

REFERENCES

Abdullah, A.M., Mousa, A.A., Abdulrahman, A.M., Mesfer, A.N., Mohammed, A.A., Salman, A.K., Madhi, A.A., Nasser, A.M. (2023), The role of modern technology in preventing and detecting accounting fraud. International Journal of Multidisciplinary Innovation and Research Methodology, 2, 1-10.

Abramova, S., Böhme, R. (2023), What Can Central Bank Digital Currency Designers Learn from Asking Potential Users. In: Nineteenth Symposium on Usable Privacy and Security, p151-170.

Aburbeian, A.M., Fernández-Veiga, M. (2024), Secure internet financial transactions. A framework integrating multi-factor authentication and machine learning, AI, 5(1), 177-194.

Adeosun, O.A., Tabash, M.I., Vo, X.V., Anagreh, S. (2023), Uncertainty measures and inflation dynamics in selected global players. Quality and Quantity, 57(4), 3389-3424.

Agarwal, J.D., Agarwal, M. (2021), Economics of cryptocurrencies: Artificial intelligence, blockchain, and digital currency. In: Information for Efficient Decision Making Big Data, Blockchain and Relevance. Singapore: World Scientific Publishing Co., p331-430.

Ahamad, S., Gupta, P. (2022), The role of block chain technology and Internet of Things (IoT) to protect financial transactions in crypto currency market. Materials Today: Proceedings, 56, 2070-2074.

Ahmad, A.H., Green, C. (2020), Mobile monefinancial inclusion and development. Journal of economic surveys, 34(4), 753-792.

Akaliyski, P., Taniguchi, N. (2023), Values in crisis: Societal value change under existential insecurity. Social Indicators Research, 171, 1-21.

Alhassan, I., Islam, K.A. (2021), Credit management strategies and financial performance of industrial goods sector in Nigeria. Indian Journal of Finance and Banking, 8(1), 59-74.

Al-Jabra, A., AlNuhait, H. (2023), A vision towards the future of cryptocurrencies Rooting, its financial significance, and legal challenges in its use. Information Sciences Letters, 12(8), 2545-2557.

Allais, M. (1966), A restatement of the quantity theory of money. The American Economic Review, 56(5), 1123-1157.

Alsmadi, A.A., Moh'd Al-Hazimeh, A. (2023), Banking services transformation and financial technology role. Information Sciences Letters, 12, 315-324.

Amin, H. (2013), Factors influencing Malaysian bank customers to choose Islamic credit cards. Journal of Islamic Marketing, 4(3), 245-263.

Anakpo, G., Xhate, Z., Mishi, S. (2023), The policies, practices, and challenges of digital financial inclusion for sustainable development: The case of the developing economy. FinTech, 2(2), 327-343.

Anwar, A.I., Fattah, S. (2023), Analysis of the Effect of Non-cash Payment Transactions, Inflation, Interest Rate on the Money Supply in Indonesia During the Pandemic Covid-19. Netherlands: Atlantis Press, p742-752.

Ardakani, O.M. (2023), The dynamics of money velocity. Applied Economics Letters, 30(13), 1814-1822.

Asante-Boakye, E., Zhao, H. (2023), Blockchain technology prospects in transforming Ghana's economy. Information Technology for Development, 29(2-3), 348-377.

Bachri, S., Rosyadi, I. (2024), The potential and challenges of Waqf in overcoming economic crises and recessions. Al-Afkar Journal For Islamic Studies, 7(1), 56-78.

Behera, R.K., Bala, P.K. (2023), Assessing factors influencing consumers' non-adoption intention: exploring the dark sides of mobile payment. Information Technology and People, 36(7), 2941-2976.

Berger, D., Vavra, J. (2019), Shocks versus responsiveness: What drives time-varying dispersion. Journal of Political Economy, 127(5), 2104-2142.

Chen, W., Fortunati, L. (2023), Mobile payment in China: A study from a sociological perspective. Journal of Communication Inquiry, 47(3), 222-248.

Cherif, A.B., Imine, A. (2023), Credit card fraud detection in the era of disruptive technologies: A systematic review. Journal of King Saud University-Computer and Information Sciences, 35(1), 145-174.

Dalal, S., Chawla, P. (2023), The power of digitalization on monetary progress: An experience. Journal of Pharmaceutical Negative Results, 14(2), 2100-2108.

Daraojimba, C., Abioye, K.M. (2023), Technology and innovation to growth of entrepreneurship and financial boost: A decade in review (2013-2023). International Journal of Management and Entrepreneurship Research, 5, 769-792.

Dasaklis, T.K., Malamas, V. (2023), A review of the lightning network's evolution: Unraveling its present state and the emergence of disruptive digital business models. Journal of Theoretical and Applied Electronic Commerce Research, 18(3), 1338-1364.

Dickey, D.A., Fuller, W.A. (1979), Distribution of the estimators for autoregressive time series with a unit root. Journal of the American statistical association, 74(366a), 427-431.

Elhajjar, S., Yacoub, L. (2022), The impact of COVID-19 on marketing for higher education institutions in developing countries: The case of Lebanon. Journal of Marketing for Higher Education, 1-20. https://doi.org/10.1080/08841241.2022.2042759

Essien, E.O., Henrietta, A. (2024), A paradigmatic discourse on the correlation between investing in artificial intelligence, effective communication and national transformation. International Journal of Advanced Multidisciplinary Research, 11(1), 1-11.

Faza, H., Hakim, L. (2023), The effect of non-cash payments on the money supply in indonesia during the covid-19 pandemic period. International Journal of Multidisciplinary., Applied Business and Education Research, 4(11), 3837-3847.

Fernandes, C., Borges, M.R. (2023), Measuring an equilibrium long-run relationship between financial inclusion and monetary stability in Mozambique. Applied Economics, 1-16. https://doi.org/10.1080/00036846.2023.2203457

Fine, B., Lapavitsas, C. (2004), Transforming the transformation problem: Why the new interpretation is a wrong turning. Review of Radical Political Economics, 36(1), 3-19.

Fisher, I., Barber, W.J. (1907), The Rate of Interest. New York City: Garland Publication, p354.

Fisher, W.P. Jr. (2023), Separation theorems in econometrics and psychometrics. Journal of Interdisciplinary Economics, 35(1), 29-60.

Foley, D. (2005), Marx's theory of money in historical perspective. In: Marx's Theory of Money: Modern Appraisals. London: Palgrave Macmillan UK, p36-49.

Friedman, M. (1970), A theoretical framework for monetary analysis. Journal of Political Economy, 78(2), 193-238.

Gill, N. (2024), Global Capitalism and the Emergence of the Peasant in Colonial Panjab. England: Stanford University Press.

Godana, S.S. (2023), The demand for money and inflation in Ethiopia. Macro Management and Public Policies, 5(3), 64-77.

Graziani, A. (2003), The Monetary Theory of Production. London: Cambridge University Press.

Guseva, A., Rona-Tas, A. (2014), Plastic Money: Constructing Markets for Credit Cards in Eight Postcommunist Countries. London: Stanford University Press.

Hanif, M. (2020), Developing a fair currency system. ISRA International Journal of Islamic Finance, 12(3), 325-345.

Hobbs, J.E. (1996), A transaction cost approach to supply chain management. Supply Chain Management: An International Journal, 1(2), 15-27.

Hofmann, C. (2020), The changing concept of money. European Business Organization Law Review, 21, 37-68.

Hyden, G. (2024), Theorizing in Comparative Politics. England: Cambridge University Press.

Inan, D.I., Hidayanto, A.N. (2023), Service quality and self-determination theory towards continuance usage intention of mobile banking. Journal of Science and Technology Policy Management, 14(2), 303-328.

Jindal, P., Chavan, L. (2023), Multimedia sustained benefits for financial services. In: Digital Transformation, Strategic Resilience, Cyber Security and Risk Management. United Kingdom: Emerald Publishing Limited, p243-262.

Johanson, J., Mattsson, L.G. (1987), Interorganizational relations in industrial systems. International Studies of Management and Organization, 17(1), 34-48.

Kayongo, A.G., Muvawala, J. (2020), Asymmetric Effects of exchange rate on monetary policy in emerging countries. Applied Economics and Finance, 7(5), 24-37.

Kemmerer, B.W., Langton, A.G. (2023), Development of the Dust Ejecta Radar Technology to Determine Plume-Surface Interaction Ejecta Velocities on Planetary Surfaces. In: International Radar Conference, p1-6.

Khalifa, A., Ali, O.B. (2023), Consumer behavior in the digital age. Journal of Sustainable Technologies and Infrastructure Planning, 7(5), 1-21.

Kicillof, A., Odriozola, E. (2017), Keynes and the General Theory Revisited. London: Routledge.

King, A. (2023), Film and financial space. In: The Financial Image: Finance, Philosophy and Contemporary Film. Cham: Springer International Publishing, p183-241.

Koomson, I., Martey, E. (2023), Mobile money and entrepreneurship in East Africa. Information Technology and People, 36, 996-1019.

Kosmetatos, P. (2023), Capitalism by Generalists: The Governance of the Ayr Bank and the Emergence of Professionalism in Mid-Eighteenth-Century Scottish Banking. Germany: Springer International Publishing, p163-193.

Kuriyama, K., Hashimoto, S. (2023), People's heterogeneous preferences for future development scenarios: A case study of Ishikawa Prefecture, Japan. Sustainability Science, 18, 1907-1924.

Laughlin, J.L. (1924), The quantity-theory of money. Journal of Political Economy, 32(3), 265-281.

Lee, D., Schmidt, P. (1996), On the power of the KPSS test of stationarity against fractionally-integrated alternatives. Journal of Econometrics, 73(1), 285-302.

Marglin, S.A. (2020), Raising Keynes: A Twenty-first-Century General Theory. United States: Harvard University Press.

Mata, M.E., Roldão, M. (2021), The Portuguese escudo area in Africa and its lessons for monetary unions. Economic History of Developing Regions, 36(3), 392-421.

Maulayati, R.R., Herianingrum, S. (2020), Effect of macroeconomic variables on third-party funds in Islamic commercial banks in Indonesia. Journal of Islamic Economics Lariba, 5(1), 19-40.

Medvedev, A., Fedchenkov, P. (2015), Waste Management as an IoT-Enabled Service in Smart Cities. In: Internet of Things, Smart Spaces, and Next Generation Networks and Systems, pp. 104-115.

Mohamed, A., Faisal, R. (2024), Exploring metaverse-enabled innovation in banking: Leveraging NFTS, blockchain, and smart contracts for transformative business opportunities. International Journal of Data and Network Science, 8(1), 35-44.

Mohamed, A.A., Nor, M.I. (2023), The macroeconomic impacts of the mobile money: Empirical evidence from EVC plus in Somalia. Journal of Financial Economic Policy, 15(1), 1-15.

Montreuil, V.L., Foucher, R. (2023), Technological changes in the era of digitalization: What do collective agreements tell us. Industrial Relations Journal, 54(1), 20-39.

Moreira, A., Hick, R. (2021), COVID-19, the Great Recession and social policy: Is this time different. Social Policy and Administration, 55(2), 261-279.

Morosan, C., Dursun-Cengizci, A. (2024), Tips and trips: A structural model of guests' intentions to stay and tip for AI-based services in hotels. Journal of Hospitality and Tourism Technology, 15(1), 170-194.

Muksalmina, M., Ahmadsyah, I. (2024), Understanding E-money preferences among students. Grimsa Journal of Business and Economics Studies, 1(1), 1-11.

Mushaddik, I.N., Nori, A.W. (2023), Malaysia's potential revolution: Embracing gold-backed cryptocurrency into international net settlement via blockchain could transform economic and financial resilience. Journal of Islam in Asia, 20(3), 2289-8077.

Musthafa, M.T., Suardi, S. (2024), Monetary policy transmission in Sri Lanka. Applied Economics, 56(2), 151-168.

Muthusamy, S.K., Kannan, R. (2023), Profits crisis: Evolving patterns of firm size and performance in traditional US industries. Journal of Industrial and Business Economics, 50, 575-603.

Ogboye, K.S., Kwarbai, J. (2022), Determinants of digital banking convenience and customer satisfaction of selected deposit money banks in Nigeria. European Journal of Accounting, Auditing and Finance Research, 10(2), 1-30.

Pedram, M. (2024), Legal regulation of the currency exchange market in Iran: A Hayekian analysis. Law and Financial Markets Review, 1-24. https://doi.org/10.1080/17521440.2023.2280222

Pérez-Arriaga, I.J., Nagpal, D. (2021), Harnessing the Power of Integration to Achieve Universal Electricity Access: The Case for the Integrated Distribution Framework. United Kingdom: Edward Elgar Publishing, p540-567.

Perkins, D.W. (2020), Cryptocurrency: The economics of money and

selected policy issues. Congressional Research Service, 1-27.
Perron, P. (1988), Trends and random walks in macroeconomic time series: Further evidence from a new approach. Journal of Economic Dynamics and Control, 12(2-3), 297-332.
Plakandaras, V., Gupta, R. (2023), Are real interest rates a monetary phenomenon? evidence from 700 years of data. Research in International Business and Finance, 66, 4.
Ron, A. (2023), When hay was king: Energy history and economic nationalism in the nineteenth-century United States. The American Historical Review, 128, 177-213.
Roy, J., Rochaida, E. (2021), Digital and electronic transactions against velocity of money. Corporate Governance and Organizational Behavior Review, 5(2), 145-155.
Rubin, I.I., Colliot-Thélène, C. (1979), A History of Economic Thought. London: Ink links, p248.
Salerno, J.T. (2023), Milton Friedman's Views on Method and Money Reconsidered in Light of the Housing Bubble. Germany: Springer International Publishing, p263-291.
Salerno, J.T. (2023), Money and the Market Proces. Germany: Springer International Publishing, p263-291.
Sarangi, B. (2023), Cashless Economy and Electronic Money. In: Indonesian Annual Conference Series, p79-90.
Sarkissian, A. (2024), The Small States Club: How Small Smart Powers Can Save the World. England: Oxford University Press.
Sarsembayev, D. (2021), Monetary theory of the genesis of the state, prospects for electronic money and transnational law, International Journal of Criminology and Sociology, 10, 636-647.
Schlatt, V., Sedlmeir, J. (2023), Harmonizing sensitive data exchange and double-spending prevention through blockchain and digital wallets: The case of e-prescription management. Distributed Ledger Technologies: Research and Practice, 2(1), 1-31.
Schmitt, B. (1996), A New Paradigm for the Determination of Money Prices. London: Palgrave Macmillan UK, p104-138.
Setiadi, D., Nurhayati, S. (2023), Youth's digital literacy in the context of community empowerment in an emerging society 5.0. Society, 11(1), 1-12.
Setyadharma, A., Iskandar, M.R. (2023), Analysis of factors affecting electronic money transactions in Indonesia. Economics Development Analysis Journal, 2023, 114-128.
Shaikh, A. (1979), Foreign trade and the law of value: Part I. Science and Society, 43, 281-302.
Shin, N., Cheng, T.C. (2023), Gaining user confidence in banking industry's quest for digital transformation: A product-service system management perspective. Industrial Management and Data Systems, 123(8), 2216-2240.
Simmons, R., Dini, P. (2021), Crisis and the role of money in the real and financial economies-an innovative approach to monetary stimulus. Journal of Risk and Financial Management, 14(3), 129.
Stiglitz, J.E., Regmi, I. (2023), The causes of and responses to today's inflation. Industrial and Corporate Change, 32(2), 336-385.
Stock, J. H., Watson, M. W. (2001). Vector autoregressions. Journal of Economic perspectives, 15(4), 101-115.
Swaney, J.A. (1987), Elements of a neoinstitutional environmental economics. Journal of Economic Issues, 21(4), 1739-1779.
Taherdoost, H. (2023), Billing and Payment Systems In E-Business Essentials. Switzerland: Springer Nature, p137-162.
Takyi, P.O. (2024), The impact of electronic levy on mobile money transactions: Lessons from Ghana. Policy Studies, 1-17. https://doi.org/10.1080/01442872.2024.2303348
Tennant, D., Brody, G. (2020), The fraught relationship between the Cashless Debit Card and basic transaction accounts. Social Alternatives, 39(1), 14-19.
Tobin, J. (2005), Irving Fisher 1867-1947. American Journal of Economics and Sociology, 64, 19-42.
Yao, W., Alexiou, C. (2024), On the transmission mechanism between the inventory arbitrage activity, speculative activity and the commodity price under the US QE policy. International Review of Economics and Finance, 89, 1054-1072.
Zeng, Y., Li, Y. (2023), Understanding the use of digital finance among older internet users in urban China. Educational Gerontology, 49(6), 477-490.