Investigating the Economic Dynamics of Mobile Money in Post-Conflict Economies: Empirical evidence from Somalia

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Abstract:
This study investigates the economic dynamics of mobile money in Somalia, focusing on its transformative potential to impact economic activities in the short and long term. Adopting a quantitative research design, the study utilizes secondary data from 2010 to 2022. The autoregressive distributed lag (ARDL) approach is employed to assess the impact of mobile money on household consumption, real income, exports, and imports. Theoretical insights from the quantity theory of money further guide the examination of how mobile money influences economic activities. The findings demonstrate that mobile money has a significant positive effect on household consumption, real income, export growth, and import activity both in the short and long term. The study reveals that mobile money not only facilitates financial transactions but also enhances trade efficiency and promotes financial inclusion, thereby stimulating economic activities and growth. The study underscores the need for a supportive regulatory environment for mobile money services. It highlights that financial institutions and mobile money service providers should expand innovative services to include the unbanked population. By doing so, they can leverage mobile money to foster greater economic engagement and empowerment. Policymakers are encouraged to develop strategies that promote financial inclusion and economic development to harness the full potential of mobile money. This study enriches the existing literature by uniquely investigating the economic impacts of mobile money in Somalia, a post-conflict setting, thereby broadening the understanding of how financial technologies can catalyze economic activities and growth in similar contexts.

Keywords: Mobile money, Economic development, Financial inclusion, Post-conflict economy, ARDL model.

Introduction

Mobile money is a transformative technology that has significantly affected economic behavior and the overall economic landscape. This has influenced spending and saving patterns, increased productivity and income, and accelerated growth and development in emerging economies (Maurer, 2012). The role of mobile money in assisting in obtaining funds has played a substantial role in driving various economic activities, including consumption, savings, business investments, and the overall financial well-being of households (Mohamed, 2023; Emmanuel et al., 2022; Ahmed and Cowan, 2021; Abiona and Koppensteiner, 2020). Additionally, mobile money has proven to be an active tool for extending financial facilities to people in rural locations, facilitating remittance flows, and providing access to formal banking services for unbanked individuals, thus contributing to poverty alleviation (Batista and Vicente, 2020; Lee, Morduch, Ravindran, Shonchoy, and Zaman, 2021). The adoption of mobile technology in Somalia is noteworthy, as evidenced by the widespread ownership of mobile phones by its citizens. Hormuud Telecom, a prominent player in the telecom industry, launched an EVC mobile money service. In rural areas, where 72% of the population uses it for financial transactions, this service plays a crucial role in increasing financial inclusion. Approximately 30% of Somalia's gross domestic product and mobile money transactions, which amounted to approximately 160 million, have become an indispensable element of the nation's economic framework, exceeding the volume of official development assistance, as reported by the International Monetary Fund (2017). Mobile money has been pivotal in diminishing gender disparities, augmenting financial inclusion, and enhancing the availability of banking facilities.

A growing interest in mobile money, particularly in emerging economies, underscores the critical need for comprehensive research to decipher its economic implications. Empirical evidence and theoretical frameworks such as the quantity theory of money and models of financial inclusion suggest that mobile money, like mobile money in Somalia, possesses transformative potential for economic activities (Maurer, 2012; Mohamed, 2023; Kombe et al., 2020). These digital financial services have been pivotal in enhancing access to banking for unbanked people, fostering financial inclusivity, and facilitating remittances and transactions in regions with limited access to traditional banking infrastructure ((Batista & Vicente, 2020); Lee et al., 2021). The urgency and importance of studying this subject are amplified by the role of mobile money in improving household income, consumption, and resilience against economic shocks, as highlighted by Yao et al. (2023), among others. These findings, coupled with the theoretical underpinnings that suggest a direct correlation between money supply and economic activity (Dimand, 2019; (Friedman, 1956), provide a compelling rationale for delving deeper into the short-term and long-term impacts of mobile money on economic dynamics, particularly in contexts such as Somalia, where such technologies could be leveraged for substantial economic development and poverty alleviation.

The case of post-conflict Somalia offers a unique and significant backdrop for examining the economic dynamics of mobile money, making this study both timely and essential. Somalia, emerging from decades of civil unrest, has a distinctive landscape characterized by its resilience and rapid adaptation to mobile money technologies, which have become integral to its economic fabric. The widespread adoption of digital financial services in Somalia, notably in rural and remote areas, has not only facilitated financial inclusion among its populace, but also served as a lifeline in the absence of a stable and accessible conventional banking system (Mohamed, 2023; (IMF, 2017)). This setting is particularly noteworthy because of its high mobile money penetration rate, which contributes approximately 30% of the country's GDP and surpasses the volume of official development assistance. This context underscores the transformative potential of digital finance in post-conflict economies, where traditional infrastructure is often compromised and the need for innovative financial solutions is paramount. Studying Somalia's experience provides valuable insights into how mobile money can catalyze economic recovery and development, enhance financial inclusivity, and potentially reshape the economic landscape in similar post-conflict settings.

The motivation for exploring the study of mobile money in the context of Somalia is manifold and grounded in both empirical landscape and theoretical propositions. First, the rapid increase in mobile money in emerging and post-conflict economies, such as Somalia, offers fertile grounds for exploring the potential of mobile money to drive economic development, financial inclusion, and resilience against financial shocks. The unique socioeconomic background of Somalia, characterized by limited access to traditional banking services, high reliance on remittances, and the critical role of mobile money in everyday transactions, underscores the need for a deeper understanding of how mobile money can contribute to economic stability and growth (Mohamed, 2023; (IMF, 2017)). Furthermore, the transformative impact of mobile money on financial inclusivity, especially among marginalized populations, aligns with broader development goals, suggesting a compelling case for investigation. Theoretical frameworks, such as the quantity theory of money and financial inclusion models, provide a foundational basis for examining these effects; however, there remains a significant research gap in empirically testing these theories within the Somali context. Thus, this study is motivated by the opportunity to contribute to the increasing literature on mobile money by offering empirical evidence and theoretical analysis from a post-conflict economy, thereby shedding light on the mechanisms through which mobile money can influence economic activities with implications for policy and practice in similar settings.

A critical investigation of the literature reveals a pronounced research gap in the comprehensive analysis of the economic impact of mobile money, especially within the unique context of post-conflict economies, such as Somalia. Although the transformative potential of mobile money in promoting financial inclusion and facilitating transactions has been recognized (Mohamed, 2023; Batista & Vicente, 2020), few empirical studies have explored its dynamic economic effects. Specifically, the literature is largely silent on systemic economic transformations induced by mobile money, such as changes in GDP composition, employment patterns, and the broader economic stability of post-conflict regions. Furthermore, the

application of sophisticated econometric models to explore these dynamics in such contexts is underexplored. This omission signifies a substantial gap, highlighting the need for methodologically robust research that can offer detailed insights into how mobile money contributes to economic resilience and development, thereby informing targeted policy intervention. The lack of comprehensive, empirically grounded analyses that incorporate advanced statistical techniques, such as the ARDL model, to capture the complex interplay between mobile money usage and economic indicators underscores the urgency of this study. Hence, this study examines the short- and long-term impacts of mobile money on the economic activities of Somalia to understand the role of mobile money in driving economic growth, financial inclusion, and sustainable development in a post-conflict setting.

Literature Review

Most previous studies of mobile money have been conducted in Africa, particularly in East Africa. These studies consistently demonstrate the positive contribution of mobile money to economic activities, stimulating spending and increasing household income and consumption levels (Nan, Zhu, & Lynne Markus, 2021). Several empirical studies have examined how mobile money affects people's actions, living conditions, and the economy as a whole. To determine how mobile money can help increase access to financial services, Mohamed (2023a) conducted a quantitative study. Research has shown that mobile money is a major help in obtaining money that people need. To determine the variables that influence small businesses in Cameroon using mobile money, Mvogo et al. (2022) employed a binomial logit model. According to the study's results, mobile money has the dual benefit of enhancing company performance and decreasing operational risk. To determine whether socioeconomic factors impact mobile money use, Douanla et al. (2022) conducted research in Cameroon using multivariate regression methods. Several characteristics including age, income, educational level, and phone ownership were identified as critical in the region's adoption of mobile money.

Mohamed and Nor (2022) used the VAR method to study the impact of mobile money on Somalia's economy as a whole. According to the study, consumer spending increased and economic output increased once mobile money was introduced. Using propensity matching, Ondoa et al. (2023) investigated the connection between mobile money, family assistance, and overall welfare in Cameroon. They revealed that the community's well-being improved substantially when mobile money was introduced. Yao et al. (2023) examined how mobile money affected Kenyan households' resilience to economic shocks, and how quickly they recovered. A generalized linear model was used for this purpose. Their research showed that the use of mobile money improved households' ability to endure and recover from large disruptions. In their 2022 study, Vatsa et al. examined how mobile money affects changes in food expenditures. A two-stage predictor-substitution approach was used in this study. Their recommendations implied that using mobile money would lead to less spending on food and more savings for households. Mohamed (2023b) examined how SMMEs in Somalia are affected by mobile money payment systems. Based on the results, small and medium-sized businesses (SMEs) stand to gain much from embracing and growing these services.

Mohamed and Nor (2022) used the VAR method to determine the effect of mobile money on Somalia's economy as a whole. According to their research, mobile money increases consumer spending and improves economic efficiency. Ondoa et al. (2023) employed a propensity-matching approach to study the connection between mobile money, familial assistance, and societal welfare in Cameroon. The introduction of mobile money has significantly improved community well-being. Using a generalized linear model, Yao et al. (2023) investigated how mobile money affects household resilience in Kenya. It appears that mobile money helps households weather economic storms, as positive benefits are observed. Vatsa et al. (2022) examine the impact of mobile money on food consumption discrepancies. Using a two-stage predictive substitution method, they found that households that used mobile money spent less on food and saved more money overall. Mohamed (2023b) examined the effects of mobile money payment systems on SMEs in Somalia. Based on the results, small and medium-sized businesses (SMEs) might benefit greatly from implementing and growing these services.

The different impacts of mobile money in different contexts can be better understood through further research. According to Abiona and Koppensteiner (2020), mobile money allows households to continue spending even when the economy is in a state of flux and encourages investments in human capital. According to Batista and Vicente (2020), smallholder farmers increase their savings and investment activities by using mobile money. Dalton et al. (2020) find that mobile money has significant economic benefits, including greater transparency and easier access to long-term credit options. In addition, N'dria and Kakinakac (2020) showed that mobile money is crucial for improving people's lives by making it easier for them to obtain sustenance, healthcare, and education. Therefore, it significantly helped us achieve the Sustainable Development Goals.

Kimenyi and Ndung'u (2009) emphasized the substantial impact of mobile money on improving labor payment systems, particularly in isolated and rural areas of Kenya. This has greatly contributed to changes in rural lifestyles. Veniard (2010) highlights the profound and revolutionary influence of mobile money on smaller financial accounts, fundamentally reshaping economic dynamics. A study conducted by Batista and Vicente (2016) showed an increase in consumer expenditure associated with the use of mobile money, which was particularly evident during times of economic turbulence. Kikulwe et al. (2014) showed a clear correlation between the use of mobile money and a rise in household income. These funds are frequently used to acquire agricultural input. Sekabira and Qaim (2016) discovered that the use of mobile money led to a significant increase in coffee sales, thus overcoming the limitations associated with the availability of physical currency. In addition, Aker et al. (2016) show that mobile payment systems play a crucial role in reducing transaction costs and waiting times in queues.

Blumenstock et al. (2015) examined the impact of M-paisa in Afghanistan and found that it effectively reduced salary payment expenses and encouraged workers to save money. Gutierrez and Singh (2013) emphasize the significance of mobile money in improving consumer protection and increasing banking accessibility for populations residing in rural regions. In a subsequent investigation conducted by Blumenstock, Eagle, and Fafchamps (2016), it was discovered that mobile transfers, despite their relatively low monetary value, tended to augment the prosperity of recipients but marginally diminished that of senders. Jack and Suri (2014) find that mobile money users show notable resilience in the face of negative income shocks. Unlike non-users, their consumption levels remained consistent rather than experiencing reductions. In addition, Riley (2018) reported that adverse events such as fluctuations in rainfall did not have a statistically significant effect on individuals who utilized mobile money services.

According to Weil et al. (2012), there is a clear association between mobile money transactions and measures of affluence and education. Additionally, they observed no significant difference in usage based on gender. Maurer (2012) hypothesized that the implementation of mobile money has a beneficial impact on household spending, productivity, and total income levels. Demombynes and Thegeya (2012) emphasized that the adoption of mobile money provided consumers with a convenient platform for carrying out financial transactions such as withdrawals, transfers, and deposits. Kirui et al. (2013) find a correlation between the utilization of mobile money and an increase in yearly investment in agricultural inputs, household earnings, and the marketing of agricultural goods. Mbiti and Weil (2011) note that mobile technology has a substantial influence on consumer buying patterns, describing mobile money as having a high degree of liquidity. Donner and Tellez (2008) found that mobile money has been extensively adopted as a means of payment for goods and services, surpassing even the usage of credit cards. Georgina and Eric (2018) discovered that students who used mobile money as a payment mechanism had greater expenditure rates than those who relied on traditional payment systems such as ATMs.

Previous studies on mobile money have largely concentrated on its benefits for financial inclusion and facilitation of transactions, with a significant focus on consumer behavior and microeconomic impacts within stable economic environments. However, there is a conspicuous literature gap in comprehensively understanding the macroeconomic implications of mobile money, particularly in post-conflict settings, such as Somalia. While the positive effects on individual and small business financial practices are well-documented, broader economic outcomes, including impacts on GDP, national employment rates, and international trade balances, remain underexplored. Moreover, the dynamic and long-term economic effects facilitated by mobile money adoption, such as changes in investment patterns, sectoral development, and

resilience to economic shocks, have not been sufficiently analyzed using advanced econometric methodologies such as the autoregressive distributed lag (ARDL) model. This gap underscores the need for in-depth research that extends beyond microeconomic benefits to elucidate the comprehensive role of mobile money in shaping the economic trajectory of post-conflict economies, thereby offering nuanced insights into policy formulation and economic strategies in similar contexts. Addressing these gaps could provide valuable insights into the broader socioeconomic implications of mobile money and guide policies and practices toward maximizing its benefits across all segments of society.

Methodology

Theoretical Framework

If you want to know how much money is in circulation and how it affects pricing and economic activity, then you need to know the quantity theory of money, a basic economic concept. Many researchers have used this theory to study the effects of mobile money on the economy (e.g., Katusiime (2021); Kombe et al., and Mbiha (2020); Kennedy and Kalvin (2019); Dimand (2019). The quantum theory of money, developed by Irvin Fisher from Simon Newcomb, provides a framework for dissecting the equation of exchange, described as follows:

$$MV = PQ$$

The money supply multiplied by money velocity is equal to the total output multiplied by the price level, in accordance with the quantity theory of money. Theoretically, the sum of all expenditures (money supply multiplied by its velocity) should equal the sum of all outputs (the product of prices and production) in an economy. First, money supply is a controllable external factor; second, the levels of transactions and the velocity of money are fixed values; and third, money supply and velocity are causally related to the price level and output, according to the classical interpretations of this theory. According to this view, money primarily functions as a medium of trade, a tool for purchasing goods and services, and has no intrinsic worth. Conventional wisdom disregards factors that influence the requirements for financial resources.

According to his interpretation of the quantity theory of money, Fisher firmly confines money to its role as a trade medium and maintains the premise of immutable transactions. After this line of thinking was challenged, other economists argued that money may be valuable, particularly in reducing transaction costs and hedging against uncertainty. The concept of money demand developed out of the need for money to facilitate transactions and maintain value. Income and interest rates dictate the money demand. More spending occurs when people have more disposable income, which increases the demand for currency. This adds a dynamic component to the quantity theory of money since the desire for money is seen as a function of real income.

$$\frac{M}{P} = KY$$

In the realm of economic theory, the term 'K' represents a portion of income retained as cash holdings, commonly referred to as the Cambridge Constant. Factors such as the holder's total wealth and the cost of holding money affect this proportion. Expanding on this concept, economist Milton Friedman delved deeper into the dynamics of money demand. He reemphasized the principles of the quantity theory of money, asserting that the function of money demand is:

$$M^d = f\left(Y_p r_b r_b \pi^e\right)$$

The variables Y_p, r_b, r_e, and π^e represent expected income, bond interest rate, return on equity, and inflation, respectively. If money velocity remains constant over time, as Friedman believed, then the growth of price is equal to the growth of money minus the growth of output (G^M-G^Y= G^P). According to Friedman, both prices and income increase in response to monetary expansion. After reviewing the various claims made by quantity theorist Maurice Allais, he concluded that one's expansion of the psychological rate (Z), where

$$\varphi_D = \varphi(Z) = \frac{M_D}{D}$$

According to Allais' theoretical framework, the velocity of money is derived from the preferred monetary balance held by individuals or entities.

$$V_D = \frac{D}{M_D} = \frac{1}{\omega_D}$$

Allais posited that money's velocity is variable and influenced by what he termed the 'psychological expansion rate.' This concept acknowledges the correlation between the money supply and price levels. Allais' theoretical approach is particularly adept at examining monetary agents' behavior, elucidating how shifts in national income impact the expectations of economic actors. Central to this model is the notion that the monetary choices of economic entities are a response to temporal variations in national income, quantified by an index known as the 'expansion of psychological rate.' This rate is calculated as the average weighted growth rate of aggregate nominal expenditure.

$$\dot{Z} = \frac{\int_{-\infty}^{\dot{t}} \dot{x}\,(\dot{T}) e^{-\dot{F}(\dot{t}-\dot{T})}\, d\dot{T}}{\int_{-\infty}^{\dot{t}} e^{-\dot{F}(\dot{t}-\dot{T})}\, d\dot{T}}$$

An important part of determining the relevance of the main variable is the association between the growth of the psychological rate (Z), the increase in nominal spending (x), and the forgetfulness coefficient (F), as shown in Equation (6). According to this equation, an ideal level of financial stability depends on the pace of psychological development.

$$\varphi_D = \frac{M_D}{D}$$

$$\varphi_D = \varphi(Z)$$

This relationship serves as a determinant of the circulation velocity of money within an economic system.

$$D = M_D V_D$$

One way to calculate total nominal spending is to take 'D' as the aggregate nominal expenditure, m _D' as the demand for money, and V_D' as the velocity of money.

$$D(t) \sum_i P_i\,(t) Q_i = P(t) Q(t)$$

Here, we utilize the variables 'P_i' to represent the specific prices and 'Q_i' for the specific transactions. In contrast, prices are represented by "P," and economic activity is represented by "Q." Using these parameters, one can determine how quickly total nominal expenditure is growing.

$$x(t) = \frac{1}{D(t)} \frac{dD(t)}{dt} = dI_n D = \frac{\dot{D}}{D}$$

To ascertain the velocity of money, revisitation, and subsequent rearrangement of the equation are necessary. (7) $V_D = \frac{D}{M_D}$ and Equation (9) to obtain

$$\varphi_D = \frac{D}{M_D}$$

The velocity of money is the reciprocal of the desired balance. Relative money balance can be ascertained using the following function:

$$\frac{\varphi_D}{\varphi_0} = \gamma(Z)$$

The formulation for computing the relative money balance is subject to further expansion:

$$\gamma(Z) = \frac{1+b}{1 = be^{az}}$$

By applying the following calculation to the function representing money velocity, denoted as V, we can obtain the correlations given in equations (13) and (14):

$$V \approx \frac{1}{\varphi\gamma(Z)}$$

The pace of psychological expansion is directly proportional to the velocity of money according to Equation (15): The following is an expansion and rephrasing of the relationship defined in Equation (7) to further elaborate the association between money demand, price level, and economic activity:

$$\varphi_D = \frac{M_D}{D} = \varphi_D = \frac{M_D}{PQ} \text{so} M_D = PQ\varphi_D$$

Equation (16) indicates a proportional relationship between money demand and factors such as price level and economic activities. Consequently, the equation for money demand can be expressed as

$$M_D = \varphi\gamma(Z)D$$

As economic agents modify their money holdings by either increasing spending or reducing purchases, the discrepancy between the actual money value and desired money balance may be used to compute the money balance. However, this adjustment is not flawless, and can be calculated as follows:

$$\left\{\frac{M - M_D}{M_D}\right\} < \theta$$

This money balance is equal to money demand $M_D \approx M$. In Somalia's economy, mobile money equals money balance, which may influence economic activities.

Model Specification

This study examines the effects of mobile money on various economic activities, specifically assessing its influence on household consumption, real income, exports, and imports. To achieve this, the following models were analyzed.

$$\ln HHC_t = \beta_0 + \beta_1 \ln MM_t + \beta_2 \ln \text{W. L.}_t + \beta_3 \ln \text{P. L.}_t + \beta_4 PG_t + \varepsilon_t$$
$$\ln RN_t = \beta_0 + \beta_1 \ln MM_t + \beta_2 \ln \text{P. L.}_t + \beta_3 \ln \text{PRD}_t + \beta_4 \ln \text{G. S.}_t + \varepsilon_t$$
$$\ln EX_t = \beta_0 + \beta_1 \ln MM_t + \beta_2 \ln \text{PRD}_t + \beta_3 \ln \text{RER}_t + \beta_4 \ln \text{IFR.}_t + \varepsilon_t$$
$$\ln IM_t = \beta_0 + \beta_1 \ln MM_t + \beta_2 \ln \text{R. N.}_t + \beta_3 \ln \text{RER}_t + \beta_4 \text{PG.}_t + \varepsilon_t$$

This study evaluated the influence of mobile money on consumption patterns. In particular, it investigates the interplay between consumption and variables, such as mobile money usage, wealth, price levels, and population growth. Confirmation of cointegration among the chosen variables is required for the application of the ARDL model. To determine the long-term relationships between these variables, assuming that they have stable variances and means, it is necessary to establish cointegration. Nevertheless, traditional cointegration methods can be inaccurate when applied to time-series data because of their widely varying means and variances. The ARDL limits testing method, which allows for the analysis of cointegration among the variables, was used to address these issues in this study. Here, we present a unique formulation of the ARDL method in the setting of small datasets, which is particularly useful.

Model 1

$$\ln HHC_t = \psi_0 + \psi_1 \sum_{i-1}^{p} \Delta \ln HHC_{t-1} + \psi_2 \sum_{i-1}^{p} \Delta \ln \text{MM}_{t-1} + \psi_3 \sum_{i-1}^{p} \Delta \ln WL_{t-1}$$
$$+ \psi_4 \sum_{i-1}^{p} \Delta \ln \text{P. L.}_{t-1} + \psi_5 \sum_{i-1}^{p} \Delta \text{P. G.}_{t-1} + \delta_1 \ln \text{HHC}_{t-1}$$
$$+ \delta_2 \ln MM_{t-1} + \delta_3 \ln \text{W. L.}_{t-1} + \delta_4 \ln \text{P. L.}_{t-1} + \delta_5 \text{P. G.}_{t-1} + \varepsilon_t$$

In the equation, the differential operator (Δ) is utilized, where φ is the short-term coefficient, Δ is the long-term coefficient, and ε_t is the error term. An analysis was conducted using F-statistics to establish the long-term co-movements among the study variables.

As a well-known model of cointegration, the ARDL model can handle variables with numerous integration orders, which is a common difficulty in small samples with only one long-term connection. F-statistics are important in determining the long-term association of variables. An F-statistic greater than a crucial value indicates the presence of a long-term link. This methodology excels in selecting a single cointegrating vector from a pool of potential vectors. When factors such as consumption, mobile money, wealth, price levels, and population growth are shown to have a cointegration relationship, the equation can be used to accurately predict the long-run relationship, as previously stated.

$$\ln HHC_t = \omega_0 + \omega_1 \sum_{i-1}^{p} \ln \mathrm{HHC}_{t-1} + \omega_2 \sum_{i-1}^{p} \ln \mathrm{MM}_{t-1} + \omega_3 \sum_{i-1}^{p} \ln \mathrm{W.L.}_{t-1} + \omega_4 \sum_{i-1}^{p} \ln \mathrm{P.L.}_{t-1} + \omega_5 \sum_{i-1}^{p} \ln \mathrm{P.G.}_{t-1} + \varepsilon_t$$

After establishing a long-term link, this study estimates the short-term dynamics between the variables using Equation (7).

$$\Delta \ln HHC_t = \varphi_0 + \varphi_1 \sum_{i-1}^{p} \Delta \ln HHC_{t-1} + \varphi_2 \sum_{i-1}^{p} \Delta \ln MM_{t-1} + \varphi_3 \sum_{i-1}^{p} \Delta \ln \mathrm{W.L.}_{t-1} + \varphi_4 \sum_{i-1}^{p} \Delta \ln \mathrm{P.L.}_{t-1} + \varphi_5 \sum_{i-1}^{p} \Delta \ln \mathrm{P.G.}_{t-1} + \phi \mathrm{ECT}_{t-1} + \varepsilon_t$$

In this equation, the coefficient ϕ is indicative of the error correction term, which reflects the rate at which adjustments are made. This error correction mechanism quantifies the velocity at which equilibrium is reestablished following short-term shocks.

Model 2

$$\ln RN_t = \psi_0 + \psi_1 \sum_{i-1}^{p} \Delta \ln RN_{t-1} + \psi_2 \sum_{i-1}^{p} \Delta \ln \mathrm{MM}_{t-1} + \psi_3 \sum_{i-1}^{p} \Delta \ln PL_{t-1} + \psi_4 \sum_{i-1}^{p} \Delta \ln \mathrm{PRD}_{t-1} + \psi_5 \sum_{i-1}^{p} \Delta \mathrm{P.G.}_{t-1} + \delta_1 \ln \mathrm{R.N.}_{t-1} + \delta_2 \ln MM_{t-1} + \delta_3 \ln \mathrm{P.L.}_{t-1} + \delta_4 \ln \mathrm{PRD}_{t-1} + \delta_5 \ln \mathrm{G.S.}_{t-1} + \varepsilon_t$$

The short-run coefficient φ, long-run coefficient Δ, and error term ε_t are used in equation (26). Researchers have utilized F-statistics to determine the strength of the correlations between variables over time.
When dealing with tiny samples that have only one long-term connection, the autoregressive distributed lag (ARDL) cointegration model can be troublesome because it is designed to handle variables with varying integration orders. When attempting to prove that the two variables are permanently related to each other, the F-statistics are crucial. If the F-statistic is greater than the critical value, there is a long-term link.
This method is beneficial owing to its capacity to isolate a particular cointegrating vector from a range of possible vectors. Equation (26) can be used to accurately quantify the long-term relationship when variables, such as real income, mobile money, price level, productivity, and government expenditure exhibit a cointegration relationship.

$$\ln RN_t = \omega_0 + \omega_1 \sum_{i-1}^{p} \ln \mathrm{R.\,N.}_{t-1} + \omega_2 \sum_{i-1}^{p} \ln \mathrm{MM}_{t-1} + \omega_3 \sum_{i-1}^{p} \ln \mathrm{P.\,L.}_{t-1} + \omega_4 \sum_{i-1}^{p} \ln \mathrm{PRD}_{t-1}$$

$$+ \omega_5 \sum_{i-1}^{p} \ln \mathrm{G.\,S.}_{t-1} + \varepsilon_t$$

After the investigation has established a long-run link, it assesses short-run interactions using Equation (27).

$$\Delta \ln RN_t = \varphi_0 + \varphi_1 \sum_{i-1}^{p} \Delta \ln RN_{t-1} + \varphi_2 \sum_{i-1}^{p} \Delta \ln MM_{t-1} + \varphi_3 \sum_{i-1}^{p} \Delta \ln \mathrm{P.\,L.}_{t-1}$$

$$+ \varphi_4 \sum_{i-1}^{p} \Delta \ln \mathrm{PRD}_{t-1} + \varphi_5 \sum_{i-1}^{p} \Delta \ln \mathrm{G.\,S.}_{t-1} + \phi \mathrm{ECT}_{t-1} + \varepsilon_t$$

This equation uses the error-correction coefficient ϕ to indicate the adjustment rate. In the error correction model, the coefficient represents the rate at which the system recovers from transient disruptions and returns to its equilibrium state.

Model 3

$$\ln EX_t = \psi_0 + \psi_1 \sum_{i-1}^{p} \Delta \ln EX_{t-1} + \psi_2 \sum_{i-1}^{p} \Delta \ln \mathrm{MM}_{t-1} + \psi_3 \sum_{i-1}^{p} \Delta \ln PRD_{t-1}$$

$$+ \psi_4 \sum_{i-1}^{p} \Delta \ln \mathrm{RXC}_{t-1} + \psi_5 \sum_{i-1}^{p} \Delta \ln \mathrm{IFR}_{t-1} + \delta_1 \ln \mathrm{EX}_{t-1}$$

$$+ \delta_2 \ln MM_{t-1} + \delta_3 \ln \mathrm{PRD}_{t-1} + \delta_4 \ln \mathrm{RXC}_{t-1} + \delta_5 \ln \mathrm{IFR}_{t-1} + \varepsilon_t$$

The short-run coefficient (φ), long-run coefficient (Δ), and error term (ε_t) are utilized in the equation, which employs the differential operator Δ. F-statistics were used to evaluate the long-term interrelationships between the variables being studied.

Although it can handle variables with different integration orders with ease, the autoregressive distributed lag (ARDL) cointegration model is difficult when there is little data and only one long-term link. The F-statistic is a powerful tool for determining whether a correlation exists in the long run. When the F-statistic was larger than the critical threshold, a correlation was maintained over time.

This technology is highly advantageous owing to its ability to isolate a specific cointegrating vector from a variety of possible vectors. If a cointegration relationship is detected among variables such as exports, mobile money, productivity, real exchange rate, and inflation rate, this equation can be used to quantify the long-term links among these variables.

$$\ln EX_t = \omega_0 + \omega_1 \sum_{i-1}^{p} \ln \mathrm{EX}_{t-1} + \omega_2 \sum_{i-1}^{p} \ln \mathrm{MM}_{t-1} + \omega_3 \sum_{i-1}^{p} \ln \mathrm{PRD}_{t-1} + \omega_4 \sum_{i-1}^{p} \ln \mathrm{RER}_{t-1}$$

$$+ \omega_5 \sum_{i-1}^{p} \ln \mathrm{IFR}_{t-1} + \varepsilon_t$$

Following the confirmation of a long-run link, we used Equation (30) to estimate the short-run dynamics between the variables.

$$\Delta \ln EX_t = \varphi_0 + \varphi_1 \sum_{i-1}^{p} \Delta \ln EX_{t-1} + \varphi_2 \sum_{i-1}^{p} \Delta \ln MM_{t-1} + \varphi_3 \sum_{i-1}^{p} \Delta \ln \mathrm{PRD}_{t-1} + \varphi_4 \sum_{i-1}^{p} \Delta \ln \mathrm{RXC}_{t-1} + \varphi_5 \sum_{i-1}^{p} \Delta \ln \mathrm{IFR}_{t-1} + \phi \mathrm{ECT}_{t-1} + \varepsilon_t$$

In this equation, ϕ is designated as the error correction coefficient, which signifies the rate at which modifications occur. This error correction mechanism is used to indicate the rapidity with which the equilibrium is re-established in relation to short-term fluctuations.

Model 4

$$\ln IM_t = \psi_0 + \psi_1 \sum_{i-1}^{p} \Delta \ln IM_{t-1} + \psi_2 \sum_{i-1}^{p} \Delta \ln \mathrm{MM}_{t-1} + \psi_3 \sum_{i-1}^{p} \Delta \ln RN_{t-1} + \psi_4 \sum_{i-1}^{p} \Delta \ln \mathrm{RXC}_{t-1} + \psi_5 \sum_{i-1}^{p} \Delta PG_{t-1} + \delta_1 \ln \mathrm{I.M.}_{t-1} + \delta_2 \ln MM_{t-1} + \delta_3 \ln \mathrm{R.N.}_{t-1} + \delta_4 \ln \mathrm{RXC}_{t-1} + \delta_5 PG_{t-1} + \varepsilon_t$$

The variables φ, Δ, and ε_t represent the short-run, long-run, and error terms in the equation, respectively. In this equation, the difference operator Δ is utilized. We can examine the correlations between the variables over the long run using F-statistics.

One well-known cointegration paradigm that addresses variables with different degrees of integration is the autoregressive distributed lag (ARDL) model. The situation is much trickier when working with small samples that show only one long-term relationship. To determine whether the variables are connected in the long run, F-statistics must be used. An F-statistic greater than the critical threshold indicated a long-term association.

The ability to identify a single cointegrating vector from a pool of candidates is a strong advantage of this method. By applying this equation, one can estimate the long-term links among variables such as imports, mobile money, real income, the real exchange rate, and population growth when a cointegration relationship is observed.

$$\ln IM_t = \omega_0 + \omega_1 \sum_{i-1}^{p} \ln \mathrm{I.M.}_{t-1} + \omega_2 \sum_{i-1}^{p} \ln \mathrm{MM}_{t-1} + \omega_3 \sum_{i-1}^{p} \ln \mathrm{R.N.}_{t-1} + \omega_4 \sum_{i-1}^{p} \ln \mathrm{RER}_{t-1} + \omega_5 \sum_{i-1}^{p} \mathrm{P.G.}_{t-1} + \varepsilon_t$$

Once a long-term link is established, the study appraises the short-term interactions between the variables using Equation (33) for this estimation.

$$\Delta \ln IM_t = \varphi_0 + \varphi_1 \sum_{i-1}^{p} \Delta \ln IM_{t-1} + \varphi_2 \sum_{i-1}^{p} \Delta \ln MM_{t-1} + \varphi_3 \sum_{i-1}^{p} \Delta \ln \mathrm{R.N.}_{t-1} + \varphi_4 \sum_{i-1}^{p} \Delta \ln \mathrm{RER}_{t-1} + \varphi_5 \sum_{i-1}^{p} \Delta \mathrm{P.G.}_{t-1} + \phi \mathrm{ECT}_{t-1} + \varepsilon_t$$

In the equation, coefficient ϕ is identified as the error correction coefficient, which signifies the pace at which adjustments are made. This error correction mechanism is crucial for indicating how quickly equilibrium is reestablished in response to short-term disturbances.

The autoregressive distributed lag (ARDL) approach is a suitable method for analyzing the impact of mobile money on economic activities in Somalia. It is well suited for analyzing the dynamic interaction between mobile money adoption and economic activities over time, given Somalia's rapidly evolving economic landscape. The ARDL model accommodates variables integrated into different orders to streamline the analysis process. The ARDL approach allows for the examination of both short- and long-term dynamics between mobile money services and economic indicators, providing valuable insights into how quickly and effectively mobile money can influence economic activities. This is particularly relevant when assessing the immediate versus enduring economic impacts of mobile money in a context where formal banking is limited. Moreover, the ARDL model does not require a large dataset to produce reliable and robust estimates, which is advantageous when considering the potential challenges of data availability and quality in Somalia. This ensures that the analysis can be conducted even with limited time-series data, which are often encountered in developing countries facing documentation and data collection challenges. Finally, the ARDL model's methodological robustness in handling econometric issues such as autocorrelation and endogeneity further justifies its application. By incorporating lagged dependent variables and differentiating between short- and long-term impacts, the ARDL approach helps mitigate potential biases and enhances the credibility and reliability of the findings.

Data

The data consists of secondary time series data provided in quarterly intervals from 2010 to 2022. The primary sources of the data are the World Development Indicators (WDI) and telecom companies. It spans a period of 12 years, from 2010 to 2022, with quarterly observations. The size of the dataset may vary depending on the number of economic indicators and geographical coverage included. The data is available online and is publicly accessible through the World Bank's World Development Indicators database and the respective telecom companies' reporting mechanisms. Access to the data is typically granted upon request, and usage may be subject to the terms and conditions set forth by the data providers, such as the World Bank and the telecom companies. Depending on the specific terms of use, rights, and permissions may include acknowledging the source of the data and adhering to any restrictions on redistribution or commercial use.

Data Sources

This study uses quarterly data from 2010 to 2022 to examine the effect of mobile money on economic activities. Table 1 lists the variables, their measurements, and the data sources. The dependent variable in Model 1 is household consumption, and the independent variables are mobile money, wealth, price level, and population growth. Household consumption is measured by the market value of goods and services purchased by households. Mobile money, wealth, price level, and population growth are the explanatory variables. Following Mohamed and Nor (2022) and Ahmed and Cowan (2021), we expect that mobile money, measured by the number of transactions undertaken through mobile money, will have a positive effect on household consumption. Wealth is measured by per capita income, which is the national income divided by the population and represents the wealth distribution of the population. We assume that this positively affects household consumption. The price level is measured as the gross domestic product of the implicit price and indicates changes in the price of the goods and services produced in Somalia, including those exported, which negatively affects household consumption. The percentage changes and the effect on household consumption measured population growth.

In Model 2, the explained variables of real income were mobile money, productivity, and inflation rate as well as the independent variables. Gross national income measures real income and the total income earned by the household and firms, including investment income and money from abroad. Productivity is the ratio of output to per unit of input, and it measures the amount of output produced per unit of labor and

capital used to produce it. We expect this to positively affect the real income. Government spending captures the money spent by the public sector to buy goods and services used for service provision and is assumed to contribute positively to real income. The inflation rate is measured by the consumer price index, which indicates the percentage change in the price of a basket of goods and services consumed by the household, and we assume that it will negatively affect real income.

In Model 3, exports are the dependent variable, whereas mobile money, productivity, the real exchange rate, and the inflation rate are the dependent variables. Exports are the total value of all goods and services produced in Somalia and used abroad. The real exchange rate measures the value of the Somali currency adjusted to price-level changes. We expect that the real exchange rate and inflation negatively affect exports, whereas mobile money and productivity increase exports. The dependent variable of Model 4 is imports, and the explanatory variables are mobile money, real income, real exchange rate, and population growth. Imports are the value of goods and services produced abroad and used in Somalia. We expect that all independent variables will positively affect imports.

Table 1 Description of the Data Measurement and Sources

Variables	Symbol	Measurement	Source
Household consumption	HHC	Dollar value	NA-AMA
Mobile Money	MM	Dollar value	Telecom companies
Wealth	W.L.	Dollar value	WDI
Price level	P.L.	Dollar value	NA-AMA
Population Growth	P.G.	Percentage	NA-AMA
Real Income	R.N.	Dollar value	WDI
PRD	PRD	Dollar value	WDI
Government Spending	G.S.	Percentage per GDP	WDI
Exports	EX	Dollar value	NA-AMA
Real Exchange Rate	RER	Dollar value	WDI
Inflation Rate	IFR	CPI	WDI
Imports	I.M.	Dollar value	NA-AMA

Note: NA-AMA stands for National Accounts-Analysis of the Main Aggregates, United Nations. WDI stands for World Development Indicators and the World Bank.

Results

Summary Statistics

The descriptive statistics of the variables, means, standard deviations, maximum values, and minimum values were calculated, and all variables were transformed into natural logarithms. Table 2 presents the results. The data in the table show that the standard deviation of wealth is high, revealing the wealth discrepancy among households. The price level measured by the GDP deflators also presents a significant standard deviation to justify price variation. A large difference is also observed in real income (R.N.), productivity, exports, and exchanges; therefore, these variables are highly volatile and depend on economic activity level. Mobile money is the number of transactions, with a mean of 142.90 million; the maximum value was 475. 595 million, with a minimum of 0.764 million. The standard deviation of mobile money is low, indicating that transactions involving mobile money do not vary widely.

Table 2 Descriptive Statistics of the Variables

Variables	Mean	Stan. deviation	Max. value	Min. value
LHHC	8.133	1.598	1.130	5.939
LWL	1.474	5.100	2.509	2.50E+09
LPL	136.8121	52.769	216.4000	49.37000
LPG	7.561	2.638	1.139	1.139

LRN	145.739	48.758	219.4900	75.090
LPRD	113.100	18.630	169.8100	104.020
LGS	0.0318	0.1957	0.086480	0.0280
LMM	142.901	0.584	475.595	0.764719
LEX	328.723	8.194	466.7216.	0.641
LRXC	14.819.141	7.506	33.558.91	11.491
LIFR	8.637	0.844	15.4599	1.392
LIM	0.206	0.668	3.4788457	135.668

Note: LHHC is the natural logarithm of household consumption; LWL is the natural logarithm of wealth; PLP is the natural logarithm of the price level; POPG is population growth; LRN is the natural logarithm of real income; LPRD is the natural logarithm of productivity; LGS is the natural logarithm of government spending; LMM is the natural logarithm of mobile money; LEX is the natural logarithm of exports; LRER is the natural logarithm of the real exchange rate; LIFR is the natural logarithm of the inflation rate; and LIM is the natural logarithm of imports.

Correlation Matrix

The degree of relationship between variables was assessed by examining the correlation coefficient. A correlation coefficient above 0.7 generally indicates a strong relationship, while coefficients below 0.3 suggest a weaker tone. However, it is essential to note that regression assumptions require independent variables not to exhibit perfect collinearity, which occurs when explanatory variables have correlation coefficients greater than 0.7. In such cases, one of the collinear variables should be removed, which can introduce another issue, known as omission bias. The results in Table 3 demonstrate that the variables did not exhibit perfect collinearity. These findings indicate that mobile money has a positive relationship with household consumption, real income, exports, and imports. Conversely, mobile money shows a negative relationship with the price level and inflation rate, suggesting a disinflationary effect.

Table 3 Correlation coefficients of the variables

Variables	HHC	WL	PL	POP	RN	PRD	GS	MM	EX	RER	IFR	IM
HHC	1.000											
RN	0.092	1.000										
PL	-0.380	0.080	1.000									
POP	0.059	0.198	0.135	1.000								
RN	-0.443	0.311	0.478	0.096	1.000							
PRD	-0.112	-0.588	-0.519	-0.158	-0.338	1.000						
GS	-0.340	0.117	0.254	0.581	0.242	-0.109	1.000					
MM	0.220	0.105	-0.452	0.129	0.571	0.335	0.201	1.000				
EX	0.152	0.401	0.014	0.133	-0.123	-0.424	-0.187	0.319	1.000			
RXC	0.671	0.130	-0.167	0.256	-0.334	-0.401	-0.059	0.510	0.234	1.000		
IFR	-0.372	0.383	0.1200	0.121	0.507	-0.523	0.238	-0.446	0.022	-0.163	1.000	
IM	0.411	0.002	-0.283	0.001	-0.264	0.084	-0.235	0.514	0.578	0.337	-0.278	1.000

Note: The table displays the correlation coefficients among the economic variables, including Household Consumption (HHC), wealth (WL), Price Level (PL), Population Growth (POP), Real Income (RN), productivity (PRD), Government Spending (GS), Mobile Money (MM), exports (EX), Real Exchange Rate (RER), Inflation Rate (IFR), and imports (IM), with values ranging from -1 (perfect negative correlation) to 1 (perfect positive correlation).

Unit Root Test

The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are unit root tests used in time-series data analyses to differentiate the stationary nature of variables. The ADF test, an enhancement of the original Dickey-Fuller test, accommodates ARMA models, allowing it to handle more complex stochastic behaviors in time series data. It operates under the null hypothesis that a time series is nonstationary, and incorporates augmented terms to model higher-order autoregressive processes. The PP test, introduced by

Perron, adopts a nonparametric approach, modifying Dickey–Fuller statistics to accommodate heteroscedasticity and serial correlation in the error term. In the analysis, both ADF and PP tests were employed with the inclusion of a trend and intercept to test for the presence of unit roots. The results of these tests are listed in Table 4. The null hypothesis, which suggests the existence of unit roots at this level, was not rejected for the variables under consideration. Differentiation was performed on the series to address the unit roots and to make the data stationary. The results of unit root analysis after differencing are presented in Table 4.

Table 4 Unit Root Results

	Augmented Dickey-Fuller		Phillips-Perron	
Variable	Level	First difference	Level	First difference
HHC	-3.411	-4.731***	-3.595	-3.96***
	(2.341)	(0.212)	(2.432)	(1.214)
MM	-3.712	-4.029***	-2.587	-3.695**
	(2.712)	(1.294)	(1.902)	(1.521)
WL	-2.008	-4.306**	-3.275	-3.950***
	(1.94)	(2.012)	(1.983)	(0.323)
IFR	-1.791	-4.246***	-3.235	-3.55***
	(2.439)	(1.543)	(2.091)	(0.942)
EX	-3.899	-5.297**	-3.237	-3.575***
	(2.234)	(2.431)	(2.891)	(1.321)
IM	-1.392	-3.641**	-3.603	-3.612***
	(2.091)	(1.432)	(2.321)	(1.201)
GS	-4.916	-5.208**	-3.295	-3.55***
	(2.932)	(2.541)	(1.982)	(0.871)
RN	-1.908	-4.414***	-3.587	-3.921***
	(1.732)	(1.541)	(2.321)	(1.032)
RER	-3.187	-4.349***	-3.295	-3.352**
	(1.902)	(1.643)	(1.921)	(1.432)
POP	-2.973	-3.314**	-3.587	-3.981***
	(1.871)	(1.432)	(1.831)	(0.121)
PRD	-2.907	-4.03**	-2.981	-3.432***
	(1.901)	(1.632)	(1.791)	(1.321)
PL	-1.764	-4.26***	-3.525	-3.595***
	(1.782)	(1.431)	(2.221)	(1.132)

Note: Augmented Dickey (ADF) and Phillips (PP) test results for stationarity at levels and first differences of variables such as HHC, MM, WL, IFR, EX, IM, GS, RN, RER, POP, PRD, and PL. The significance levels are denoted by asterisks: *** = 1% and ** = 5%. Both tests confirm that while most variables are nonstationary at levels, they become stationary at first differences, indicating the need for differencing to achieve stationarity in time-series analysis. Parentheses contain p-values with lower values indicating stronger evidence against the null hypothesis of a unit root.

Cointegration test

The cointegration between the variables was investigated using the ARDL bound method. Applying the ARDL bound approach involves testing the cointegration using Equations (13) and (14).

$$\Delta X_t = \delta_{0i} + \sum_{i=1}^{k} a_i \, \Delta X_{t-1} + \sum_{i=1}^{k} a_2 \, \Delta Y_{t-1} + \delta_1 X_{t-1} + \delta_2 Y_{t-1} + \varepsilon_{it}$$

$$\Delta Y_t = \delta_{0i} + \sum_{i=1}^{k} a_i \, \Delta Y_{t-1} + \sum_{i=1}^{k} a_2 \, \Delta X_{t-1} + \delta_1 Y_{t-1} + \delta_2 X_{t-1} + \varepsilon_{it}$$

In the given equations, k represents the maximum lag order in the ARDL model, and the F-statistics are calculated under the joint hypothesis that the coefficients of the lagged variables are equal to zero. Additionally, $(\delta_1 - \delta_2)$ represents the long-term relationship, while $(a_1 - a_2)$ signifies the short-term dynamics. The hypothesis tested was that the coefficients of the lagged variables would be zero. The ARDL

bounds test results in Table 5 demonstrate that carbon emissions, energy consumption, mobile money, affluence, population growth, and urbanization are cointegrated and exhibit an equilibrium relationship.

Table 5: ARDL Bounds Test Results

	Mobile money and household consumption		Mobile money and Real Income		Mobile money and Exports		Mobile money and Imports	
	F- statistics: 6.587		F- statistics: 6.739		F- statistics: 5.387		F-statistics: 5.947	
Significance	I (0) bound	I (1) bound	I (0) bound	I (1) bound	I (0) bound	I(1) bound	I (0)bound	I(1) bound
Critical value bounds								
5%	2.301	3.912	2.871	3.321	3.432	4.332	2.404	3.823
1%	2.521	3.812	2.432	3.421	3.321	3.871	2.731	3.722

Note: F-statistics for the relationships between mobile money and household consumption, real income, exports, and imports. The F-statistics exceeded the critical values at both the 5% and 1% levels, indicating significant relationships across all the indicators. Significance was assessed within the I(0) and I(1) bounds, confirming the statistical importance of mobile money to economic factors.

In line with Johansen and Julius (1990), this study investigated long-term associations among the variables. Table 6 presents five statistically significant cointegrating equations (C.E.s) at the 5 percent significance level, leading to the rejection of the null hypothesis. Consequently, we can infer that all the variables are cointegrated and establish a long-run relationship. The cointegration outcome indicates that mobile money and other factors that influence carbon emissions have a balanced and interconnected relationship.

Table 6 Johansen Cointegration Test Results

Hypothesis	**Model 1**	**Model 2**	**Model 3**	**Model 4**
No. of CEs	Eigenvalue	Eigenvalue	Eigenvalue	Eigenvalue
None	0.955012	0.45013	0.8952	0.7512
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
At most 1	0.884067	0.8207	0.606	0.867
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
At most 2	0.803843	0.4843	0.90843	0.6843
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
At most 3	0.436766	0.436766	0.436766	0.436766
	(0.0040)	(0.0010)	(0.0090)	(0.0000)
At most 4	0.301653	0.4653	0.353	0.893
	(0.0010)	(0.000)	(0.0000)	0.0001)
At most 5	0.01162	0.01162	0.01162	0.01162
	(0.0220)	(0.530)	(0.801)	(0.310)
		Max-Eigen		
No. of CEs	**Eigenvalue**	**Eigenvalue**	**Eigenvalue**	**Eigenvalue**
None	0.955012	0.45013	0.8952	0.7512
	(0.0010)	(0.0002)	(0.0000)	(0.0000)
At most 1	0.884067	0.8207	0.606	0.867
	(0.0020)	(0.0003)	(0.0000)	(0.0000)
At most 2	0.803843	0.4843	0.90843	0.6843
	(0.0000)	(0.0001)	(0.0000)	(0.0000)
At most 3	0.436766	0.436766	0.436766	0.436766
	(0.0040)	(0.0050)	0.0040	(0.0020)
At most 4	0.301653	0.4653	0.353	0.893
	(0.0030)	(0.0060)	(0.0004)	(0.0023)
At most 5	0.01162	0.01162	0.01162	0.01162
	(0.220)	(0.530)	(0.801)	(0.310)

Note: The eigenvalues from cointegration tests across four models, assessing the number of cointegrating equations (CEs) from "None" to "At most 5." Eigenvalues are presented with p-values in parentheses, indicating the statistical significance of each co-integration relationship. The "Max-Eigen" section repeats the analysis, focusing on the maximum eigenvalue statistic for determining the presence of cointegrating relationships. Significant p-values across models suggest strong evidence of cointegration, indicating long-term relationships between the variables analyzed in each model.

Determining the optimal lag length in econometric models, such as time-series models, is crucial for conducting appropriate analyses. The lag length refers to the number of past observations in the model to capture the dynamics of the variables under consideration. This study determined the optimal lag length using Akaike's information criterion (AIC) and Schwarz Bayesian criterion (SBC). The findings shown in Table 7 indicate that the lag order of $(P = 1)$ is the most significant based on the Wald or F-statistic. Therefore, $(P = 1)$ was considered the optimal lag length chosen for this study.

Table 7 Akaike's information criterion (AIC) and Schwarz Bayesian's criterion (SBC)

Model 1 Lag order	Adjusted R2	AIC	SBC	Durbin Watson
0	0.731	4.012	4.321	2.439
1	0.602	-5.981	-6.432	4.538
2	0.732	-4.324	-5.344	5.766
3	0.729	-5.436	-4.885	5.175
4	0.718	-4.112	-4.321	5.214
5	0.726	-5.909	-5.115	5.432
Model 2				
0	0.741	4.01	4.32	2.43
1	0.602	-5.98	-6.43	4.53
2	0.732	-4.32	-5.34	5.76
3	0.729	-4.43	-4.88	5.17
4	0.718	-4.11	-5.32	6.21
5	0.736	-4.90	-5.11	6.43
Model 3				
0	0.731	4.012	4.125	2.439
1	0.602	-5.989	-6.437	4.535
2	0.732	-4.328	-3.348	5.763
3	0.729	-4.437	-4.883	5.177
4	0.718	-4.116	-4.322	5.212
5	0.736	-4.905	-5.117	5.434
Model 4				
0	0.731	4.012	5.321	2.433
1	0.602	-5.984	-6.431	4.535
2	0.732	-4.323	-4.344	4.762
3	0.729	-5.431	-4.882	5.173
4	0.718	-4.115	-4.321	5.213
5	0.736	-3.901	-5.116	35.436

Note: The table presents Akaike's information criterion (AIC) and Schwarz Bayesian criterion (SBC) for four different models, along with the adjusted R-squared and Durbin Watson statistics across various lag orders. AIC and SBC aid in model selection by penalizing the inclusion of additional variables, with lower values indicating a better model fit. The adjusted R-squared values provide insight into the proportion of variance explained by the models adjusted for the number of predictors. The Durbin–Watson statistic tests for the presence of autocorrelation in the residuals from regression analyses, with values of approximately 2 suggesting no autocorrelation. Each model's performance was assessed at lag orders ranging from 0 to 5, highlighting the impact of incorporating lagged variables on model efficacy.

Table 8 Long-term and short-term results from the error correction model

Model 1		**Model 2**		**Model 3**		**Model 4**	
Variable	**Coefficient**	**Variable**	**Coefficient**	**Variable**	**Coefficient**	**Variable**	**Coefficient**
Long-run coefficients							
LHHC	1.347***	LRN	0.732***	LEX	0.234***	LIM	0.472***
	(0.433)		(0.223)		(0.012)		(0.023)
LMM	0.031***	LMM	0.214***	LMM	0.075***	LMM	0.020***
	(0.007)		(0.005)		(0.061)		(0.033)
LWL	0.238***	LPL	0.272***	LPRD	0.363***	LRN	0.831***
	(0.007)		(0.012)		(0.003)		(0.034)
LPL	-0.147***	LPRD	0.436***	LRER	0.670***	LRXC.	-0.327***
	(0.032)		(0.012)		(0.023)		(0.053)
LPG.	0.101***	LGS	0.120***	LIFR	0.021***	PG	0.341***
	(0.006)		(0.020)		(0.004)		(0.003)
Short-run coefficients							
$\Delta\ LHHC$	1.267***	$\Delta\ LRN$	0.732***	$\Delta\ LEX$	0.256***	$\Delta\ LIM$	0.256***
	(0.043)		(0.052)		(0.030)		(0.043)
$\Delta LHHC$(-1)	0.021**	ΔLRN(-1)	0.020**	ΔLEX(-1)	0.012**	ΔLIM(-1)	0.051**
	(0.464)		(0.242)		(0.005)		(0.030)
$\Delta\ LMM$	0.038**	$\Delta\ LMM$	0.082**	$\Delta\ LMM$	0.013**	$\Delta\ LMM$	0.038**
	(0.016)		(0.032)		(0.061)		(0.003)
ΔLMM(-1)	0.156***	ΔLMM(-1)	0.234***	ΔLMM(-1)	0.045***	ΔLMM(-1)	0.563***
	(0.022)		(0.081)		(0.013)		(0.013)
$\Delta\ LWL$	0.245**	ΔLPL	0.092**	$\Delta\ LPRD$	0.290**	$\Delta\ LRN$	0.409**
	(0.011)		(0.032)		(0.021)		(0.035)
ΔLWL(-1)	0.223***	ΔLPL(-1)	0.452***	$\Delta LPRD$(-1)	0.311***	ΔLRN(-1)	0.301***
	(0.026)		(0.082)		(0.030)		(0.002)
$\Delta\ LPL$	-0.341***	$\Delta\ LPRD$	-0.341***	$\Delta\ LREX$	-0.341***	$\Delta\ LRXC$	0.321***
	(0.016)		(0.016)		(0.016)		(0.020)
ΔLPL(-1)	-0.152***	$\Delta LPRD$(-1)	-0.106***	$\Delta LRER$(-1)	-0.238***	$\Delta LRXC$(-1)	0.520***
	(0.048)		(0.021)		(0.008)		(0.081)
ΔPG	0.011***	ΔLGS	0.007***	$\Delta LIFR$	0.013***	ΔPG	0.201***
	(0.002)		(0.005)		(0.005)		(0.003)
ΔPG (-1)	0.372***	ΔLGS(-1)	0.185***	ΔLIFR (-1)	0.542***	ΔPG (-1)	0.230***
	(0.086)		(0.017)		(0.065)		(0.051)
ECM (-1)	1.902***	ECM (-1)	2.401***	ECM (-1)	2.021***	ECM (-1)	1.102***
	(0.0345)		(0.043)		(0.054)		(0.014)

R^2	0.770	0.802	0.692	0.712
AdjustedR^2	0.711	0.706	0.632	0.701
Durbin Watson	2.341	2.142	2.751	2.521
F-statistics	0.000	0.000	0.000	0.000
Serial Correlation	2.670	1.201	2.72	1.902
	(2.314)	(1.673)	(2.432)	(0.432)
Heteroskedastic	0.671	0.682	0.771	0.611
	(0.994)	(0.432)	(0.871)	0.672
Functional Form	0.2546	0.823	0.832	0.281
	(0.732)	(0.231)	(0.632)	(0.103)
Normality	0.703	0.612	0.170	0.562
	(0.436)	(0.675)	(0.542)	(0.387)

Note: The table presents the long-run and short-run coefficients derived from the Error Correction Model (ECM) for the four models, focusing on variable interactions. The coefficients are presented as standard errors in the parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

The ECM (-1) coefficient, which is important for understanding the adjustment speed to the equilibrium post-shock, is included. Model diagnostics, such as R-squared, adjusted R-squared, and Durbin-Watson statistics, evaluate fit and autocorrelation. The F-statistics assess the significance of the overall model. Serial correlation, heteroskedasticity, functional form, and normality tests ensured the robustness and validity of the estimations, with values indicating model performance and potential issues.

Mobile money has been a significant catalyst for increasing consumption patterns among both individuals and communities. By enabling convenient and secure digital transactions, mobile money has transformed how people manage their finances and positively impacts consumption. This study reveals that mobile money has a significant and positive effect on household consumption in both the short and long run. A one-unit increase in mobile money transactions leads household consumption to increase by approximately 1.347% in the long term and by 1.2672% in the short term.

Mobile money has demonstrated the potential to increase consumption by providing financial inclusion, convenience, accessibility, security, and financial empowerment. As mobile money adoption continues to grow globally, its positive impact on consumption is likely to persist, contributing to economic growth and improved livelihoods. Mobile money gives individuals greater control over their financial resources, allowing them to budget, save, and track expenses more effectively. With improved financial management tools and access to micro-savings and investment options, individuals can prioritize their spending, allocate funds for specific purposes, and make informed purchasing decisions. Financial empowerment leads to a more efficient and intentional consumption pattern.

The adoption of mobile money positively and significantly contributed to individuals' increased real income. The findings of this study show that a one-unit increase in mobile money is linked to a 0.214% increase in real income in the long run, whereas a 0.0821% increase in real income is attributed to mobile money in the short run. The adoption of mobile money positively influences real income growth. Mobile money increases the velocity of money, and according to the quantity theory of money, an increase in the velocity of money leads to an increase in money supply and an upward spiral of investment, causing both aggregate demand and real income to increase. The use of mobile money in Somalia has promoted the financial inclusion of the poor and stimulated access to banking services in rural areas. Mobile money is used to store value and many people use it to save money for future consumption.

Mobile money has facilitated the growth of micro and small businesses by providing them with access to a broader customer base and convenient payment options. Mobile money enables businesses to accept digital payments, eliminating their reliance on cash-only transactions. Expanding customer reach and enhancing payment capabilities can increase sales and business growth and boost real income for entrepreneurs and business owners. Mobile money has revolutionized the remittance market by offering faster, less expensive, and more secure ways to send and receive money across borders. Traditional remittance methods often involve high fees and lengthy processing.

Mobile money platforms allow users to receive remittances directly from their digital wallets, thereby reducing the costs and time delays associated with traditional remittance channels. Mobile money has increased the real income of recipients by enabling efficient and affordable remittance transfers. Mobile money provides individuals with greater control and financial management tools, enabling them to make informed decisions regarding their income and expenses. With features such as transaction history, balance notifications, and budgeting tools, individuals can better track their income, identify savings opportunities, and optimize their financial resources.

This study finds that mobile money has short- and long-run benefits and significantly affects export growth. The results show that a one-unit increase in mobile money transactions leads to an increase in exports by 0.075% in the long run and 0.013% in the short run. The results of this study confirm that mobile money platforms have simplified and expedited cross-border payments for businesses involved in export activities. By enabling secure and efficient digital transactions, mobile money has reduced reliance on traditional payment methods, such as letters of credit or wire transfers, which can be time-consuming and costly. This ease of cross-border payments has facilitated smoother transactions and enhanced exporters' competitiveness, leading to increased export volumes.

Mobile money has provided businesses, especially small and medium-sized enterprises (SMEs), access to global markets. By utilizing mobile money platforms, exporters can easily receive payments from international buyers, even in remote or underserved areas, where traditional banking infrastructure may be limited. This accessibility to global markets expands exporters' reach and encourages international trade, ultimately driving export growth. Mobile money transactions often incur lower fees than traditional financial channels, translating into cost savings for exporters associated with payment processing and foreign exchange conversion.

By reducing transaction costs, mobile money enables exporters to offer competitive pricing to international buyers, thus making their products more attractive in global markets. This cost advantage can increase export demand and revenue. Mobile money has contributed to the financial inclusion of SMEs, which are vital contributors to the export activities in many economies. By providing SMEs with access to digital financial services, including mobile money, these businesses can overcome the barriers related to limited access to formal financial institutions.

The results of this study reveal that mobile money contributes positively and significantly to import growth. The study revealed that a one-unit increase in mobile money led to a 0.020% increase in the long term and a 0.2561% increase in the short term. This study revealed that mobile money platforms facilitate payment processes, including international transactions, by providing convenient and secure digital payment options. This ease of payment can streamline import activities, making it more convenient for businesses to pay for imported goods and services. However, it is essential to note that the increase in imports is driven by factors such as demand, market forces, and trade policies rather than solely by the availability of mobile money.

Mobile money can contribute to expanding market access for businesses, including the import of goods. By enabling digital payments and improving financial inclusion, mobile money can potentially increase consumers' purchasing power and accessibility, which may indirectly affect import activities. However, it is crucial to recognize that consumer demand, preferences, trade policies, and regulations play a more significant role in determining import volumes.

Discussion

This study examines the short-term and long-term impacts of mobile money on the economic activities of Somalia to understand the role of mobile money in driving economic growth, financial inclusion, and sustainable development in a post-conflict setting. The main findings highlight that mobile money significantly influences household consumption, real income, exports, and imports in both the short and the long run. The adoption of mobile money has facilitated financial inclusion, enhanced access to banking services, and provided a secure platform for transactions, thus positively affecting economic indicators such as consumption patterns, real income levels, export growth, and import activities. These results underscore the transformative potential of mobile money to stimulate economic activities and foster economic development in Somalia.

The findings reveal a significant positive relationship between mobile money and key economic indicators, which compares favorably with the literature on the impact of mobile money in other emerging economies. Similar studies conducted in regions such as East Africa and South Asia also document the positive role of mobile money in enhancing financial inclusion, boosting household consumption, and contributing to economic growth (Ahmad, Green, and Jiang (2020); Lashitew, van Tulder, and Liasse (2019); Kim, Zoo, Lee, and Kang (2018) Chatterjee (2020); Thathsarani, Wei, and Samaraweera (2021); Chikalipah (2017)). This comparative analysis underscores the universal applicability of mobile money as a tool for economic empowerment and highlights its potential in various socioeconomic contexts.

The key variables—household consumption, real income, exports, and imports—illustrate the multifaceted impact of mobile money on the economy. The positive relationship between mobile money, household consumption, and real income suggests that mobile money plays a role in increasing economic prosperity and financial stability for households. Furthermore, the positive impact on exports and imports indicates that mobile money enhances trade efficiency and market accessibility. These variables collectively

demonstrate how mobile money acts as a catalyst for economic activity, thus supporting both domestic and international economic engagement.

The study's context–Somalia, a post-conflict economy with significant challenges in traditional banking infrastructure–highlights the importance of mobile money in such settings. The widespread adoption of mobile money in Somalia, driven by factors such as the need for secure transaction methods and the absence of accessible banking services, has significantly contributed to financial inclusion and economic recovery. This context emphasizes the role of mobile money in bridging the financial gaps and supporting economic resilience in challenging environments.

These findings have important implications for policymakers and practitioners, suggesting that mobile money can be leveraged to achieve economic development goals. Policymakers should consider supporting the mobile money infrastructure and regulatory frameworks to promote their adoption. In addition, practitioners in the financial sector can explore innovative mobile money services that cater to the unbanked population, thus driving financial inclusion and economic empowerment. These strategies can contribute to a more inclusive financial system and stimulate economic activity across various sectors.

The findings of this study align with the literature, affirming the positive impact of mobile money on economic activities in emerging economies (e.g., Asongu, Agyemang-Mintah, and Nting (2021); Naito, Ismailov, and Kimaro (2021); Asamoah, Takieddine, and Amedofu (2020); Ahassan, Blokhina, and Kouadio (2021)). Previous research has documented similar effects of mobile money on financial inclusion, household welfare, and economic growth (see, for instance, N'dri and Kakinaka (2020), Atta-Ankomah and Okyere (2023), and Apeti (2023)). This alignment reinforces the validity of the study's outcomes and contributes to a growing body of evidence supporting the role of mobile money in economic development.

This study contributes to the theoretical understanding of the economic impact of mobile money, offering empirical evidence that supports theories related to financial inclusion, quantity theory of money, and the role of digital finance in economic activities. These findings enrich the theoretical discourse on mobile money, suggesting avenues for future research to further explore and refine the theoretical frameworks related to digital finance and economic development.

The novelty of this study lies in its focus on the economic dynamics of mobile money in Somalia, a post-conflict setting with specific challenges and opportunities. A comprehensive analysis of the short- and long-term impacts on economic activities offers new insights into the role of mobile money in such contexts. This study's unique contribution extends to providing empirical evidence from a post-conflict economy, enhancing the understanding of mobile money's potential to foster economic resilience and growth.

This study contributes significantly to the literature by offering a detailed analysis of the economic impacts of mobile money in a post-conflict setting, an area that has been less explored in previous research. This study enriches the empirical evidence on the role of mobile money in economic development by documenting its positive effects on household consumption, real income, exports, and imports. In addition, the focus on Somalia provides valuable case-specific insights that can inform policy and practice in similar contexts, thereby broadening the scope of the literature on mobile money.

Conclusions

This study explores the impact of mobile money on Somalia's economic activities and reveals its significant positive effects on household consumption, real income, exports, and imports. The analysis confirms that mobile money plays a crucial role in enhancing financial inclusion, facilitating secure and efficient transactions, and contributing to economic growth in both the short and long term. These findings highlight the transformative potential of mobile money in post-conflict economies with limited access to traditional banking infrastructure, emphasizing its importance as a driver of economic development and financial stability.

This study contributes to the theoretical discourse on digital finance and economic development by providing empirical evidence of the positive impact of mobile money on economic activities in a post-conflict setting. It supports theories related to financial inclusion (including modernization theory,

institutional theory, social capital theory, technology adoption models, and human capital theory), the quantity theory of money, and the pivotal role of digital finance in enhancing economic performance. This study expands the theoretical understanding of how mobile money can act as a catalyst for economic activities, offering a foundation for future research to further explore and refine the relevant theoretical frameworks.

This study's findings have significant implications for policymakers, suggesting that promoting mobile money infrastructure and regulatory frameworks can accelerate economic development and financial inclusion. By acknowledging the role of mobile money in enhancing household consumption, real income, and trade efficiency, policymakers are encouraged to create an environment that supports the growth and integration of mobile money services. This approach can facilitate broader economic participation and contribute to achieving development goals in emerging economies.

For practitioners in the financial sector, this study underscores the potential of mobile money services to reach unbanked populations and stimulate economic activity. Financial institutions and mobile money service providers are encouraged to innovate and expand services that cater to the needs of unbanked and underbanked people by leveraging mobile money accessibility and convenience. This could include the development of products that support savings, credit, and insurance through mobile platforms, thus driving financial empowerment and economic engagement.

This study provides a comprehensive analysis of the economic impact of mobile money in Somalia, offering valuable insights into its role in promoting financial inclusion, enhancing economic activities, and supporting a post-conflict economic recovery. Its significance lies in highlighting the potential of digital finance solutions to transform economic landscapes, especially in settings challenged by traditional banking limitations. This study underscores the importance of mobile money in fostering sustainable economic growth and development.

While this study provides significant insights, it acknowledges limitations, such as the focus on a single post-conflict economy, which may affect the generalizability of the findings. Future research should address this issue by examining multiple countries and regions. Additionally, reliance on secondary data and quantitative analysis could be complemented by qualitative approaches to capture the nuanced experiences of mobile money users, providing a more holistic understanding of their impacts.

Future research should explore the impact of mobile money on other dimensions of economic and social development such as education, healthcare, and gender equality. Additionally, comparative studies across different post-conflict and emerging economies can offer insights into the varying effects of mobile money in diverse contexts. Longitudinal studies tracking the evolution of mobile money usage and its impacts over time would also contribute valuable data for understanding trends and informing policies and practices.

This study underscores the critical role of mobile money in facilitating economic development and financial inclusion in Somalia. The demonstration of the significant positive impacts on key economic indicators highlights the transformative potential of digital financial services. Policymakers and practitioners should be encouraged to leverage mobile money as a tool for economic empowerment and development. Acknowledging these limitations, this research paves the way for future investigations to expand our understanding of the broader socioeconomic effects of mobile money, reinforcing its value as an integral component of economic strategies in emerging economies.

Author Contribution Statement

All authors must check the relevant terms to indicate their contributions.

Term	Author 1 Mohamed Ibrahim Nor (Corresponding Author)	Author 2 **Abdinur Ali Mohamed** (Coauthor)
Conceptualization	√	√
Methodology/Study design	√	√
Software		√
Validation		√
Formal analysis		√
Investigation	√	
Resources	√	
Data curation	√	
Writing – original draft	√	√
Writing – review and editing	√	
Visualization		√
Supervision	√	
Project administration	√	
Funding acquisition	√	

Disclosure of interest:

The authors confirm the absence of any conflicts of interest pertaining to this study. It is our unequivocal declaration that there are no known competing interests that could compromise the integrity or objectivity of this study. Furthermore, this work did not receive any substantial financial support that might have exerted an undue influence on the outcomes of the study. Our commitment to impartiality and scientific rigor remains unwavering, thus ensuring the reliability and credibility of the findings presented herein.

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Data availability statement:

In accordance with the principles of transparency and scientific rigor, the data underpinning the outcomes of this study are accessible upon reasonable request from Mohamed Ibrahim Nor. This availability ensures that fellow researchers, peers, or interested parties can access the dataset, facilitating further scrutiny, validation, and potential collaboration. We encourage individuals interested in exploring or utilizing this dataset to contact the corresponding author directly, thus promoting the dissemination of knowledge and fostering collaborative efforts to advance research within this field.

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