



**Denominational inflation: Limited currency divisibility in cash payment
systems – Tanzania as a case study**

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ABSTRACT

This study examines the impact of the limited divisibility of money on price setting and inflation in Tanzania, a country that relies heavily on cash transactions. Through analyzing bus fares and prices listed in both domestic and international online shopping platforms, the research highlights the economic implications of rounding prices to the nearest available currency denomination due to the absence of small denominations. The analysis reveals that ordinary bus users pay more due to price rounding to the nearest available denominations. Digital payment systems, on the other hand, reduce the need for adjustments that inflate costs. The study employed logistic regression to examine the relationship between the last digit of the price and the two different shopping malls. The findings suggest promoting digital payment systems to enhance the effectiveness of monetary policy, reduce transaction costs, and ensure price accuracy, thereby proposing policy directions for Tanzania to transition from cash-based to digital payment systems.

Key Words: Denominational Inflation, Payment Systems, Currency, Inflation, Monetary Policy, Money.

JEL Codes: E31, D12, O55

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1. INTRODUCTION

The divisibility of money has been discussed by various scholars, including Berentsen and Rocheteau (2002), Green and Zhou (1998), and Lee and Wallace (2006). Money's divisibility allows a government to create units that can be easily broken down for transactions, promoting equal exchanges of goods and services. Mishkin (2012) writes five criteria for money to function effectively. On divisibility, which he mentions as one of the criteria, he writes, 'it must be divisible so that it is easy to make change' (Mishkin, 2012, p. 46). Without the ability to make changes, the exchange becomes somewhat challenging. In the exchange, either producer or consumer may be worse off if the divisibility is limited. That is, either the consumer will pay more or less; the former favors the producer, and the latter favors the consumer.

There is a consensus that, prior to the nineteenth century, small denominations of currency were not widely accessible (Lee & Wallace, 2006). While the problem of small change may seem historical, it persists to this day in some countries. For example, hyperinflation led Zimbabwe to introduce a banknote of 100 billion Zimbabwean Dollars, and during that time, a loaf of bread was sold for more than 100 billion Zimbabwean Dollars (Coomer & Gstraunthaler, 2011). Nyamunda (2021) demonstrates that Zimbabwe's currency regime faced difficulties in obtaining coins for use in smaller daily transactions. The Reserve Bank of Zimbabwe released bound coins totaling \$10 million in denominations of 1, 5, 10, and 25 cents on December 18, 2015. In the 1980s, coins worth less than 10 cedis were falling out of circulation in Ghana. Before that, the coins started from five pesewa (100 pesewa = one cedi) (Obuobi et al., 2020). That is, the problem with small change is not a historical problem, as it was in the twentieth century, and it persists in the twenty-first century in some countries.

The number of denominations in the currency increases the efficiency of cash payments; hence, the fewer denominations, the less efficient the cash payments become (Bouhdaoui & Van Hove, 2017). However, inflation makes some denominations out of circulation (Coomer & Gstraunthaler, 2011; Linzmayer, 2011; Nyamunda, 2021; Obuobi et al., 2020). As demonstrated, the higher denominations of the circulating currency are the results of inflation. This causes the smaller units of currency to fall out of circulation. The phasing out of smaller units of money creates pricing problems because market players may not be able to set prices that are payable in the available denominations.

Scholars have demonstrated that cash payment systems are the most costly payment instrument for society. Bouhdaoui and Bounie (2012) state that Central banks globally have consistently pursued strategies to minimise the expenses associated with banknote production. These approaches include measures like the withdrawal of certain denominations, replacing traditional paper banknotes with coins, and the adoption of innovative technologies. Withdrawing denominations as an approach to minimize costs requires a study to determine if this method is efficient, especially when a country's payment system relies heavily on cash payments.

Lee & Wallace (2006) have shown that the optimal divisibility of money is related to the costs of producing and maintaining money. In this sense, the total cost of producing and maintaining money decreases in the size of the monetary unit. This means that the cost of providing the initial stock of money and the cost of maintaining the stock both decrease as the size of the monetary unit increases. As a result, the optimal degree of divisibility of money is

influenced by finding a balance between the benefits of trade facilitated by having many small monetary items and the costs associated with producing and maintaining those items. This idea is crucial in the cash payment system, but the world is in a digital era where money has become digital. Hull and Sattath (2021) have revisited the properties of money, where the emphasis was not on the divisibility of the currency. As they considered a non-physical currency, some of the properties they introduced are reversibility, throughput, untraceability, and privacy.

In the case of small change, Sargent and Velde (2002) found that governments use a standardized approach for supplying and pricing coins and currency. The monetary authority establishes fixed prices by offering unlimited conversion of various denominations at set exchange rates. The small change is an issue with the physical currency. That is, if a country adopts the use of non-physical currency, the problem will disappear, for example, in digital payments.

This paper discusses the effects of the limited number of denominations on monetary policy. Inflation is among the macroeconomic problems that can lead to other macroeconomic issues, such as unemployment (Abu, 2019; Sasongko & Huruta, 2019). The long-run inverse relationship between inflation and unemployment is well explained in the Phillips curve (Hazell et al., 2022; McLeay & Tenreyro, 2020). Inflation reduces the purchasing power of the consumers (Halim et al., 2022). The limited denominational divisibility of money necessitates that market players set prices with denominations that can be paid with circulating denominations. The failure to produce the smallest units leads to higher prices and a general increase in the price level.

There are limited studies on payment systems, one of the factors that affect monetary policy. Existing studies discuss cost-push, demand-pull, built-in inflation, and rising wages (Jain et al., 2022; Lapavitsas, 2022; Reis, 2022; Sharma & Yadgari, 2023). This has led to a discussion about the supply side versus the demand side. There are limited studies on how the payment system can cause inflation. This study aims to introduce transactional inflation, also known as denominational inflation, which explains how the means of payment cause inflation.

Denominational inflation, as observed in this study, stems from an economy that relies more on cash payments. It is a result of the limited divisibility of currency. The denominational inflation exists even when the product is divisible. For example, a product weighing 10.512 kilograms will not require a small adjustment to ensure a fair transaction. Due to the limited denominations in circulation, the price will be rounded to the nearest unit of the circulating denominations. Nonetheless, some products are strictly indivisible, and thus, they require the divisibility of money to facilitate a fair exchange.

This study examines the cash payment system and its role in causing denominational inflation. It has considered the fact that prices, after accounting for all other factors, will depend on the available denominations. The study used Tanzania as a case study. Recently, Tanzania had a challenge in transitioning from trial to consistent adoption of digital payment methods for purchasing goods (FinScope Tanzania, 2023). The use of non-physical currency in Tanzania is not as big as in other countries. For example, in East Africa, Kenya uses mobile money more than Tanzania and Uganda (Suri, 2017). This makes Tanzania a best case study for this research, as the adoption of mobile payments is limited.

2. LITERATURE REVIEW

2.1 Monetary Policy in Tanzania

The Bank of Tanzania's (BoT) monetary policy is fundamentally designed to maintain inflation within a medium-term target of five percent, measured as the annual change in the Consumer Price Index (CPI). A stable inflation rate ensures predictability in the economy, fostering an environment conducive to investment and development. However, the BoT acknowledges the inherent challenges of managing inflation in an open economy, particularly the impact of supply-side shocks and global fluctuations in commodity prices. These external factors, beyond the control of monetary policy, can occasionally lead to deviations from the inflation target. In addition to the external factors, the BoT has not documented that the means of payment can also be a problem for the monetary policy. Florens Luoga, the then Governor of the BoT, highlighted the use of cash as a challenge to monetary policy during the inauguration of the BoT's Mwanza branch on July 13, 2021.

To achieve its inflation objectives, the BoT relies on the Central Bank Rate (CBR), which serves as the intermediate target. The CBR is based on inflation forecasts and economic assessments, striking a balance between the dual goals of controlling inflation and promoting economic growth. Complementing this is the seven-day interbank cash market interest rate, which functions as the operating target. This dual-target system creates a structured pathway for achieving inflation and broader economic objectives.

The Bank of Thailand (BoT) employs a range of monetary policy instruments to manage liquidity and indirectly influence inflation. Repurchase agreements (repo and reverse repo) are used for short-term liquidity management, allowing the Bank to adjust the money supply in response to market conditions. Open market operations, including the trading of debt securities and foreign currency, provide additional mechanisms for liquidity control. Structural liquidity is managed through tools such as the Statutory Minimum Reserve Ratio (SMR) and the discount rate. The BoT also offers standing lending facilities, such as intraday and Lombard loans, ensuring smooth banking operations and minimizing disruptions that could lead to inflationary pressures.

Despite its framework, External shocks, such as fluctuations in global oil prices or disruptions in food supply chains, can exert upward pressure on inflation that monetary policy alone cannot mitigate. While external shocks have been discussed in several literature, domestic challenges have not been discussed. In this study, the domestic challenge of denominational inflation is discussed to inform how the central bank can control inflation. Central Bank can exert its powers through financial intermediaries in the financial market. However, a good number of Tanzanians are financially illiterate (Capital Markets & Securities Authority, 2022). While they are financially illiterate, they still exchange and transact; this serves as a good starting point for implementing monetary policy for financially illiterate individuals.

2.2 Mobile Money in Tanzania

Tanzania implemented the use of Mobile phone-based money transfer technology in April 2008 (Omwansa, 2009). By 2024, there will be six companies offering mobile money services. Global mobile money datasets from the Global System for Mobile Communications Association (GSMA) have recorded that four mobile money services in Tanzania offer merchant payment services.

Table 1. Mobile money in Tanzania and their launching dates

Mobile Money	Company	Launching date
Vodacom M-Pesa	Vodacom (Vodafone)	April 2008
Tigo Pesa	Tigo (Honora)	August 2010
Airtel Money	Airtel (Bharti Airtel)	April 2012
HaloPesa	Viettel eCommerce (Halotel)	October 2016
T Pesa	TTCL	August 2017
AzamPesa	AzamPay	March 2022

The introduction of mobile money has increased financial inclusion and deepened financial access (Nyonzo, 2022). This is because people who are limited to financial services can access these services using their mobile phones. The Bank of Tanzania (BoT) has been recording mobile transactions since 2008; however, the data is available every month starting from 2013. From the year 2013 to May 2024, the average amount that every subscriber transacted in every month was 86,088 Tanzanian Shillings (31.92USD²). For the same period, every subscriber transacted on average three times a month.

2.3 The Quantity Theory of Money

According to the quantity theory of money, variations in the money supply are the main factor influencing inflation. The theory suggests that substantial increases in the money supply led to corresponding increases in price levels. This relationship implies that inflation is primarily driven by monetary factors (Friedman, 1989). Although other elements, such as income levels, demand for products, and expenditure frequency, also matter, the influence of the money supply is greater.

According to Mishkin (2012), the quantity theory of money explained changes in the level of prices for classical economics. They maintained that changes in the amount of money are the only factors that affect price levels.

Quantity Theory of Money uses the equation of exchange. The product of the money supply and its velocity over a year must equal nominal income, which is the total nominal expenditure on goods and services during that time, per the equation of exchange.

That is,

$$M \times V = P \times Y \dots (1)$$

where M is the total quantity of money (the money supply), V is the velocity of money, which is the turnover rate of money and refers to how often, on average, each year. P is the price level, and Y is the aggregate output (income).

$$\text{Rearranging the equation } P = \frac{M \times V}{Y} \dots (2)$$

² The exchange rate pegged to 1 2700 Tanzanian Shillings

The equation indicates a positive relationship between the money supply and the price level. However, However, in an economy where the divisibility of money is limited, there is an adjustment unit. The price will be rounded to the nearest unit that can facilitate the transaction.

Let the adjustment unit = μ , that is, price level $P = P + \mu$

$$\text{Then } P + \mu = \frac{MV}{Y} \dots (3)$$

$$P = \frac{MV}{Y} - \mu \dots (4)$$

Equation 4 shows that the adjustment unit is negatively related to the price level and positively related to the money supply.

Looking at the relationship to the money supply

$$M = \frac{Y(P + \mu)}{v} \dots (5)$$

As for this, the more currency experiences indivisibility, the more it increases the adjustment unit, and that, in turn, increases the demand for money.

The money supply affects the general price level. However, for this study, it is explained that the availability of currency denominations also influences the money supply. This, in turn, affects the money supply and the price level. This is the fact that the producers do set prices depending on the available denominations.

2.4 Objectives

2.4.1 General Objective

To examine how the limited divisibility of money increases prices

2.4.2 Specific Objectives

- i. Examining how the problem of small change affects price setting.
- ii. Examining the divisibility problem in the payment system.

2.5 Statement of the problem

The divisibility of money is a critical characteristic that ensures efficient and equitable transactions in an economy. Given the costs of issuing currency, some economies with higher denominations fail to print the smallest denominations. When money is not sufficiently divisible, challenges arise in setting prices for goods and services because producers will set the prices depending on the currencies in circulation. While the issue of small change is often considered a historical problem, it persists in contemporary economies, particularly those that rely heavily on cash payments. Given the digital gap, developing countries tend to use cash more frequently than developed countries, which are increasingly becoming cashless societies. This has implications for monetary policy, as inflationary pressures arising from limited currency divisibility, referred to here as 'denominational inflation,' are not well understood or documented. Denominational inflation occurs when transactions are rounded to the nearest

available denomination, leading to price distortions. This study aims to inform policy strategies for transitioning to digital payment systems and enhancing the effectiveness of monetary policy in economies that rely heavily on cash.

2.6 Significance of the study

Adam Smith identified four functions of government, which were later expounded upon by Milton Friedman. Protecting individuals from coercion and facilitating are among the functions of the government (Friedman & Friedman, 1990). The money facilitates voluntary exchange. However, the limit on the divisibility of money limits the flexibility of price setting. The study is significant in that it contributes to understanding how the government can facilitate exchange and control inflation. It provides a way to minimize the inflation that results from the limited divisibility of the currency, especially when the commodity is indivisible. The study will provide reasons for developing countries to promote alternative electronic means of payment to overcome the problem of small change, which is a result of the limited divisibility of currency.

Friedman argues that inflation is a monetary problem, and he mocks the well-known reasons, such as weather, greedy businesspeople, and grasping trade unions. He argues that the mentioned reason cannot produce money; that is, the government avoids acknowledging its responsibility for inflation, *ibid.*, from the problem of small change, which is also a monetary issue. This study will demonstrate that the failure to facilitate exchange through the use of highly divisible payment systems leads to inflation. This study contributes to the understanding of inflation and the science of payment systems in combating inflation, a phenomenon that Friedman described as a "dangerous and fatal economic disease."

3.METHODOLOGY

This study used different data samples. Data samples were obtained from online shopping malls and the Land Transport Regulatory Authority of Tanzania (LATRA).

Two online malls that operate in Tanzania were used in this study to compare the denominations used. One is a domestic online mall, and the other is an international online mall. In the domestic online mall, customers pay in cash, while in the international online mall, customers pay electronically; however, all prices are cited in Tanzanian shillings. For the international mall, Kikuu, the Chinese online mall, was used as it operates in Tanzania. The domestic online shopping mall is Dar Shopping. On this, 100 pages of the website were scrapped using Data Miner, a Chrome extension used for data scraping. Dar Shopping, the domestic online mall, allows customers to pay in cash after the product is delivered. As for Kikuu, customers pay for the product online using digital payments, such as mobile money or Kikuu Pay. The order is given to the dealer, and the delivery process starts. To present this in a more mathematical way, a multivariable logistic model was employed. The multivariable model is utilized for analysis involving a single dependent variable and multiple independent (Ebrahimi Kalan et al., 2021). The following equation gives the model.

$$\log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \beta_6x_6$$

Where $\frac{\pi}{1-\pi}$ is the binary independent variable market. Which is 1 if the market does not have online payment and zero if the market uses online payment. x_1 is the binary representation

of the last digit of the price listed in the market: one if the price has zero as its last digit and zero if the price has a non-zero last digit. x_2 represents the last two digits of the price, one if the last two digits are '00' and 0 if the last two digits are not. x_3 represents last three digits of the price, zero if the last two digits are '000' and zero if otherwise. x_4 represents the last two digits of the price, one if the last two digits are 50 and zero if otherwise. x_5 represents the last three digits of the price, one if the digits are 100 and zero if otherwise. x_6 represents last three digits of the price, one if the digits are 500 and zero if otherwise. β_0 represents intercept term. β_1 to β_6 represent the coefficients of the predictors.

The government of Tanzania sets prices for certain services, such as transport, through the Land Transport Regulatory Authority of Tanzania (LATRA). Hence, I used fares for commuter buses and long-distance buses to check the additional amount that a person pays to avoid the problem of small change. This is based on the fact that LATRA calculates prices per kilometer, but the displayed price is adjusted to the denominations in circulation.

4. RESULTS

4.1 Bus fares

The Land Transport Regulatory Authority (LATRA) in Tanzania has announced new bus fares following discussions with stakeholders. Its regular meeting on October 25, 2023, approved fare revisions for both urban and long-distance buses, ensuring that the revised fares considered fundamental factors to maintain service availability and affordability for users. The Board approved the use of the new fare. The approved fare adjustments are analysed in the table two and table three.

Table 2. Fares for Tanzanian urban buses (commuter buses)

Distance	Previous Price (P_b)	Calculated Price (P_t)	Displayed/Paid Price (P_d)	Adjustment Unit (μ) ($P_d - P_t$)
<10KM	500	601.22	600	-1.22
11 to 15 KM	550	685.14	700	14.86
16 to 20KM	600	804.08	800	-4.08
21 to 25KM	700	897.22	900	2.78
26 to 30KM	850	1087.64	1100	12.36
31 to 35KM	1000	1284.87	1300	15.13
36 to 40KM	1100	1407.66	1400	-7.66
Σ	5300	6767.83	6800	32.17

For buses traveling long distances, the prices are charged by the kilometer (LATRA, 2023b).

New fares were announced in November 2023.

Table 3. Old and New bus fares per Kilometer in Tanzanian Shillings

Class	Old fare (in Tsh)	New Fare (in Tsh)
Ordinary Bus	41.29	48.47 Tsh
Semi Luxury Bus	56.88	67.84 Tsh

The prices are listed on the LATRA fare document (LATRA, 2023a).

Data from LATRA shows that there are 1,262 bus routes; however, some of these routes are reverse routes. For example, the data lists the route from the Lindi region to Mtwara via Mingoyo but then lists the route from the Mtwara region to Lindi via Mingoyo, which has the same price and distance. I have resolved the duplication problem, and thus, I am left with 657 routes. The routes have mentioned the distance in Kilometers, and therefore, the calculated price is the price per kilometer multiplied by the distance of the route.

For semi-luxury, the suppliers are paid less than the required amount, while ordinary customers are paid more. Because the adjustment unit is the paid price minus the calculated price, when it is negative, it means the calculated price is greater than the displayed price. When it is positive, it means the displayed price is greater than the calculated price.

Table 4: Summary of the long-journey buses and adjustment unit

Adjustment Units (Average)	Year 2022	Year 2023
Ordinary bus	566.4218	266.1164
Semi-Luxury bus	-0.975972	-13.09237

Sixty-one percent of the ordinary buses' fares are less than the calculated price, and 39 percent of the fares are more. For semi-luxury buses, 47 percent pay less, and 53 percent pay more than the calculated prices. On average, the passages pay 13.10 Tsh less than the calculated fares for 2023.

Using the t-test to compare fares for those who pay more and those who pay less in ordinary buses, the result is significant that people are paying more than the calculated fare. It is also significant that people using ordinary buses pay more than those using semi-luxury buses.

4.2 Online mall prices

Considering the domestic online market, Dar Shopping, I scrapped the first 100 pages and removed duplicate products, resulting in a dataset with 2133 observations, specifically including the price and product name. The minimum price for the products I scrapped is 150 Tsh (0.05 USD), and the highest price is 22,862,500 Tsh (8,467.59 USD). In Kikuu, the online Chinese mall that operates in Tanzania, the issues are different. Kikuu uses electronic payments that are available in Tanzania, such as mobile money, and Kikuu has a wallet, the K-Pay. Customers can deposit money into K-Pay and start making payments to purchase products at Kikuu. There was a total of 4,954 observations collected from the Kikuu online market. Some variables were randomly removed to maintain 2133 observations, the number equal to the number of observations in the Dar shopping mall. The minimum price collected is 5,394 Tsh (approximately 1.99 USD), and the maximum price is 663,710 Tsh (approximately 245.82 USD).

While the 50Tsh coin is still in use, the data shows it is less cited unit when people pay in cash. In Dar shopping mall, only 2.58 percent of the prices listed have 50 as their last two digits, and in Kikuu mall, it is only 5.44 percent. Taking another value, which is 100, the data shows Dar shopping mall has 0.42 percent, and Kikuu has 0.47 percent of the prices listed with 100 as the last three digits. Moreover, considering another value of 500, Dar Shopping has 11.48 percent of the listed prices, with 500 as their last digits. At the same time, Kikuu has no price, which ends with 500Tsh. This is summarized in table five.

Table 5. Last digits of the prices cited at Kikuu mall and Dar shopping in percent

		Last digits = 50	Last digits = 100	Last digits 500
Kikuu	Yes	5.44	0.47	00.00
	No	94.56	99.53	100.00
Dar Shopping	Yes	2.58	0.42	11.58
	No	97.42	99.58	88.42

Checking the zeros in the last digits also provides insight into which market lists prices that exhibit high divisibility. Dar shopping has only 1.17 percent of its prices, with a non-zero unit as its last digit, while Kikuu has 44.02 percent. This means that Dar Shopping does not list prices with the smallest units, while Kikuu does. When it comes to the last two digits, Dar shopping accounts for 3.84 percent of the prices that do not have two zeros at the end, while Kikuu has 93.86 percent. This means Kikuu's prices are more divisible compared to Dar shopping, as evidenced by checking the last two digits of their prices. As for the last three digits of the prices, Dar shopping has 24.14 percent of its prices with no three zeros as the last digits, while Kikuu scores 99.39 percent, as summarized in Table 6. By checking the last digits, the Kikuu mall shows that it uses the smallest monetary units compared to the Dar shopping mall, which is a cash-based establishment.

Table 6. Last digits of the prices cited at Kikuu mall and Dar shopping in percent

		Last three digits	Last two digits	Last single digit
Kikuu	Zero	0.61	6.14	55.98
	Non-Zero	99.39	93.86	44.02
Dar Shopping	Zero	75.86	96.16	98.83
	Non-Zero	24.14	3.84	1.17

Using logistic regression to determine the likelihood of the means of payments and their effects on price setting, the outcome is shown in Table 7. The model achieved a significant fit, as indicated by the Wald chi-squared statistic 413.05 and p-value <0.001, demonstrating that the predictors collectively explain a substantial proportion of the variance in the payment method.

The coefficient for the last digit in price is negative 6.1598, which indicates a significant and negative association with cash-only markets. This suggests that products priced with zero as the last digit are significantly less likely to be found in cash-only markets compared to markets that support electronic payments. The coefficient for the last two digits is 6.6539 and significant. This suggests that prices ending in '00' are strongly associated with cash-only markets. This indicates that such round pricing is more commonly used in domestic, cash-driven transactions. The coefficient for the last three digits of the price is 4.3300 and significant. This implies that prices ending in '000' are more likely to appear in cash-only markets. Such pricing may reflect a preference for whole-number denominations in cash transactions.

The coefficient for 50 as the the last two digits in the price, is 5.4134 and is significant. This suggests that prices ending in '50' are more frequently associated with cash-only markets, likely due to the convenience of rounding for cash payments. The coefficient for 100 as the the last three digits is -0.5995, but it is not statistically significant. This indicates no strong evidence that prices ending in '100' are more or less likely to be associated with either type of market.

The coefficient for 500 as the last three digits of the price is 17.7961, but it is not statistically significant. This limits any meaningful interpretation of this variable.

Table 7. Logistic regression results

Predictors	Coefficients (β)	Std. Err.	z	P>z	95 percent Conf.	Interval
Last digit	-6.159796	.7077276	-8.7	0.000	-7.54692	-4.77268
Last 2 digits	6.653883	.7181835	9.26	0.000	5.24627	8.061497
Last 3 digits	4.330038	.3040726	14.24	0.000	3.734066	4.926009
50 as the last digits	5.413402	.7264174	7.45	0.000	3.98965	6.837154
100 as the last digits	-.5994576	.4754161	-1.26	0.207	-1.53126	0.332341
500 as the last digits	17.79605	596.081	0.03	0.976	-1150.5	1186.093

Pricing patterns ending in ‘00,’ ‘000,’ or ‘50’ are significantly more prevalent in cash-only markets, suggesting a tendency toward round-number pricing in such contexts. Pricing with a single zero as the last digit is significantly less common in cash-only markets, reflecting the potential influence of electronic pricing standards on international online platforms.

Pricing patterns ending at 100 and 500 lack sufficient evidence for a definitive association with either market type. This highlights the influence of pricing strategies on payment methods in the Tanzanian online marketplace.

5. DISCUSSION

The lack of certain currency denominations due to the limited divisibility of money affects price setting and the price level. One of the key findings of this study is the pervasive impact of denominational constraints on pricing. The absence of smaller denominations forces businesses to round prices to the nearest available unit, often resulting in inflated costs for consumers. This problem is particularly evident in transport services. Ordinary bus users bear a disproportionate burden, paying more than calculated fares due to rounding. Conversely, semi-luxury bus fares are sometimes set lower than calculated costs, negatively affecting producers. This dual impact illustrates how denominational limitations exacerbate economic inequities.

From the online market, prices are even using the smallest units when using a digital payment system. Cash transactions in markets often require rounding prices to 100 Tsh. Rounding prices to the nearest available denomination can lead to higher consumer prices. This is evidenced by the low percentage of prices ending in non-zero digits or small denominations, such as 50 or 100 Tsh, in the Dar es Salaam shopping mall, which uses cash.

Digital payment systems present a viable solution to these challenges. Unlike cash transactions, digital platforms allow for precise pricing, eliminating the need for rounding. Data from Kikuu shows that digital transactions support finer price granularity, ensuring prices reflect actual values. Electronic payment reduces the need for price rounding, thereby maintaining price accuracy. This is reflected in the higher frequency of prices with non-zero last digits and smaller units of currency, which supports a more efficient market dynamic. The logistic regression analysis confirms these observations, showing a significant association

between cash-only markets and pricing strategies that favor round numbers, which are less flexible and less consumer-friendly in terms of price fairness.

Moving to electronic payments is keeping pace with the evolution of currency. Since the barter system, there have been two types of money: commodity money and fiat money. Remaining in the previous forms with little effort to migrate into the new forms of money costs the nation. This calls for an increase in the adoption of digital payment systems to circumvent the issues associated with small changes.

6. CONCLUSION

Government actions often result in significant benefits for a select few while imposing minor burdens on a larger number of individuals (Friedman, 1993). In this issue, people on the demand side, who outnumber those on the supply side, are affected by the problem of the limited divisibility of money. Consumers who use cash payments are paying more than the exact amount due to the divisibility of money. The results for the bus fares show that ordinary people pay relatively more. This suggests that the problem of limited divisibility of money affects people with low incomes more than those with higher incomes.

While the problem has been proved in the bus fares, the online mall that uses non-cash payments has shown a higher level of currency division than the mall that uses cash. This makes it logical to say that digital payments divide the money more. That is, providing timers with the actual price adjusted by rounding to the nearest denomination. Digital payments are affected by the infrastructure index and transaction costs. I have shown how the cost of the transactions affects how people use the service (Nyonzo, 2022, 2024). A good way to promote payments is by improving digital infrastructure, which, in turn, reduces production costs. For this study, it is logical to suggest that the digital transaction cost should not exceed the adjustment unit.

Looking at the consumer price index, the study suggests that the higher the digital infrastructure index, the more likely the consumer price index is to lower. The more digitalized the country is, the more the digital payments are used. Central banks perform the function of regulating the price level, and they are on the supply side of the money market. This adds another way of regulating prices by promoting the use of digital currency over cash.

In Tanzania, as in many other countries, cash payments impact the effectiveness of Monetary Policy. However, studies such as those by Mawejje and Lakuma (2019) and Wiafe et al. (2022) have demonstrated that mobile money can enhance the effectiveness of monetary policy implementation. Popovska-Kamnar (2014) argued that the impact of electronic money on monetary policy becomes evident when considering its capacity to replace physical currency in circulation. Thus, the use of electronic payment systems will benefit not only market players but also central banks. Regarding the prevalence of mobile money in Tanzania, the central bank needs to regulate the setting of prices to make it an affordable and desirable means of payment.

The central banks will benefit in two ways: first, by reducing the cost of producing money, and second, by making monetary policy even more efficient. To encourage electronic payments, governments that rely heavily on cash should make these services available and cost-effective. This study leaves the area open for further research, specifically to determine transactions for digital payments. Recently, customers have been charged when they pay for goods. If the transaction charges exceed the adjustment unit in cash payment, the problem will persist, although it will manifest in a different form.

The move towards digital payment systems appears not only as an evolution in currency usage but also as a critical strategy for mitigating the economic distortions caused by the limited divisibility of the Tanzanian currency. This transition could lead to more equitable pricing, control inflation, and foster a more inclusive economic environment.

REFERENCES

- Abu, N. (2019). Inflation and Unemployment Trade-off: A Re-examination of the Phillips Curve and its Stability in Nigeria. *Contemporary Economics*, 13(1), 21–34.
- Berentsen, A., & Rocheteau, G. (2002). On the efficiency of monetary exchange: how divisibility of money matters. *Journal of Monetary Economics*, 49(8), 1621–1649. [https://doi.org/https://doi.org/10.1016/S0304-3932\(02\)00178-2](https://doi.org/https://doi.org/10.1016/S0304-3932(02)00178-2)
- Bouhdaoui, Y., & Bounie, D. (2012). Efficient payments: How much do they cost for the Central Bank? *Economic Modelling*, 29(5), 1579–1584. <https://doi.org/https://doi.org/10.1016/j.econmod.2012.04.026>
- Bouhdaoui, Y., & Van Hove, L. (2017). On the socially optimal density of coin and banknote series: Do production costs really matter? *Journal of Macroeconomics*, 52, 252–267. <https://doi.org/https://doi.org/10.1016/j.jmacro.2017.05.002>
- Capital Markets and Securities Authority. (2022, June 30). *Capital Markets and Securities Authority | Enhanced Reader*. moz-extension://713dd966-45b1-4891-8733-59e73f03b7e3/enhanced-reader.html?openApp&pdf=https%3A%2F%2Fwww.cmsa.go.tz%2Fuploads%2Fpublications%2Fen-1729606908-Draft4%2520Annual%2520Report%25202021%2520-%252022%2520_Final%252022102024.pdf
- Coomer, J., & Gstraunthaler, T. (2011). The Hyperinflation in Zimbabwe. *Quarterly Journal of Austrian Economics*, 14(3).
- Ebrahimi Kalan, M., Jebai, R., Zarafshan, E., & Bursac, Z. (2021). Distinction between two statistical terms: multivariable and multivariate logistic regression. *Nicotine and Tobacco Research*, 23(8), 1446–1447.
- FinScope Tanzania. (2023). *Insights that drive innovation*. <https://www.fsdt.or.tz/wp-content/uploads/2023/07/FinScope-Tanzania-2023-Full-Report-Insights-that-Drive-Innovation.pdf>
- Friedman, M. (1989). Quantity theory of money. In *Money* (pp. 1–40). Springer.
- Friedman, M. (1993). *Why Government Is the Problem*. Hoover Institution Press. <https://books.google.co.tz/books?id=vIPVuMtTV6cC>
- Friedman, M., & Friedman, R. D. (1990). *Free to choose*. Free to Choose Enterprise.
- Green, E. J., & Zhou, R. (1998). A Rudimentary Random-Matching Model with Divisible Money and Prices. *Journal of Economic Theory*, 81(2), 252–271. <https://doi.org/https://doi.org/10.1006/jeth.1997.2356>
- Halim, H., Astuty, P., & Hubeis, M. (2022). Effect of inflation and consumption credit on purchase power of the community. *International Research Journal of Management, IT and Social Sciences*, 9(2), 226–234.
- Hazell, J., Herreno, J., Nakamura, E., & Steinsson, J. (2022). The slope of the Phillips Curve: evidence from US states. *The Quarterly Journal of Economics*, 137(3), 1299–1344.

- Hull, I., & Sattath, O. (2021). Revisiting the properties of money. *ArXiv Preprint ArXiv:2111.04483*.
- Jain, M. P., Sharma, A., & Kumar, M. (2022). Recapitulation of Demand-Pull Inflation & Cost-Push Inflation in An Economy. *Journal of Positive School Psychology*, 2980–2983.
- Lapavitsas, C. (2022). The return of inflation and the weakness of the side of production. *The Japanese Political Economy*, 48(2–4), 149–169.
- LATRA. (2023a). Nauli mpya za mabasi ya masafa marefu (mikoani) zitaanza kutumika kuanzia tarehe 08 Disemba, 2023. In LATRA. <https://www.latra.go.tz/uploads/documents/en-1702037457-NAULI%20MPYA%20ZA%20MABASI%20YA%20MASAFA%20MAREFU-LATRA%2008.12.2023.pdf>
- LATRA. (2023b). Taarifa kwa Umma: Kuanza kutumika rasmi kwa nauli mpya za mabasi ya masafa marefu na mijini (daladala) kuanzia Ijumaa, tarehe 08 Desemba, 2023. In LATRA. https://www.latra.go.tz/uploads/documents/en-1701991259-LATRA_TAARIFA_KWA_UMMA_NAULI_YA_MABASI_YA_MASAFA_MAREFU_&_MIJINI-08.12.2023.pdf
- Lee, M., & Wallace, N. (2006). Optimal divisibility of money when money is costly to produce. *Review of Economic Dynamics*, 9(3), 541–556. <https://doi.org/https://doi.org/10.1016/j.red.2006.05.001>
- Linzmayr, O. W. (2011). *The Banknote Book: Tanzania*. <https://www.bot.go.tz/webdocs/Other/Bank%20of%20Tanzania%20notes%20history.pdf>
- Mawejje, J., & Lakuma, P. (2019). Macroeconomic effects of Mobile money: evidence from Uganda. *Financial Innovation*, 5(1), 23. <https://doi.org/10.1186/s40854-019-0141-5>
- McLeay, M., & Tenreiro, S. (2020). Optimal inflation and the identification of the Phillips curve. *NBER Macroeconomics Annual*, 34(1), 199–255.
- Mishkin, F. S. (2012). *The Economics of Money, Banking and Financial Markets (The Pearson Series in Economics)*. Pearson Paris.
- Nyamunda, T. (2021). ‘Open for business’ but bankrupt: Currencies, the ‘new dispensation, and the Zimbabwean economy. *Journal of Asian and African Studies*, 56(2), 204–217.
- Nyonzo, F. (2022). Tanzania’s solidarity tax. *Review of African Political Economy*, 1–9. <https://doi.org/10.1080/03056244.2022.2138308>
- Nyonzo, F. (2024). Assessing Tanzanians’ Response to the Implementation of a Mobile Money Transaction Levy. *African Multidisciplinary Tax Journal*, 4(1), 167–186. <https://doi.org/10.47348/AMTJ/V4/I1A9>
- Obuobi, B., Nketiah, E., Awuah, F., Agyeman, F. O., Ofosu, D., Adu-Gyamfi, G., Adjei, M., & Amadi, A. G. (2020). Impact of currency redenomination on an economy: An evidence of Ghana. *International Business Research*, 13(2), 62–73.
- Omwansa, T. (2009). M-PESA: Progress and prospects. *Innovations*, 107, 475.
- Popovska-Kamnar, N. (2014). The use of electronic money and its impact on monetary policy. *Journal of Contemporary Economic and Business Issues*, 1(2), 79–92.
- Reis, R. (2022). *The burst of high inflation in 2021-22: How and why did we get here?* Bank for International Settlements, Monetary and Economic Department.
- Sargent, T. J., & Velde, F. R. (2002). *The big problem of small change*. Princeton University Press.
- Sasongko, G., & Huruta, A. D. (2019). The causality between inflation and unemployment: the Indonesian evidence. *Business: Theory and Practice*, 20, 1–10.

- Sharma, P., & Yadgari, M. R. (2023). The Impact of Macroeconomic Variables on the Contingent Built-in Inflation: Evidence from Indonesia. *Business Economic, Communication, and Social Sciences Journal (BECOSS)*, 5(3), 189–197.
- Suri, T. (2017). Mobile money. *Annual Review of Economics*, 9, 497–520.
- Wiafe, E. A., Quaidoo, C., & Sekyi, S. (2022). Monetary policy effectiveness in the advent of mobile money activity: Empirical evidence from Ghana. *Cogent Economics & Finance*, 10(1), 2039343. <https://doi.org/10.1080/23322039.2022.2039343>