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The Cost of Cash Processing as a Determinant of the Central Bank Digital Currency: A Critical Analysis of The Zambian Case

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Abstract
This paper focuses on evaluating the Cost of Cash processing as a determinant of Central Bank Digital Currency (CBDC) in Zambia. The study adopted a two-tier CBDC model which used the methodology of time series monthly data to ascertain if the introduction of a CBDC could reduce the cost of processing currency and mitigate the high cost of processing cash in circulation (CIC). The statistical tests adopted the use of ordinary least squares (OLS) regression that werwasnducted at level and at first difference to stabilize the time series and to avoid spurious results. The preliminary empirical results depicted the existence of a nonnonsignificantlationship between a CBDC and the cost of cash in the Zambian jurisdiction. The relationship between CBDC and the high cost of processing currency was found to be insignificant and this was partially due to the fact that the two-tier CBDC model used was a hybrid model and assumed that CBDC would be used in parallel with fiat currency and all the requirements of processing currency remained unchanged.
Keywords: Central Bank Digital Currencies (CBDC), Cash in Circulation (CIC), Cost of Currency, Two-tier, Zambia
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1. Introduction

This study looked at the history of currency and payment systems platforms in the pre and post-independence era in Zambia. It brings out the major risks posed by virtual currencies on the payments systems landscape and highlights the value and the properties that a Central Bank Digital Currency (CBDC) brings to mitigate the risks of these growing virtual currencies risks (BOZ, 2017). The study was beneficial to the government of the Republic of Zambia, the ministry of finance, the monetary authorities, financial regulators, Technology regulators and financial conduct authorities in Zambia and the sub-Saharan region. Furthermore, the research brought out potential benefits of a CBDC and evaluated how CBDC can bring about innovation in the payment systems landscape, lower the cost of cross border payments, increase financial inclusion and provide insights on how to safeguard, ensure stability, a secure, stable and sound financial system and to foster sustainable economic development in the country (BOZ, 2020). The study also looked at other major prevailing determinants for introducing a CBDC in Zambia and how it can improve the efficiency of payments systems, make a stronger national defense against AML/CFT, demonstrate whether a CBDC can ensure non-discriminatory access to domestic financial services and how they can mitigate the high costs associated with processing cash in circulation.

2. Virtual Currencies (VC)

Virtual currencies are sometimes referred to as cryptocurrencies or crypto assets and are a form of Financial Technology (FinTech) innovation and digital asset that has the potential to disrupt the way financial services currently operate globally (BIS, 2019). These VC's are already having an impact on the worldwide financial systems as a payments system platform and their unique properties make them function as a form of electronic money and forms of digital assets which can be used for payments and investments. They bring about secure, always available, peer-to-peer and decentralized payment methods that have some distinct advantages over the traditional methods of payments (Auer, Raphael; Böhme, Rainer, 2021). According to the financial stability board, FinTech is defined as the financial technology that is applied to financial services, resulting in new business models, applications, processes, products and services with an associated disruptive effect on financial markets and institutions (FSB, 2019). This definition emphasizes the focus on technology-driven innovations that could potentially reshape how the financial services industry operates in developing countries and Zambia in particular as it evolves into several platforms as depicted in Figure 1.1. Given the wide range of innovations across financial services, the existing regulatory architecture should be assessed to determine and evaluate the cost of processing currency as a determinant for a CBDC.

These VC's poses a great risk to the money supply and the currency in circulation. There is a problem because these virtual currencies are not recognized as legal tender by the monetary authorities and still not yet legal tender in the country and the Central Bank of Zambia has to date just issued a cautionary statement advising citizens to trade and transact in virtual currencies at their own risk (BOZ, 2018). This problem of virtual assets continues to grow as the assets are actively traded but not issued by the monetary authority, not regulated and supervised and are obtained by mining, peer-to-peer exchange which is a process by which new virtual currencies are entered into circulation using high end computing resources. This problem distorts monetary policies, financial stability and money supply losing kwacha to virtual currencies and risk of suffocating of the kwacha by growing illegal market which also poses the risk of money laundering and terrorism financing. This problem can be addressed by adopting some form of centralized currency in form of a CBDC that will deal with the risk of suffocating the kwacha and could facilitate instant, inclusive, interoperable and secure and trusted payment platforms that will be regulated, supervised and monitored (FSB, 2020). Figure 1.1 below shows the growing landscape of financial technologies in Zambia including virtual platforms.

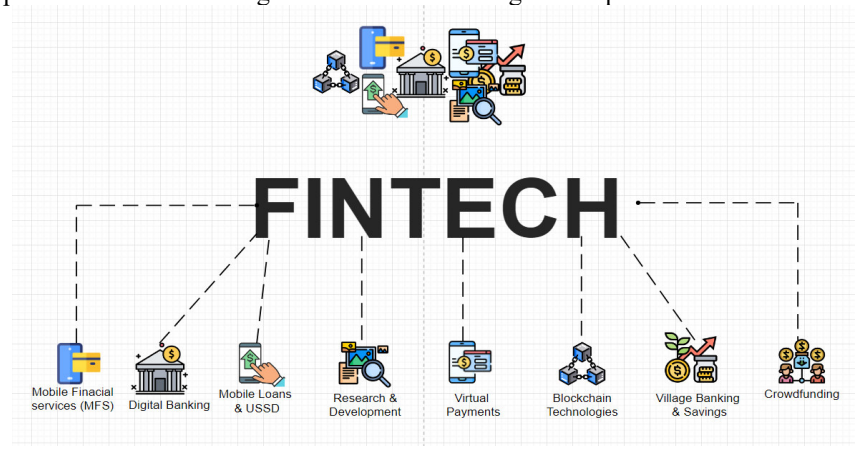

Figure 1.0: Zambia's Financial Technologies Ecosystem 2021 (Source: Authors Construct)

2.1 Zambian Virtual Currency Landscape

Evidence from global cryptocurrency platforms (ChainAlysis, 2021) shows that there is a lot of virtual currencies trading and activity going on in the SADC region, particularly Zambia and citizens are currently trading in these virtual currencies peer-to-peer using several online platforms such as https://paxful.com/ https://www.remitano.com, https://www.coinmama.com, https://www.localbitcoins.com and many other available global online platforms according to (CryptoCompare, 2021). Regrettably, the illiteracy surrounding the virtual currency is not just affecting the general public because it also affects those who are assigned with the responsibility of regulating the financial services landscape and those fighting cybercrime which may have its origins in the use or misapplication of virtual currencies. The regulators are currently playing catch up and only issuing cautioning statements to the citizens on the risks of using virtual currencies instead of exploring through research and development in order to get the most out of this technology. The digital financial services DFS and the specific virtual currency platforms form part of the overall financial services infrastructure in Zambia which is under the regulation of the ICT and telecommunications regulator called Zambia Information and Communications Authority (ZICTA). The communications platforms are composed of the terrestrial networks owned by Internet Service Providers (ISP's) and connect base stations and communications towers in different locations around the country. This is an essential and fundamental underlying infrastructure that facilitates and allows for the use of virtual assets or currencies as a medium of exchange.

2.2 Cost of Processing Currency and CBDC Considerations

Literature reviews that according to the report by the Bank for international settlements (Boar, Codruta; Wehrli, Andreas, 2021), almost 86% of the Central Banks around the globe surveyed are exploring some work on the motivations, benefits and risks of implementing CBDCs, 60% of central banks are now conducting experiments and proofs-of-concept on CBDCs with an increase of 42% from 2019 and 14% of these central banks are in the process of developing and prototyping stage of CBDCs. The BIS report further reviews that the primary motivations for emerging market and developing economies (EMDEs) for CBDCs are mainly around mitigating the high costs of processing fiat currency, introducing stronger AML/CFT compliance, and increasing financial inclusion, enhancing payment systems efficiency and safety. Other literature (Mohammadreza & Hosseini, 2018), (Brunnermeiera & Niepelt, 2019) reviews that the primary motivations for advanced economies differ from those of developing economies and mainly include advancing the digital economy agenda, promoting cashless societies, increasing payment systems efficiency and safety (BIS, 2020). The BIS study further concludes that

Central Banks representing a fifth of the world's population are likely to issue a retail CBDC in the next three years from the time of this study. The study further goes on to review that CBDCs present an opportunity for central banks in developing and emerging economies to modernize their payment infrastructure and make central bank money available to retail users, taking advantage of advances in technology such as distributed ledger technologies such as blockchain (BIS, 2020). Depending on the design choices, CBDCs have the potential to improve efficiency and the cost of remittances and enhance financial inclusion. However, CBDCs also come with risks if not carefully designed to fit a country's specific needs, CBDCs could result in reputational risks for the central bank.

Other studies on the understanding the cost of handling cash in the developing nations of the Asia Pacific (Wincor, 2018), showed that banks in these emerging markets achieved the highest cost reductions in minimizing the use of cash by adopting financial technologies and digital financial services that use electronic means of exchanging value. For the more mature markets in this region, banks and central banks focus on the cost of holding excess cash mainly through improving their forecasting and planning capabilities and developing a leaner cash supply chain. The study further shows that the reduction of excess cash usage, will soon be the focus of attention of emerging market banks, as increasing pressure on the cost of cash handling due to tougher competition for profit margins and contracting margins is no longer just a characteristic of mature markets anymore but increasingly drives emerging market banks in the morgen digital era. The whitepaper also examines the composition of the costs associated with cash handling, shows key the pinpoints in the cash supply chain and provides retail bankers with ideas how to manage those cost more efficiently. The research brings out the main drivers for improving efficiency in cash handling are to minimize cost and increase security by carefully balance cost savings and control in the development of an integrated cash supply chain. The human capital in terms of labor cost also comes up as the main cost factor in mature markets, as technology, outsourcing and process streamlining have significantly reduced costs such as machine downtime, excess cash, theft and insurance claims. The European payments council in the publication on the improving the efficiency of the handling of cash (EPC, 2019), also points out that emerging markets see the highest cost savings from minimizing the labor cost, particularly in outsourcing cash replenishment and maintenance, while the opportunity to cut cost through minimizing excess cash is not yet seized. EPC further reviews that adequate forecasting is the key to minimizing the excess use of cash but is also the most challenging task, as it is influenced by many other variables. In Zambia, the cost of cash is not very clear, but the preliminary research conducted on the central Banks currency operations reviews several cost centers for cash are always on the rise.

3. Theoretical Model for Cash in Circulation (CIC)

Research by (Keister, Todd; Sanches, Daniel, 2019), reviews that when a digital currency is introduced into this environment, a key issue is the type of setting in which it can be used. Some costs are associated with the fiat currency cycle from the printing of the notes and minting the coins, distribution of the cash, security around the currency distribution in bulletproof armoured vehicles and specialized security cash in transit escort services. The accumulative cost of processing currency in circulation (CiC) also includes the actual cost of printing the currency, currency management and the cost of cash processing machines such as the BPS M7, DLR7000 high-speed banknote processing machine, BPS, C5 and C4 desktop processing machines, glory FS-300 and FS-120 machines, Kisan smart K3 machines and Nota packs. The process also includes the costs associated to currency recycling that makes use of currency shredding machines such as online bracketing (OBS) machines that perform the mutilated and soiled notes management and reissuing back for public circulation. The currency processing cycle is summarized in Figure 2.0 below.

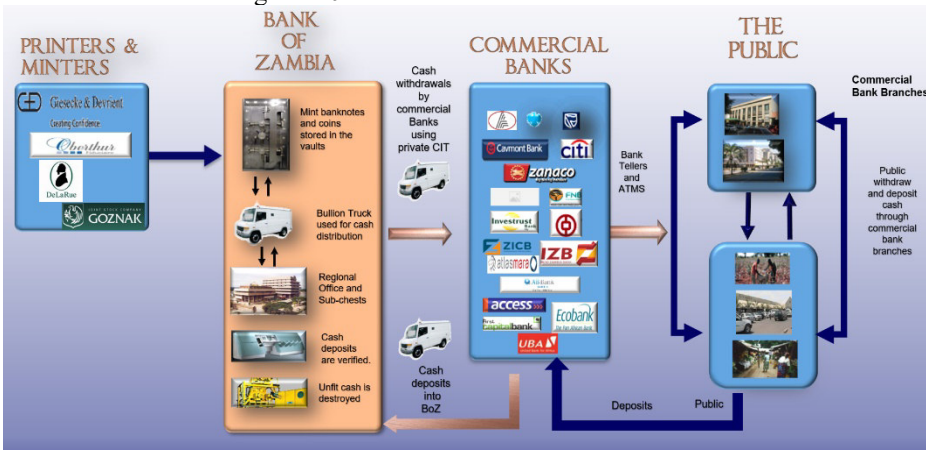

Figure 2.0: Currency Processing Cycle (Source: BoZ)

3.1 Cumulative Cost of Currency

The cumulative cost of cash processing is therefore associated with the simple model (Ramos , Garratt, & Arauz, 2021) that assumes that we let the total cash in circulation (CiC) include all the costs of processing currency and CBDC Ci, where i is accumulative cost = C1,C2,C3…….n, is nth indicator of all the costs associated with cash processing as shown below:

C_1 = Cost of Printing Currency
C_2 = Cost of Currency Management
C_3 = Cost of Currency Recycling
C_4 = Cost of Currency Distribution
C_5 = Cost of Human capital for cash processing
C_6 = Cost of Currency Electronic Management and Security
C_7 = Cost of Currency Shredding machines
C_8 = Cost of Online Bracketing System Process (OBS)
C_9 = Cost of Soiled notes Management and reissuing
C_{10} = Cost of Currency Processing
.
C_n = Other cost of cash processing

3.2 Summary Equation

Equation 1: Cost of Cash Processing

$$^{CBDC}_{tn}CiC = C_1 + C_2 + C_3 + C_4 + C_5 + C_6 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + C_{nt} \quad (10)$$

The outlined cash processing operations and machines need to be purchased, contracted, serviced and maintained for efficient currency processing operations. This is a high cost to Central Banks and estimates from a study by (Ramos , Garratt, & Arauz, 2021) shows the cost being an average of 0.3% of a country's GDP. These costs add up and contribute to the high cost that are associated with processing cash. Research from the Reserve Bank of South Africa (SARB, 2021) also confirms the estimates that the cost of handling currency makes up about 0.3% of the total GDP in the country and these costs can be mitigated by issuing a Central Bank Digital Currency and eliminate the high costs of processing currency. Another study by the European Payments Council (EPC) on the social and private costs of retail payment instruments are approximately 0.4% of GDP indicating that due to the high usage of cash, the social cost of cash represents nearly half of the total social costs of all retail payment instruments in Europe (EPC, 2019).

3.3 Analysis and Results

The study's empirical tests commenced with testing for the presence of unit root in all the variables using Augmented Dickey-Fuller test statistic (ADF) tests. The data analysis adopted the ordinary least squares (OLS) as the main type of linear least-squares method for estimating the unknown parameters in the linear equation. The paper employed E-views 12 computer software platform to obtain the results. Before estimating the two-tier model, we run unit root tests with cross-sectional independence for the key variables cash in circulation (CiC), internet penetration (IP), mobile service subscriptions (MS), narrow money (M0, M1), broad money (M2,M3) and the nominal exchange rate (NER) as shown in the EViews output in Table 1.1 below.

Table 1.1: (CiC) at Level with intercept (Source: Authors Construct, EViews Output)

Null Hypothesis: CIC_CASH_IN_CIRCULATION has a unit root
Exogenous: Constant
Lag Length: 12 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.067642	0.9970
Test critical values:	1% level	-3.500669	
	5% level	-2.892200	
	10% level	-2.583192	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CIC_CASH_IN_CIRCULATION)
Method: Least Squares
Date: 06/08/22 Time: 14:31
Sample (adjusted): 2014M02 2021M12
Included observations: 95 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CIC_CASH_IN_CIRCULATION(-1)	0.031291	0.029308	1.067642	0.2889
D(CIC_CASH_IN_CIRCULATION(-1))	-0.066054	0.103016	-0.641198	0.5232
D(CIC_CASH_IN_CIRCULATION(-2))	-0.020970	0.106288	-0.197293	0.8441
D(CIC_CASH_IN_CIRCULATION(-3))	-0.210841	0.108504	-1.943157	0.0555
D(CIC_CASH_IN_CIRCULATION(-4))	-0.280587	0.110866	-2.530871	0.0133
D(CIC_CASH_IN_CIRCULATION(-5))	-0.039348	0.114674	-0.343126	0.7324
D(CIC_CASH_IN_CIRCULATION(-6))	-0.153846	0.111841	-1.375578	0.1727
D(CIC_CASH_IN_CIRCULATION(-7))	-0.098647	0.115857	-0.851457	0.3970
D(CIC_CASH_IN_CIRCULATION(-8))	-0.043926	0.114215	-0.384592	0.7015
D(CIC_CASH_IN_CIRCULATION(-9))	0.062087	0.112112	0.553790	0.5812
D(CIC_CASH_IN_CIRCULATION(-10))	-0.071693	0.110008	-0.651705	0.5164
D(CIC_CASH_IN_CIRCULATION(-11))	-0.081049	0.111891	-0.724357	0.4709
D(CIC_CASH_IN_CIRCULATION(-12))	0.812725	0.114742	7.083036	0.0000
C	-98311.94	159948.6	-0.614647	0.5405

R-squared	0.520530	Mean dependent var	92502.80
Adjusted R-squared	0.443578	S.D. dependent var	477075.2
S.E. of regression	355867.9	Akaike info criterion	28.53782
Sum squared resid	1.03E+13	Schwarz criterion	28.91418
Log likelihood	-1341.546	Hannan-Quinn criter.	28.68989
F-statistic	6.764360	Durbin-Watson stat	1.977180
Prob(F-statistic)	0.000000		

The statistical results are obtained and presented in Table above and using the cash in circulation ($^{CBDC}_{tn}CiC$) as the dependent variable, the coefficient for internet penetration ($\sum_{eff} CBDC$,IP) is equal to 1.067642 testing at critical values of 1%, 5% and 10% levels. The relationship between CBDC and the high cost of processing currency was found to be insignificant, and this was partially due to the fact that the two-tier CBDC model used was a hybrid model and assumed that CBDC would be used in parallel with fiat currency and all the requirements of processing currency remained unchanged.

4. Conclusion

The study results concluded that the CBDC should aim to interoperate with other already existing fiat and electronic payment system platforms such as mobile financial services. The main determinates of issuing CBDC should be driven by the need for stronger national defense against AML/CFT, nondiscriminatory access to domestic financial services and for the CBDC to mitigate the high cost of processing cash. The research further

showed that a decision to issue CBDC could depend on the determinants explored in this study including mitigating the cost of currency. The results showed that CiC (cash in circulation) variable with the captured at level with intercept is nonstationary and insignificant. The relationship between CBDC and the high cost of processing currency was found to be insignificant and this was partially due to the fact that the two-tier CBDC model used was a hybrid model and assumed that CBDC would be used in parallel with fiat currency and all the requirements of processing currency remained unchanged.

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