



Abiodun Popoola

Department of Economics
Faculty of Social Sciences
Ahmadu Bello University, Zaria, Nigeria
micabipopo@gmail.com

Effects of central bank financial strength on policy outcomes – a study of selected African countries

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Abstract

Aim/purpose – The purpose of this paper is to investigate the relationship between financial strength and policy outcomes of central banks in Africa. This is against the background of challenging policy tasks facing African central banks and the fact that they increasingly have to respond to occurrences that stem from the volatile global financial system.

Design/methodology/approach – Three panel regression models were developed and estimated to capture the effects of the financial strength of the central banks of ten selected countries on their inflation outcomes, official exchange rate, and interest rate. Annual data derived from the balance sheets of ten African central banks as well as macroeconomic variables from World Development Indicators for the period 2000-2014 were used for the empirical analysis.

Findings – This study found out that: central bank financial strength is not a significant determinant of inflation outcomes in African countries; central bank financial strength has a significant impact on the determination of official exchange rate in Africa; and central bank financial strength is not a significant factor in the determination of interest rates by central banks in Africa.

Research implications/limitations – A major implication is that central bank financial strength is necessary for result-oriented exchange rate policy in African countries. However, studies employing other estimation methods may make for more robust results. Also, the inclusion of central banks that report the results of their operations in other languages apart from English may make for better generalization.

Originality/value/contribution – This study is unique in that it has focused exclusively on central banks of countries in Africa. It has also added value by considering the effect of central bank financial strength not only on inflation, but also on exchange rate and interest rate which are issues of serious concern in developing countries.

Keywords: central bank financial strength, policy, inflation, exchange rate, interest rate.

JEL Classification: E52, E58.

1. Introduction

Countries that are externally exposed to financial flows are most vulnerable to contagion effects. Such countries tend to have liberal exchange rate regimes and undeveloped or developing asset markets. The central banks of such nations which include all countries in Africa tend to have serious challenges as their central banks face great risks to solvency, effectiveness of monetary policy, financial system stability, and macroeconomic stability particularly because of the liberalization of their capital accounts. The need for adequate financial strength of such central banks can therefore not be overemphasized.

The link between the financial strength of a central bank and its ability to fulfil its mandate, that is, implementing effective monetary policy, responding to systemic/global crises, and aiding economic growth, is well documented in studies like Ize (2005, 2006), Klüh & Stella (2008), Kurihara (2012), Lonnberg & Stella (2008), Pajdo (2017), Pinter (2015), and Stella (2002, 2008), among others. Such literature have shown that whenever a central bank transacts with the rest of the world through issues of currency, foreign exchange operations, investment of funds, engagement as lenders of last resort/undertaking financial system bailouts, and outright monetary policy operations, its balance sheet is affected.

Klüh & Stella (2008) assert that the importance of central bank financial strength for policy outcomes increases exponentially as the financial strength of a central bank becomes weaker or its policy commitments become more obvious. More generally, the financial strength of an independent and credible central bank must be commensurate with its policy tasks and the risks it faces. Several other studies, including Chantapacdepong, Chutasripanich, & Jindarak (2012), Ize (2005, 2006), Perera, Ralston, & Wickramanayake (2013) and Stella (2008) have also sought to establish if the balance sheet position of a central bank is an important factor determining policy outcomes.

Central banks conduct monetary policies by being involved in markets and, ultimately, moving them. Such policies sometimes result in large price fluctuations and huge volumes of transactions with consequent side effects that are so large such that the affected market(s) cannot be returned easily to its usual status (Kurihara, 2017). Around August 2007, the malfunctions of financial markets worldwide became obvious. The insolvency of financial institutions threatened the global financial system to such a degree that central banks responded using non-traditional tools which altered the structure and strength of their balance sheets.

There is no gainsaying the fact that central banks in Africa have policy tasks that are, to say the least, very challenging. The first issue is that of national development for which, in most of the countries, central banks play an obviously important role. Also, the relatively undeveloped nature of the financial markets makes monetary policy operations not to go along a smooth curve. The matter of globalization of financial systems compels the central banks to watch the capital and current accounts closely almost on daily basis as these have a strong impact on the exchange rate and, consequently and directly, on their economies.

Added to all these is the fact that the global financial system is itself subject to vagaries that do result in financial and currency crises with attendant consequences on other nations far and near. An example is the global financial crises of 2008/2009 that began as a seemingly simple issue in the sub-prime market of the United States. The repercussions from that single faraway market had significant influences on the financial systems of both developed and developing countries with countries in Africa not being exempted.

The issues highlighted from two previous studies in this area combine to form a major motivation for this study. First is Mohan & Kapur (2014) which sought to determine the effect of advanced economies central banks' actions on emerging economies and assess the scope and feasibility for international monetary coordination. A result of that study is that emerging market economies were negatively affected by the actions of central banks of advanced economies. The other is the observation by Swiston, Frantischek, Gajdeczka, & Herman (2014) that the relationship between central bank financial strength and policy may differ across countries based not just on quantitative indicators but as well on accounting standards, expectations of the financial position in the future, and institutional factors. Then, it has become necessary to begin to focus on the financial strength of the central banks of African countries in order to ensure that they are strong enough to conduct effective monetary policy and to deal with the challenges of future episodes of financial crisis.

This study seeks to fill two major gaps. Firstly, compared to other regions, very few studies on central banks financial strength have been done using only African countries as the sample size. While some of the previous studies included some African countries in their samples, no part of their estimations was done exclusively on the central banks of African countries. Central banks of countries in Africa are the focus of this paper. Secondly, studies being carried out in this area regard inflation only as the outcome of monetary policy and, consequently, the effect or otherwise of central bank financial strength in the determination of this outcome. In this study, however, the consideration is not limited to inflation. Rather, the effects of central bank financial strength on the determination of the official exchange rate and interest rate are also considered. The latter two are serious economic issues in African countries.

The direction of this paper is to ascertain the financial strength of the selected central banks and determine how the financial strength has impacted on their policy achievement over the period 2000-2014. It is expected that the outcomes of the study will be useful in ensuring the effectiveness of macroeconomic stability, financial system stability and a stable payments system. The study may also help to give prominence to the issue of whether or not balance sheet positions of central banks are key to more effective monetary policy in Africa.

Aside this introduction, the paper sets out, in the next section a review of related literature conceptually, theoretically and empirically. Section 3 contains the methodology of the work and discusses, among other things the data and data sources, the models estimated, and the means of interpreting the models. Section 4 shows the findings of the study by outlining the results while section 5 discusses the results from the models and the implications. Section 6 contains the conclusion of the study and spells out the implications, the contribution as well as the limitations of this study.

2. Literature review

2.1. Conceptual literature

Generally, the operations of a central bank would involve the central bank performing the functions of: issuance of legal tender currency, maintenance of external reserves to safeguard the international value of the local currency, promotion and maintenance of monetary stability and a sound and efficient financial system, acting as banker and financial adviser to the government, and acting as

lender of last resort to banks. These functions make it necessary for a central bank in itself to be strong financially (Archer & Moser-Boehm, 2013). Stella (2008) clarifies that a central bank is financially strong when it is relatively unconstrained and weak when financial constraints are binding on policy choices.

Ize (2005, 2006) conceptualizes central bank financial strength as an expression for central bank's net worth and its relation to inflation outcomes. From these studies, the stronger a central bank is, the lower will be the foreign liabilities and net claims on government and the higher will be its capital as well as its claims on banks. Thus, it becomes imperative for central banks that are not strong not only to have in hand international reserves that are equal to (or nearly equal to) that of strong central banks but, in addition, they have to provide more financing to governments. This holds despite the fact that they have less capital and are not as profitable.

One of the ways of financing the higher claims by such banks is that they acquire foreign debt. Stella (2008), however, opines that this pattern of asset accumulation can undermine the credibility of monetary policy. According to the author, unless monetary policy is loosened, negative structural profits can lead to progressive loss of capital as well as increasing debt sustainability problems. This will be so, particularly, if a substantial fraction of claims on government are nonperforming or yield below-market returns. From Stella (2005, 2008), financial strength of a central bank can be defined as the sum of Capital and Other Items Net (OIN) relative to total assets. When this concept is adopted, 'weak' central banks would be those for which this measure of financial strength is negative, while the central banks for which this measure is positive territory would be regarded as 'strong'.

Klüh & Stella (2008) also clarify that the approach adopted by Ize (2005) suggests using a stock measure of central bank capital and controlling for elements of the central bank's objective function including exchange rate-related issues. To the authors, accounting capital is a very imperfect proxy for net worth because implicit liabilities and assets are not recorded in typical accounting frameworks, even though they might be much higher than accounting items. Moreover, according to them, evidence suggests that, even if appropriately measured, a stock concept might not fully capture the indication of central bank financial strength. In particular, it is not unlikely that transitory profitability problems also impact a central bank's approach to macroeconomic stabilization.

Klüh & Stella (2008) went on to present the following conceptualizations of central bank financial strength:

- (i) Net worth of central banks (a stock measure). This follows Stella (2008) and is calculated the sum of central bank capital (CBC) and other items net (OIN) divided by total assets.
- (ii) Profitability – this is a flow concept and refers to the Return on Average Assets in a year. By this, the authors confirm that though profit is not a motive of central banking, the financial strength of a central bank may be measured by its profits.
- (iii) For a set of countries which made profits and losses in different years, central bank profits and losses are expressed as a percentage of GDP for the respective years.
- (iv) Accumulated losses over a specified period of time – this is scaled by the gross domestic product of the country.

The stock measure of Stella (2005, 2008) and Klüh & Stella (2008) seems to be the dominant measure of central bank financial strength. This has been used in several studies including Benecká, Holub, Kadlčáková, & Kubicová (2012), Perera et al. (2013), and Swiston et al. (2014). This measurement of Klüh & Stella (2008) is the approach adopted in this study.

2.2. Theoretical literature

Profitability and market capitalization are not primary considerations for a central bank (Stella, 2008). This is so as in view of the specific legal statutes creating it, the performance of a central bank is assessed fundamentally on how well the institution meets the objectives stated in its mandate. Thus, of primary importance is how a central bank effectively guides macroeconomic conditions by creating conditions in the rest of the economy that are conducive to the central bank's objectives of economic growth, price stability, and financial stability. From Mester (2003), a secondary consideration is how efficiently the central bank achieves these 'outputs'; that is, the internal efficiency with which it minimizes the cost of attaining its objectives.

Cukierman (2013) observes that up to the eruption of the US subprime crisis in 2008, conventional wisdom concerning monetary policy was that: the (real) interest rate is the main policy instrument and a sufficient statistic for the stance of monetary policy; the central bank should lean against bubbles to the extent that they push actual inflation away from the inflation target; under inflation targeting, financial stability and prudential considerations took a back seat.

An argument of Morahan & Mulder (2013) is that the global financial crisis revived the theory that, during a financial crisis, the central bank has a comparative advantage in swiftly preventing the crisis from becoming a generalized panic that would seriously cripple the financial system. According to the authors, the main reason for this comparative advantage is that financial crises are characterized by sudden huge increases in excess demand for liquidity. Thus, the central bank is the choice institution for satisfying this derived need for liquidity or else the financial system would be disrupted or even outrightly grounded. This follows from the monopoly of the central bank over the creation of high-powered money and explains the actions of the United States central bank, the Federal Reserve when Lehman Brothers collapsed in September 2008.

In exploring precisely whether financial performance and financial strength of the central bank impacts policy performance, authors caution that in a number of countries, the central bank is financially so strong that it is very difficult to imagine it becoming an obstacle to policy and the focus of the public discussion in those countries is squarely on the micro elements of central bank performance. Schwarz, Karakitsos, Merriman, & Studener (2014) argue that if credibility is important for the success of monetary policy, the central bank must be financially strong. The practical implication of this premise is that financially strong central banks should ensure that their strength remains adequate to cope with their policy responsibilities and such risks as are engendered by their operations. This cannot be truer than in Africa where expectations of economic agents and deliberate attacks by speculators notably affect central bank operations. Current examples include the artificial depreciation of the Nigerian Naira in 2016 as well as the fall of the South African Rand in 2017.

Oulidi & Ize (2009) assert that the main difference between the strong and the weak reflects their relationship with their government. While central banks that are strong benefit from well-paying claims on their government, weak central banks are heavily burdened with interest-paying liabilities, including to their own shareholder. In other words, while the strong have a profitable relationship with their shareholder, the weak seem to have been hard pressed to transfer funds to their owner in any way possible. The authors also put it forward that balance sheet volatility is a good predictor of profitability. This suggests that the more active a central bank is, the higher its exposure to extraordinary gains or losses. The same is true of central banks that operate in more turbulent macro-economic environments such as developing economies.

Perera et al. (2013) suggest that policy makers should be aware that it is essential to maintain the financial health of the central bank balance sheet conducive to long run price stability. In this wise, their economic auditors should in turn utilize risk-based models to ascertain whether in most circumstances the central bank can survive adverse events without the need to abandon its objectives. The need for this in Africa is obvious as the past global financial crisis resulted in high volatility of monetary policy practices and recent country experiences show that lack of strength of the central bank can lead to rapid deterioration of production and consumption.

2.3. Empirical literature

In the attempt to determine the effects of financial strength of African central banks on inflation outcomes, official exchange rate determination and interest rate determination, this paper has considered and seeks to build on several works some of which are mentioned hereunder. Klüh & Stella (2008) employed not one but four different sets of information in their conceptualization of central bank financial strength before carrying out their regressions. In order to evaluate the impact of central bank financial strength on macroeconomic outcomes, they focused on regressions with a measure of price stability as the dependent variable. In a first step, they employed a panel data set for Latin America and the Caribbean spanning from 1987 to 2005, and included 15 countries. In a second step, they turned to a large cross-section of about 100 countries (all countries for which information on CPI inflation is available in International Financial Statistics). For the dependent variable, they used data from the IFS database to calculate CPI inflation rates for the period 1987 to 2005. The result of their study is a relatively stable and negative relationship between central bank financial strength and inflation.

Similar to Klüh & Stella (2008), Benecká et al. (2012) focused their econometric analysis on the link between central bank financial strength and inflation and employed the stock measure of financial strength which is

$$CBFS_{1t} = \frac{CBC_t + OIN_t}{TA_t}$$

However, their analysis differs from Klüh & Stella's in two important respects. First, they used a broader and more recent panel data sample covering 105 countries worldwide between 2002 and 2009. Second, in some of their estimates, they ex-

explored whether the strength of the relationship between central bank finances and inflation outcomes depends on the degree of legal central bank independence. This implies that, possibly with a high degree of independence, a central bank may be less exposed to the political-economy aspects of its financial situation.

Benecká et al. (2012) also employed the stock measure of financial strength and found a statistically significant negative relationship between some measures of central bank financial strength and inflation in a few regressions. In particular, no financial strength indicator maintains a significantly negative coefficient across all econometric methods. At the same time, their recursive estimations confirm the findings of Klüh and Stella (2008) concerning non-linearity of the relationship. Their instruments of estimation were, first, the Ordinary Least Square and, then, the Generalized Method of Moments.

Chantapacdepong et al. (2012) aimed to explore the effect of central bank balance sheet on policy implications through principle, country case studies and statistical relationship. Their main findings suggest that the erosion of central bank capital does not directly affect the policy effectiveness. The findings also suggest that policy should not conflict with the core mandate of the central bank, for instance, the policy rate reduction below the appropriate level of the economy, or else it could affect central bank credibility and economic stability.

In the same wise, Perera et al. (2013) sought to provide empirical evidence towards establishing a robust relationship between central bank financial strength and the central bank's key policy outcome variable, inflation. By mainly using the dynamic panel data system GMM estimator on a sample of selected advanced and emerging countries, they found that greater central bank financial strength tends to generate low inflation rates and hence concluded that financial strength of a central bank is vital to maintaining price stability.

Finally, Swiston et al. (2014) examined the financial strength of central banks in Central America and the Dominican Republic. By the use of inferential statistics, the authors report that some of the central banks are working off the effects of intervention in distressed financial institutions during the 1990's and early 2000's as their net income has improved since then owing to lower interest rates, a reduction in interest-bearing debt, and recapitalization transfers. Also, claims on the government have fallen, but remain high and are typically reimbursed at below-market rates, and capital is negative when adjusting for this while their capital is sufficient to back a low inflation target given that the income position is supported by unremunerated reserve requirements.

3. Research methodology

3.1. Population and sample

Annual data for a group of central banks in Africa were used for the empirical analysis. The population of the study is the 42 central banks in Africa. Out of this number, a sample of ten central banks was drawn using the multi-stage sampling technique. In the first stage, the 42 central banks were stratified into two groups. Stratification was done based on English-reporting and other-language-reporting. The study essentially is on central banks that report their financial operations in English.

From the English-reporting central banks, the study came up with a sample of ten and this was based on availability of their financial reports for the period 2000-2014. The financial statements of some of the English-reporting central banks like Liberia and Zimbabwe are not available for large parts of the period of study. For Egypt, the financial statements of the central banks are not prepared separately, but form part of the consolidated public accounts. Thus, the selected central banks are those of Botswana, Ghana, Kenya, Malawi, Mauritius, Namibia, Nigeria, South Africa, Uganda, and Zambia.

Another reason for basing the sample on the mentioned countries is that all the central banks chosen use basically the same principles in preparing their balance sheets as well as income statements. This makes for good comparison of the data. Finally, the financial statements of the central banks in the sample are available and are largely consistent as regards the accounting policies. Thus, the study used a balanced panel of data for the analysis.

3.2. Variables and models

To determine the financial strength of the central banks in the sample, the stock measure of central bank financial strength as advanced by Klüh & Stella (2008) and which has been subsequently adopted other studies like Benecka et al. (2012), Perera et al. (2013) and Swiston et al. (2014) was used. Thus, central bank financial strength (CBFS) was calculated as the sum of central bank capital (CBC) and other items net (OIN) divided by Total Assets

$$CBFS_{jt} = \frac{CBC_{jt} + OIN_{jt}}{TA_{jt}}$$

The objective of establishing the impact of the financial strength of the central banks on their policy tasks involves the task of empirically assessing the relationship between central bank financial strength and inflation, exchange rate, and interest rate. For this objective, three general models are utilized in this paper.

In the first model, the dependent variable is the natural logarithm of annual inflation rate. The official exchange rate and the monetary policy rate are the dependent variables of the second and third models, respectively.

The key variable of interest is central bank financial strength but a set of additional explanatory variables was selected from prior theoretical and empirical studies that centered on the examination of inflation, exchange rate and interest rate and their determinants. Perera et al. (2013) advise that it is appropriate that the number of explanatory variables chosen for the empirical models be not large. This advice was taken in order to avoid the problem of multicollinearity and also to keep the models parsimonious.

Accordingly, the empirical models used in this study for the establishment of the nexus between central bank financial strength and policy outcomes are as follows:

$$\text{INF}_{jt} = \beta_0 + \beta_1 \text{INF}_{jt-1} + \beta_2 \text{CBFS}_{jt-1} + \beta_3 \text{RPCI}_{jt-1} + \beta_4 \text{ICOP}_{jt-1} + \beta_5 \text{BMG}_{jt-1} + \beta_6 \text{CBI}_{jt-1} + \Psi_{it} \quad (1)$$

where:

INF_{jt} – the inflation outcome of the j^{th} central bank in period t ,
 INF_{jt-1} – the inflation outcome of the j^{th} central bank in period $t-1$,
 CBFS_{jt-1} – central bank financial strength of the j^{th} central bank in period $t-1$,
 RPCI_{jt-1} – real per capita income of the j^{th} country in period $t-1$,
 ICOP_{jt-1} – international crude oil price in period $t-1$,
 BMG_{jt-1} – broad money growth of the j^{th} country in period $t-1$,
 CBI_{jt-1} – central bank independence of the j^{th} country in period $t-1$,
 Ψ_{it} – composite error term.

$$\text{ExR}_{jt} = \beta_0 + \beta_1 \text{ExR}_{jt-1} + \beta_2 \text{CBFS}_{jt-1} + \beta_3 \text{ICOP}_{jt-1} + \beta_4 \text{BMG}_{jt-1} + \beta_5 \text{Inf}_{jt-1} + \beta_6 \text{CBI}_{jt-1} + \beta_7 \text{CAB}_{jt-1} + \Psi_{it} \quad (2)$$

where:

ExR_{jt} – the official exchange rate of the j^{th} central bank in period t ,
 ExR_{jt-1} – the official exchange rate of the j^{th} central bank in period $t-1$,
 CBFS_{jt-1} – central bank financial strength of the j^{th} central bank in period $t-1$,
 RPCI_{jt-1} – real per capita income of the j^{th} country in period $t-1$,
 ICOP_{jt-1} – international crude oil price in period $t-1$,

BMG_{jt-1} – broad money growth of the j^{th} country in period $t-1$,
 CBI_{jt-1} – central bank independence of the j^{th} country in period $t-1$,
 CAB_{jt-1} – current account balance of the j^{th} country in period $t-1$,
 Ψ_{it} – composite error term.

$$\text{IntR}_{jt} = \beta_0 + \beta_1 \text{IntR}_{jt-1} + \beta_2 \text{Inf}_{jt-1} + \beta_3 \text{ExR}_{jt-1} + \beta_4 \text{CBFS}_{jt-1} + \beta_5 \text{BMG}_{jt-1} + \beta_6 \text{CBI}_{jt-1} + \Psi_{it} \quad (3)$$

where:

IntR_{jt} – the official interest rate determined by the j^{th} central bank in period t ,
 IntR_{jt-1} – the official interest rate determined by the j^{th} central bank in period $t-1$,
 INF_{jt-1} – the inflation outcome of the j^{th} central bank in period $t-1$,
 ExR_{jt-1} – the official exchange rate of the j^{th} central bank in period $t-1$,
 CBFS_{jt-1} – central bank financial strength of the j^{th} central bank in period $t-1$,
 BMG_{jt-1} – broad money growth of the j^{th} country in period $t-1$,
 CBI_{jt-1} – central bank independence of the j^{th} country in period $t-1$,
 Ψ_{it} – composite error term.

The lagged explanatory variables were included so as to ensure consistent and robust results that which are corrected for endogeneity. This was the approach adopted in Benecka et al. (2012) as well as Perera et al. (2013).

3.3. Methods of estimation

The estimation of the econometric model is based on panel data. Panel data is a data set in which the behavior of variables is observed across time. For the panel data analysis, three techniques are used. The study used pooled Ordinary Least Squares (OLS), the Fixed Effects Method (FEM) and the Random Effects Method (REM). Pooled OLS consists of grouping the data altogether and running the regression. Fixed effects technique, however, considers the link between the predictor and the outcome variables within an entity such as country. On the other hand, the basis of the random effects model is that the variation across entities is assumed to be arbitrary and not correlated with the regressors in the model.

After the OLS, fixed effects, and random effects regressions, the Hausman specification test was performed to determine which of fixed and random effects would depict more robust results. The Hausman specification test was done with the null hypothesis that there is no significant difference between the estimators

of the FEM and estimators of the REM. The decision rule is that fixed effects should be used if the probability of the computation is significant.

Before the regression, however, the descriptive statistics and the correlation matrix of the dependent variable as well as the independent variables were first examined. Next, the Variance Inflation Factor (VIF) of the variables was computed. This is a way to check for multi-collinearity among the variables. An average VIF of more than 10 would indicate multi-collinearity which would lead to biased regression results.

3.4. Description of and sources of data

Data for the study were, basically, the figures from the balance sheets and the income statements of the ten central banks in the sample the period 2000-2014. The annual reports were retrieved from the websites of the selected central banks. In addition to this, some macroeconomic data and the measure of the independence of the central bank for each of the countries were also used for the regression models. The data and sources are spelt out in Table 1.

Table 1. Types, measurement and sources of data used

Type of data	Measurement	Source of the data
Central bank financial strength	Central bank capital plus other items net divided by total assets	Annual reports of the sampled central banks
Inflation	Rise in the consumer price index	World Development Indicators*
Exchange rate	Official exchange rate	World Development Indicators
Interest rate	The real interest rate	World Development Indicators
Real per capita income	GDP per capita (constant 2010 US\$)	World Development Indicators
International crude oil price	Average annual OPEC price	www.statista.com
Broad money growth	Annual % of money growth	World Development Indicators
Current account balance	Current account balance as % of GDP	World Development Indicators
Central bank independence	Several measures having to do with governance in each central bank and the level of government intervention.	Dincer & Eichengreen (2014)

* The World Bank (2016).

Source: Author's compilation.

4. Research findings/results

This section presents the results of the study. The purpose of this paper being the investigation of the relationship between central bank financial strength and policy performance of central banks in Africa, the computations as regards financial strength and inflation are first presented to check the importance of this variable for the achievement of price stability. For convenience, the period of study is stratified into three, 2000-2006, 2007-2010, and 2011-2014 and the means of the different periods presented in tables 2 and 3 together with the mean for the entire period.

4.1. Analysis of the absolute and relative financial strength

The financial strength of the central banks in the sample was calculated as the sum of central bank capital (CBC) and other items net (OIN) all divided by total assets (TA). A score of at least 0.2 would suggest a strong central bank and imply that at least 20% of the assets of such a central bank are financed by its capital. The absolute and relative scores of the financial strength of the sampled central banks for the period of study are presented in the table below.

Table 2. Summary of the central bank financial strength scores for the sample

Countries	Mean CBFS 2000-2006	Mean CBFS 2007-2009	Mean CBFS 2010-2014	Mean CBFS 2000-2014
Botswana	0.55	0.65	0.61	0.59
Ghana	0.06	0.12	0.16	0.11
Kenya	0.08	0.06	0.13	0.09
Malawi	0.06	0.10	0.19	0.11
Mauritius	0.36	0.41	0.34	0.36
Namibia	0.24	0.19	0.12	0.19
Nigeria	0.15	0.07	0.15	0.14
S/Africa	0.08	0.04	0.08	0.07
Uganda	0.11	0.12	0.14	0.12
Zambia	0.04	0.07	0.11	0.07

Source: Author's computation.

The central bank financial strength scores shown in Table 2 above were computed from the figures reported by the central banks in their annual financial statements. Using this basis of at least 0.2, it is shown by Table 2 that, generally, the sampled central banks are not financially strong. This is because only two of the sampled central banks (Botswana and Mauritius) met the 0.2 benchmark and this they did for all the years under study.

4.2. Analysis of the inflation outcomes of the sampled countries

Table 3 below shows the policy performance in terms of inflation outcomes for the countries in the sample for the period. From the table, central banks of the countries in the sample, despite that 80% of them are not financially strong, have achieved commendable performances in terms of inflation outcomes. The basis for this claim is the inflationary outcomes that are surprisingly very low. This applies to the time before, during and after the financial crisis.

Table 3. Summary of the inflation figures for the sample

Countries	Mean inflation (%) 2000-2006	Mean inflation (%) 2007-2009	Mean inflation (%) 2010-2014	Mean inflation (%) 2000-2014
Botswana	8.50	9.30	6.58	8.02
Ghana	19.7	15.50	11.14	16.02
Kenya	9.14	15.06	8.0	9.95
Malawi	16.8	8.37	17.60	15.37
Mauritius	5.40	7.00	4.12	5.68
Namibia	6.00	8.60	5.40	6.34
Nigeria	11.1	9.50	10.66	10.63
S/Africa	5.07	8.57	5.42	5.89
Uganda	4.81	10.40	9.36	7.45
Zambia	14.49	12.17	7.26	13.95

Source: Author's computation.

The above central bank inflation outcomes were computed from the figures for each of the countries provided by World Development Indicators.

From Table 3 above, the countries with the highest average inflation figures over the study period are Ghana and Malawi 16.02% and 15.37%, respectively, while the 15-year average for the entire sample was 9.93%. This is well below the findings of Stella (2008) which showed an average inflation of 23.8% for financially weak central banks and 11.2% for financially strong central banks. This calls to question the need of central bank financial strength to achieve low inflationary outcomes for African countries.

4.3. Relationship between central bank financial strength and policy performance

In this subsection, the results of the panel regression to evaluate the effects of the financial strength of the central banks in the sample on their monetary policy performance are considered. Policy performance is taken as inflation outcomes for each year. This is the norm in central bank literature as it is believed that the primary objective of a central bank is price stability. This study, however, also considers the impact of central bank financial strength on the official exchange rate and the interest rate of the respective countries for the study period. Panel regression results are presented for the three models specified in the methodology.

Apart from the variance inflation factor, correlation analysis was also carried out to observe association between key variables. Strong correlations between the explanatory variables would suggest the problem of multi-collinearity. In all the models, the correlation matrix for the variables in the model indicates that there are no strong correlations among the explanatory variables.

For the first regression, the signs of the correlation coefficients for inflation and the other determinants of inflation are observed to be compliant with a priori expectation. While there is negative correlation between real per capita income (RPCI) and inflation, positive correlation coefficients between international crude oil price (ICOP) and inflation, broad money growth (BMG) and inflation, as well as central bank independence (CBI) and inflation are observed. Normally, a positive correlation would exist between inflation in a certain year and its lagged value. This is also the observation of this study as inflation is positively correlated with previous year's inflation (INF_{t-1}). There is also as expected a negative correlation between central bank financial strength and inflation.

The results of the Hausman specification test for the models shows that the regression results of the Random Effects Model is the appropriate one to be interpreted. The summary of the random effects results is presented in Table 4 below.

Table 4. Extract from the results of the panel regression for central bank financial strength and inflation

Variable	Coefficient	z-score	Probability of z
INF_{t-1}	0.3939668	5.25	0.0000
CBFS	-0.0815407	-1.54	0.124
BMG	0.2554384	4.07	0.0000
CBI	0.3361607	2.28	0.023
ICOP	-0.008255	-0.12	0.904
RPCI	0.0052885	0.09	0.929
Constant	0.3204731	1.23	0.219
R-Squared 0.4263			

Source: Author's compilation from estimation results of Model 1.

Table 4 above was constructed as a summary of the panel regression results. It shows the coefficients of the explanatory variables in relation to inflation with central bank financial strength being the explanatory variable of major interest.

The next regression deals with the assessment of the significance of central bank financial strength on the official exchange rate determined of the countries in the sample. Table 5 below summarizes the regression results of CBFS and exchange rate.

Table 5. Extract from the results of the panel regression of central bank financial strength and exchange rate

Variable	Coefficient	z-score	Probability of z
ExR _{t-1}	0.7058274	15.94	0.0000
CBFS	0.0400756	2.37	0.019
ICOP	0.0667936	3.75	0.0000
BMG	0.0067871	0.47	0.638
INF	-0.0062568	-0.37	0.714
CBI	-0.3641271	-2.58	0.011
CAB	-0.0022711	-3.38	0.001
Constant	0.194134	2.22	0.028
R-Squared 0.9875			

Source: Author's compilation from estimation results of Model 2.

The regression results of the regression to examine the impact of central bank financial strength on the interest rates determined by the central banks in the study period are presented in Table 6.

Table 6. Extract from the results of the panel regression of central bank financial strength and interest rate

Variable	Coefficient	z-score	Probability of z
Int _{t-1}	0.3493217	4.79	0.0000
INF	0.109274	0.95	0.340
ExR	0.0615011	1.96	0.050
CBFS	0.239215	0.34	0.734
BMG	0.2570003	2.71	0.007
CBI	0.1589056	0.82	0.411
Constant	0.1685553	0.89	0.373
R-Squared 0.2643			

Source: Author's compilation from estimation results of Model 3.

5. Discussion

From the regression result in the first model, central bank financial strength, international crude oil price, and real per capita income were found to be insignificant determinants of inflation in the sampled central banks whereas previous year's inflation, central bank independence and broad money growth were significant.

The key implication here is that the policy performance of central banks in African countries (which is proxied as inflation outcomes) has no significant relationship with the financial strength of the central banks. In the same way, the policy performance of central banks in African countries (which is proxied as inflation outcomes) has no significant relationship with the international crude oil price and the real per capita income of the sampled countries. The coefficient, z-score, and 'p' of the constant show that the behavior of the central banks in the sample is largely homogeneous.

A priori, a negative coefficient was expected for central bank financial strength. This expectation was satisfied -0.0815407 was the coefficient of the regression. However, this was found to be insignificant even at 10% going by the probability value of 0.124. From this it can be inferred that, to a large extent, policy performance of central banks of countries in Africa did not depend on their having substantial capital in the study period. This outcome is contrary to the findings of several studies. For instance, Klüh & Stella (2008) and Benecká et al. (2012) focused their econometric analysis on the link between central bank financial strength and inflation and found a statistically significant negative relationship between some measures of central bank financial strength and inflation in a few regressions.

From the second model, the estimation results show that the behavior of the central banks in exchange rate determination is heterogeneous. In other words, country effects and differences significantly influence the determination of the official exchange rate. This is shown by the z-score of 2.22 of the constant term and the probability of 0.028. From the results, the major variable of interest, central bank financial strength, is shown to have a significant impact on the determination of the official exchange rate by the central banks. The result also shows that the official exchange rate of the countries in the sample is significantly affected by the current account balances of the countries, the international crude oil price, how independent the central banks are and the exchange rate in the previous period.

The third panel regression considers the relevance of central bank financial strength in the fixing of interest rate by the central banks. From the results, there is homogeneity in the behavior of the central banks as regards interest rate determination. Here, central bank financial strength is shown not to be a significant factor in the determination of the interest rate by the central banks. Rather, broad money growth, the interest rate for the period, and the exchange rate are the key determinants.

6. Conclusions

6.1. Summary of findings

This study is backed by the argument that developing countries require separate modelling due to their unique and fundamental problems such as weak fiscal and financial institutions, low credibility of monetary institutions, poor record with regard to monetary policy conduct, and vulnerability for shocks in capital flows. Another plausible argument for it is that all the theories that are applied to advanced countries and empirical inferences may not be applicable to emerging countries due to their unique problems. These arguments suggest the need for estimating models separately for developing countries such as was done in this study.

This study found out that central banks of countries in Africa do not have adequate strength financially. This study also concludes that financial strength is not a significant determinant of inflation outcomes in African countries. This conclusion was reached from the results of the computations done by panel regression. However, given their relative lack of financial strength, the common thread is inflation figures that are not high by global comparison.

From the second model, the major variable of interest, central bank financial strength, is shown to have a significant impact on the determination of the official exchange rate by the central banks. This study thereby concludes that central bank financial strength is necessary for result-oriented exchange rate policy in African countries.

The third panel regression model assessed the impact of central bank financial strength on the determination of the interest rate. The major conclusion from the regression output is that central bank financial strength is not a significant factor in the determination of interest rate by central banks in Africa.

6.2. Research contribution

Several studies abound in the area of central bank finance. This study has added to the literature in this area by focusing exclusively on African countries. In another way, the paper is unique for the fact that it has considered not only the effect of central bank financial strength on inflation, but also its effects on exchange rate and interest rate. The latter two are issues of major concern in developing countries.

6.3. Research implication

This study has found out that central bank financial strength is not significantly related to inflation outcomes. Despite the apparent low financial strength of almost all the sampled central banks, the inflation rates are relatively low when compared with global standards. Particularly, Stella (2008) and some other studies shows that high financial strength makes for lower inflation outcome and vice versa. Conversely, this study has shown that central bank financial strength is significantly related to exchange rates.

These results have in no wise negated the importance of previous studies. Rather, it has demonstrated among other things that more research focus be placed on the operations and results of central banks in Africa.

6.4. Research limitations and future works

This study is not without limitation. In methodology, there are several areas for improvement. For instance, out of the 42 central banks in Africa, only 10 were used as the sample of the study. Another issue is the estimation technique. It is possible that studies employing other estimation methods rather than OLS may make for more robust results. In the same vein, including central banks in Africa that report the results of their operations in other languages apart from English is necessary and would make for better generalization.

Thus, the stage is set for future empirical works in this area. But apart from issues of financial strength, there is also need for studies on monetary survey of African countries and their relative importance, the monetary policy practices of central banks in Africa, and the impact of regional leaders' (that is Nigeria, Kenya, Egypt, and South Africa) central banks on the monetary policy practices and outcome of the countries in their sub-regions.

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Data reference

The data for the central bank financial strength were derived from the balance sheets of the central banks which were accessed through the website of each central bank. They are as follows:

- Botswana: www.bankofbotswana.bw
- Ghana: <https://www.bog.gov.gh>
- Kenya: <https://www.centralbank.go.ke>
- Malawi: <https://www.rbm.mw>
- Mauritius: <https://www.bom.mu>

Namibia: <https://www.bon.com.na>
Nigeria: <https://www.cbn.gov.ng>
South Africa: <https://www.resbank.co.za>
Uganda: <https://www.bou.or.ug>
Zambia: <https://www.boz.zm>