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Central bank independence and inflation in Africa: The role of financial systems and institutional quality

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ABSTRACT

The study examines the effects of financial systems and the quality of political institutions on the effectiveness of central bank independence in achieving lower inflation. Drawing from the fiscal theory of price level (FTPL) and political economy of macroeconomic policy (PEMP) literature; we estimate a panel regression model, using Two Stage Least Squares instrumental variables procedure, on a sample of 48 African countries over the period 1970–2012. The study finds that central bank independence-inflation nexus is dependent on the model, sample and estimation technique used. After accounting for various control variables and introducing inflation targeting as an additional explanatory variable, the study shows that, unlike in developed countries, CBI is not sufficient in achieving lower inflation in Africa and the developing world. However, common to developed, developing and African countries, is that, higher central bank independence is more effective in lowering inflation in the presence of high levels of banking sector development and institutional quality. The findings of the study also show that while stock market development enhances the effectiveness of CBI in developed and developing countries, it has no significant effect on CBI effectiveness in Africa.

1. Introduction

Price stability has been an important public policy goal and the independence of the central bank, has been identified by extant literature to be a determinant in achieving lower inflation rate. Central bank independence (henceforth CBI) is the freedom of monetary policymakers from direct political or governmental influence and direction, in the conduct of monetary policy (Walsh, 1995). It is the separation of the authority that prints money (the central banks) from the authority that spends it (the treasury). It is expected that, with this separation of authorities, central banks can focus on achieving price stability. Financial development has also been established to improve monetary policy effectiveness (Krause and Rioja, 2006) through its role in effectively transmitting policy rate changes to the economy and allowing the central bank to better target inflation based on the adequacy of information provided by the financial system as well as the amount of money in the economy, that passes through the financial system. Institutional quality has also been identified as a favourable determinant of inflation performance (Hielscher and Markwardt, 2012) as it ensures that political authorities are held accountable for their actions including the ability to address society's welfare such as having low inflation rates (Rogoff, 1985). While financial development and institutional quality have widely been empirically established to lower inflation, the empirical results for central bank independence and inflation is mixed (Klomp and De Haan, 2010). Particularly while in developed countries, CBI leads to lower inflation, in developing and African countries, studies have not found any relationship between CBI and inflation, except for CBI governor turnover rates in some studies (Cukierman, 2008). Cukierman (1992) in not finding a significant relationship between legal CBI and inflation in developing countries attributed it to wide divergences between actual practice and the law in such economies. This has led others in recent times to argue that, there could be conditions under which CBI leads to lower inflation, and the financial system and institutional quality could be important to the effectiveness of central bank independence in achieving price stability (Posen, 1995; Klomp and De Haan, 2010; Hielscher and Markwardt, 2012). This however, is yet to be fully explored empirically particularly in Africa.

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As shown in Fig. 1, though inflation rates all over the world have been on a decline since the 1970s, there are marked differences in the levels of inflation among developed, developing and African countries, developed countries have had the lowest inflation rates while Africa has had the highest rates of inflation. Reducing inflation is therefore still a top priority for many African governments and policy makers.

Since Cukierman (1992), there have been brisk and significant institutional reforms in African jurisdictions, on improving good governance and sound economic management policies (Crowe and Meade, 2008). These have been fostered by the promotion of regional organisations such as ECOWAS, African Monetary Union (AMU), and South African Development Community (SADC).

Financial development has been established to improve monetary policy effectiveness (Krause and Rioja, 2006). This enables central banks to better target inflation and for policy rate changes to have the maximum effect on credit growth and supply. Particularly, in markets where credit is made to private businesses and households, inflation erodes the value of debt to be repaid and as such the central bank is pressured to ensure that inflation remains low so as to preserve the value of credit given. Low inflation also enables repayment of loans and reduces non-performing loans which can negatively affect the financial system. As such in highly developed financial markets, independent central banks work towards achieving much lower inflation rates since not doing so may widely affect financial systems negatively.

Political stability has also been identified as a favourable determinant of inflation performance (Hielscher and Markwardt, 2012). Posen (1995) also argues that political institutional characteristics such as those reflected in democracy, accountability, rule of law and bureaucratic systems are needed to improve the credibility of the monetary policy regime. There exists evidence on the positive effects of high institutional quality reflected in political stability example democracy, rule of law on maintaining the independence of the central bank and fostering the necessary environment useful for successful and efficient implementation of its price stabilization objective (Hielscher and Markwardt, 2012). Klomp and De Haan (2010) establishes that in transparent governance systems, legal CBI is effective. Central banks' reputation to be independent are enhanced by the quality of political institutions (Hielscher and Markwardt, 2012). This is because, generally, for people to have high confidence in governments' sticking to their decisions and the law, the presence of high quality institutions to hold them accountable is paramount. The quality of institutions relate to the levels of political stability, the rule of law and respect for civil rights which are a reflection of government's willingness and ability to respect the legal provisions made to ensure that central banks remain independent from government interference in the discharge of its duty towards maintaining low levels of inflation. In most democratic jurisdictions, where there is transparency in governance and institutions are left to work, where there is political stability and civil rights are respected, voters can freely express their like or dislike for a government who flouts the laws. This promotes accountability of government and policy-makers.

CBI alone, does not suffice!

Comparatively few attempts have been made to study the extent to which these two can enhance CBI's impact on a country's macroeconomic performance (Hielscher and Markwardt, 2012). This is relevant particularly in the context of most developing countries including sub-saharan Africa, where CBI studies have not empirically established a negative relationship between CBI and macroeconomic performance. The few that have done so have focused on 6, 11, and until recently, 21 African countries found no significant impact of CBI, except in some few cases when the turnover rate of governors are used as proxies for CBI (Presnak, 1996; Wessels, 2006; and Kasseeah et al., 2011). They didn't consider how the effectiveness of CBI in leading to low inflation, can be enhanced by financial systems and institutional quality.

While there exists a wide gap between developed and developing (African) countries in terms of financial development and institutional quality, there have been significant efforts to develop banking, stock and bond markets, improve democracy, good governance, institutional quality and rule of law in Africa in the past two decades. In Fig. 2, we observe that financial development in Africa and developing countries, measured by the ratio of private credit to GDP from 1970 to 2016, is low relative to developed countries.

In Fig. 3, we also observe that developed countries have had higher levels of institutional quality, measured by the rescaled political rights score (from 0 for least ratings and 6 for highest rating) from Freedom House from 1970 to 2016. Africa has had the lowest levels of institutional quality.

So developed countries having high levels of financial development and institutional quality, do also have the lowest inflation rates. Whilst Africa and developing countries, with lower levels of financial development and institutional quality, have higher inflation rates. This could provide explanation for the inability of studies to identify a clear link of CBI on inflation in Africa, and an explanation as to why developed countries have lower inflation rates compared to Africa and developing countries. This study seeks to

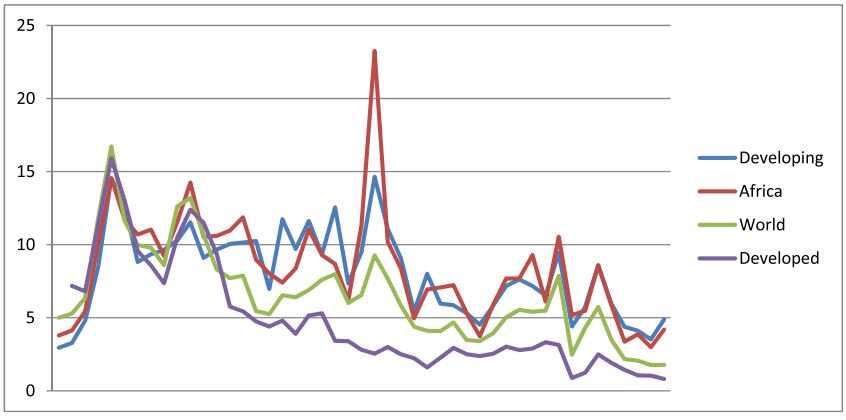

Fig. 1. Inflation.
Source: World Development Indicators (2017).

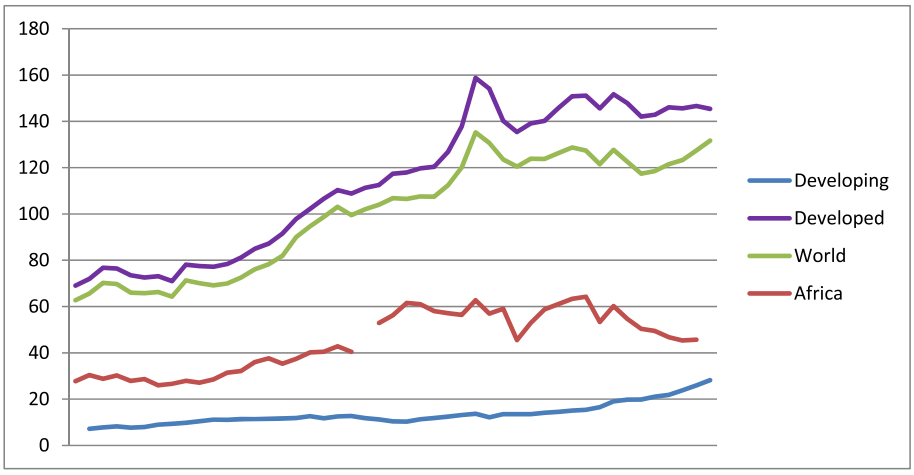

Fig. 2. Financial Development.
Source: World Development Indicators, 2017.

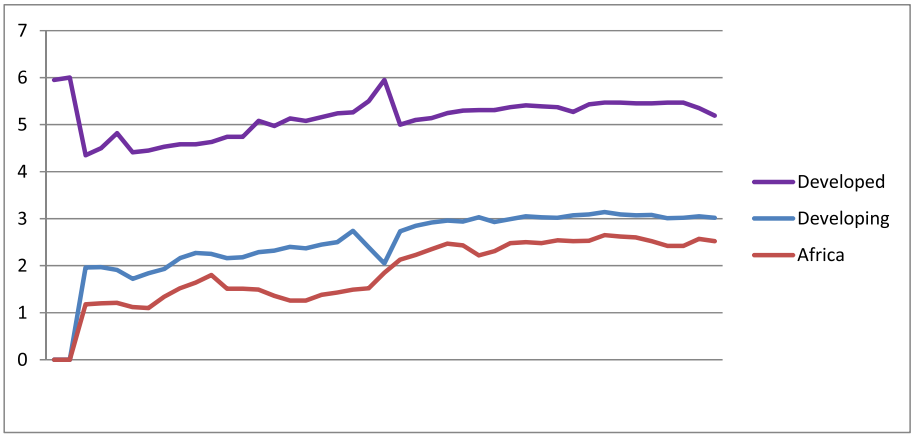

Fig. 3. Institutional Quality.
Source: Freedom House, 2017.

contribute to filling the gap in this regard.

Following from Posen (1993)'s argument for support for CBI, from the financial sector and political institution, it is the objective of this paper therefore, to argue that, the quality of the financial sector as well as political institutions enhance the credibility of the monetary policy framework that an independent central bank functions in. This credibility anchors inflationary expectations, and improves monetary policy coverage and effectiveness, thereby resulting in lower inflation rates.

This paper contributes to literature by seeking to examine the impact of financial systems and the quality of political institutions on the central bank independence - inflation nexus using data spanning, 1970–2012 in 48 African countries which is the largest number of countries to be included in one study on the continent. Secondly, the paper uses the interaction terms between financial development and institutional quality measures and CBI, to explain the differences in outcome from various studies on the central bank independence (CBI) inflation nexus. We examine the findings on the Africa sample, and compare with that of 48 developed and 117 developing economies. The study also compares the relative effectiveness of banking sector development, stock market development and bond market development, on the CBI inflation nexus in Africa, developed and developing countries.

The study after accounting for various control variables and introducing inflation targeting as an additional explanatory variable, shows that, unlike in developed countries, CBI is not sufficient in achieving lower inflation in Africa and the developing world. However, common to developed, developing and African countries, is that, central bank independence is more effective in lowering inflation in the presence of high levels of financial development and institutional quality. In Africa and developing countries, banking sector development is more effective in enhancing CBI's effect on inflation, while in developed countries; stock market development enhances CBI's effectiveness in reducing inflation more than banking sector development.

The rest of the paper is structured as follows. we review extant literature on central bank independence and inflation, as well as financial development and institutions. We then outline our methodology, analyze and present the results and conclude based on our findings.

2. Literature review

2.1. Financial systems, central bank independence and inflation

In the last two decades, many countries have granted their monetary authorities greater independence (Klomp and De Haan, 2010). It is widely believed that central banks otherwise will give

in to pressure from politicians who may be motivated by short-run electoral considerations (Kirchgässner, 1991; 1991). CBI gives credibility to monetary policy in this way. For central bankers who have adopted inflation targeting, the independence to choose a policy goal and/or instrument with which this goal can be achieved is embedded in its independence from government.

Earlier studies primarily identify a negative link between CBI and inflation in developed countries (Grilli et al., 1991; Cukierman, 1992; Alesina and Summers, 1993; Eijffinger and Schaling, 1992). Hillman (1999) argues that the higher the degree of CBI is, the higher the rate of inflation becomes. Others found no relationship between CBI and inflation rate (Alesina and Summers, 1993; Cargill, 1995; Campillo and Miron, 1997; Logue and Sweeney, 1981). Particularly in developing countries, studies have found no relationship between de jure measures of CBI and inflation. Cukierman (1992) attributed this to the broad disregard for laws in developing countries where though central banks have been granted independence per their charter, political authorities do not comply with such regulations. This results in a wide difference between legal or de jure CBI and actual or de facto CBI. Results of more recent studies are also ambiguous (Crowe and Meade, 2008; Jácome and Vázquez, 2008; Klomp and De Haan, 2010; Arnone and Romelli, 2013). Siklos (2002) shows that central banks that were made independent in the 1990s, already achieved lower inflation performance in the 1980s. Hielscher and Markwardt (2012) even identity a non-linear relationship between CBI and inflation and as such supporting calls for limitations on the independence of the central bank. In Africa, CBI reforms have been fostered by the promotion of regional organisations such as ECOWAS, African Monetary Union (AMU), and South African Development Community (SADC). However, many countries, were unable to achieve the convergence goals for the ECO (the proposed currency for the ECOWAS region) which include single digit inflation, fiscal-deficit of not more than 4% of GDP, central bank's financing of fiscal deficit not more than 10 per cent of previous year's tax revenue, among others. .

On the basis of these results, there are arguments that central bank independence is not enough to guarantee price stability and that there is a need for support systems to achieve its objective. Klomp and De Haan (2010) after adopting a random coefficient estimation technique to account for unobserved heterogeneity, suggested that CBI does not have a general effect on inflation and that there could be conditions under which the negative relationship between CBI and inflation exist as suggested by Posen (1995) (Klomp and De Haan, 2010). The financial system and political environment are two (2) of such systems suggested in literature to be potential conditions necessarily for effective CBI (Posen, 1995). Few studies have however examined this argument.

Evidence of a clear impact of financial development's impact on stabilization policies abound: Cecchetti and Krause (2001) find evidence suggesting that an improvement in the depth of the financial sector and the intermediation process, measured by a less centrally controlled banking system, has contributed to the reduction in inflation and output variability. Bittencourt et al. (2014) also emphasise the role of deeper financial markets in allowing private agents to smooth expenditure, thereby reducing fluctuations in economic activity. Coenen and Straub (2005) also emphasise the role of deeper financial markets in allowing private agents to smooth expenditure, thereby reducing fluctuations in economic activity. Ma and Lin (2016) also establishes the interdependence of monetary policy and financial systems. The financial system is important in assessing the link between CBI and inflation for various reasons:

Posen (1993) argues that, the causal relationship between CBI and inflation, is explained by a third factor which he terms financial opposition to inflation. According to Posen, central banks are more able to enforce an anti-inflationary policy, when there is a coalition of interest, politically capable of protecting the central bank's anti-inflationary policy. This coalition is represented in developed countries, by the financial sector. He claims that effective financial opposition to inflation (FOI) is relevant for successful stabilization objectives. Central banks' decisions do not only reflect their institutional capabilities and legal constraints, but that such determinations also respond to the political environment. Therefore, the central bank can guarantee price stability only as long as the financial sector is ready to support policies associated with reducing inflation: that is, the more developed the financial sector, the more successful will be stabilization policies.

He argues that since CBI has distributive consequences and does not please all the people all the time. CBI is not self-enforcing. The distributive consequences of CBI come as a result of disinflation cost, which comes in the form of higher unemployment (Debelle and Fischer, 1994; Posen 1993, 1995; Cukierman, 1992). Cukierman (1992), further explain that differences in statutory CBI do not necessarily predict inflation, because some political authorities, particularly in developing countries pursue inflationary monetary policy regardless of statutes. The preferences therefore, for price stability require some political support to insure against the risk to monetary institutions as it is to examine the monetary institutions themselves (Posen, 1993).

He develops four propositions regarding indicators that explain and measure financial opposition to inflation. These indicators included (i) countries with financial sectors that have universal banking; (ii) countries with less regulatory power of the central bank over the financial sector; (iii) countries with federal systems of government and (iv) countries with less fractionalisation of the political party system; all having more effective financial opposition to inflation. He found statistical support for a causal link between financial opposition to inflation and CBI on one hand, and lower inflation rates, on the other, for the period 1950–1989.

This study posits that, more developed financial sectors are well able to participate effectively and efficiently in the monetary policy transmission mechanism, whereby they are able to operate at low cost and therefore pass on lower interest rates to customers. This results in lower interest rates compared to other jurisdictions whose financial sectors are underdeveloped and operate at higher costs. These higher operating costs are passed on to customers thereby resulting in higher interest and inflation rates. In such circumstances, the central bank is less effective in achieving lower inflation rates.

Another way by which the financial sector improves the effectiveness of central bank independence is in the form of the financial sector providing good corporate governance checks on the central bank. In well developed financial sectors, the block can provide a great check on the central banks' decisions and policies and keep a close eye on it meeting its targets as well as abiding by the independence provisions granted it. This enables the central bank to be practically independent and focused on achieving its price stability objectives.

In poorly developed financial sectors, the central bank cannot target as much lower inflation levels than it would have, because of the unemployment it stands to create (Mehrotra and Yetman, 2015). When lower inflation rates are desired, the tightening of monetary policy results in lower credit available to borrowers, resulting in lower investment, production, and output. In poorly developed financial sectors, the effect of monetary policy tightening will be that relative to demand, lower amounts of credit will be available due to the small size of the financial sector. This will result in the possibility of higher variability in investment, consumption, output, and unemployment. However in highly developed financial markets, the availability of credit will mean that

when monetary policy rates are tightened in order to achieve price stability,.the financial markets can provide enough credit to still stimulate investment, smoothen consumption, and generate employment. So independent central banks in such jurisdictions can desire and achieve lower inflation rates relatively. A well-developed financial sector also reduces the crowding out effect of limited finance which can lead to higher interest rates on loans, which feed subsequently into higher cost of production, and higher prices of goods and services.

In addition, a well-developed financial sector that has a strong capital base is able to withstand periods of default by customers as a result of lower prices and revenues for businesses and individuals who anticipated higher prices to enable them pay-off their loans. When an independent central bank creates lower inflation, then prices of goods and services are not as high as could have been anticipated by lenders and borrowers. This results in lower revenues, not adequate to pay back loans, leading to a fragile financial system. The possibility of this happening can result in the central bank, targeting higher inflation rates, than they would, if financial systems were strong enough to withstand such defaults. So financial systems highly capitalised, can result in central banks being able to target lower inflation rates, knowing very well that, should defaults arise, the financial system is capable of soaking these defaults in.

Low inflation has been identified in the literature as an essential precondition for the development of debt markets. Like sound public finances, low inflation is deemed to be important for creating the right incentives for investors and for facilitating the development of markets in fixed income securities (IMF and World Bank, 2001; Mihaljek et al., 2002). In a similar vein, in economies where bond markets are well developed, bondholders will prefer lower inflation rates so as to preserve the value of their investments. High inflation and large fiscal deficits, it has been argued, distort economic behaviour in favour of short-term speculative projects and discourage the long-term investment projects conducive to sustainable economic development. A second hypothesis is that, in addition to greater reliance on the domestic bond issuance, lower inflation should also lead to smaller international bond issuance. In such jurisdictions, pressure is placed on the central bank to maintain lower inflation rates so as to encourage bondholders to invest in government and corporate bonds (Tirole, 2002).

A well developed financial sector also provides well resourced personnel to fill up vacancies in the central bank to enable it achieve its vision. This is in line with the argument that the ability of the independent central bank to achieve lower inflation levels, plays a role in managing the expectations of the private sector, as well as improving the credibility of the monetary policy regime. The ability of the financial sector to provide this support therefore comes from its capability, experience and size. With more developed financial sectors, more resourced persons, can be employed in the central bank, to provide the needed expertise for the independent central bank to achieve price stability.

2.2. Political institutions, central bank independence and inflation

Since the 1990s, a number of studies (Campillo and Miron, 1997; Aisen and Veiga, 2008; Hielscher and Markwardt, 2012) have examined the relationship between institutional quality and inflation. According to Hielscher and Markwardt (2012), there are a number of reasons why the quality of institutions matters in attempts to assess the link between CBI and inflation. To begin with, as a determinant of inflation, institutional quality becomes a necessary control variable in estimations. For example, Campillo and Miron (1997) show that politically unstable countries have higher inflation rates and that CBI does not help to explain a country's inflation history.

Aisen and Veiga (2008) attempted to provide evidence on the determinants of inflation volatility; hypothesising that political and institutional factors are the main determinants of inflation volatility. They argue that politically unstable countries are more often susceptible to political shocks leading to discontinuous monetary and fiscal policies and higher inflation volatility. Their study showed that greater political instability, lower economic freedom and higher degrees of polarization and political fragmentation lead to higher inflation volatility.

Further to the above reason, CBI is a possible result of the level of political institutions in a country For instance, in countries with good checks and balances, monetary institutions have greater autonomy (Moser, 1999; Keefer and Stasavage, 2000 and Farvaque, 2002). Hence, measures of the quality of institutions can be used as potential instruments for legal CBI measures that can be used to address issues of endogeneity in CBI-inflation studies. (Crowe and Meade, 2008).

Cukierman et al. (1989) and Aisen and Veiga (2006) show that developing countries have an inefficient tax collecting systems which propel governments to print money for financing public expenditures. This reliance on seignorage results in inflation.

Edwards and Tabellini (1991) in their empirical study find evidence in which change in government and polarization, as measures of political instability result in inflation in developing countries. Alesina and Drazen (1989) develop a model in which political instability and polarization impact the social choice function and hence budget deficits and debt. A government who believes that it will lose an election will finance excess expenditures with debt since it will not bear the associated costs of debt repayment and by so doing, squeezes the fiscal space for of the opponent party when they win the next election. Cumulatively, this leads to higher budget deficits and debt. They expect that countries with high political instability and more polarized circumstances, would have higher budget deficits and thus, according to FTPL, result in higher levels of inflation. To study this prediction Cukierman et al. (1989) showed that higher degrees of political instability result in higher inflation rates.

Alesina and Drazen (1989) identify a channel of deficit persistence which they called ‘war of attrition’, between different socioeconomic groups with distributional objectives that conflict. Drawing from the literature on dynamic games between a monetary and fiscal authority with conflicting objectives, they found that even if termination of a deficit is efficient; each group attempts to wait the others out and do not come to a political agreement until certain groups make their political opponents to partly tolerate the burden of fiscal adjustment. Finally, stabilization would be highly expensive for any group. Stabilization only occurs when a disproportionate share of the burden inevitably, will be accepted and borne by one party. Thus more political parties in a parliament make it harder to reach an agreement and lead to a higher budget deficit and inflation rate.

Aisen and Veiga (2006) show that in a country with frequent government changes, macroeconomic policies will also change consistently because the new economic executives want to pursue their own ideas which are different from their predecessors. Macroeconomic policy changes will therefore threaten price stability. In addition, cabinet changes and government crisis will shorten the horizon of policy makers. Therefore, the importance of short term objectives will increase and keeping inflation in rational range would be difficult.

Paldam (1987) investigates the relationship between inflation and political instability in eight Latin American countries over 1946–83. He is of the view that this relation is bi-directional and

works in two paths. The main path is conveyed to inflation costs and responsibility hypothesis which states that people recognize that government is responsible for economic outcomes. One of the strong results of popularity functions literature is that higher inflation rate leads to lower popularity and less partnership in election. Therefore when inflation reduce, the popularity makes the current government remain in power; and vice versa. The path from politics to inflation is related to public expenditures whereby weak governments finance expenditures by inflation tax. Consequently, in a situation whereby inflation increases, they cannot resist political pressures and would change executives and plans.

Drazen (2000) argues that interest groups request other groups to bear the burden of disinflation costs. In fragmented communities with diverse groups of beneficiaries and weak political institutions, they are incapable of changing the status quo, in the face of difficult economic conditions leading to higher and more persistent inflation rates.

Furthermore, the quality of political institutions might directly influence the relationship between CBI and inflation. From a theoretical point of view, increasing CBI helps to solve time-inconsistency problems by strengthening the reputation of monetary policy. However, indicators of CBI convey little information about the credibility of such an arrangement. To achieve the beneficial reputation effects of CBI, the established institutional design needs to be credible (Hielscher and Markwardt (2012). High-quality political institutions might generally be associated with greater trust in governmental decisions and legal arrangements. As a result, the quality of institutions might be a positive determinant of the reputation effects of CBI. Posen (1995) argues that preferences for price stability embodied by CBI, require political support to insure against the risk to monetary institutions and to examine the monetary institutions themselves.

Further to this, good governance and broader institutional quality that guarantee the rule of law would insulate the independent central bank from practical interference from government in achieving their objective of price stability.

Khani Hoolari et al., (2014) in examining the determinants of inflation in Iran, find that the effects of monetary determinants on inflation, depended on the political environment and that there was a positive relationship between political instability and governance indicators.

Keefer and Stasavage (2003) show that the effectiveness of central bank independence in strengthening credibility and enhancing inflation performance is increased by the presence of multiple political veto players. Hayo and Voigt (2008) also find evidence that a significant relation between CBI and inflation only exists if checks and balances are sufficiently strong.

Hielscher and Markwardt (2012) show that granting a central bank more autonomy does not necessarily lead to better inflation performance. To lower inflation by increasing independence, the change in independence must be sufficiently large, and the quality of the political institutions must be sufficiently high. They argue that political institutional characteristics such as those reflected in democracy, accountability, rule of law and bureaucratic systems are needed to improve the credibility of the monetary policy regime.

Where there are high levels of the rule of law, belief in the legal system is high resulting in high respect for central bank independence legislation. This has implications for inflationary anchoring expectations. Rogoff (1985) argues that central bank independence is beneficial to the society, in terms of it keeping inflation at low levels. Therefore, any attempt by government to overstep this design, resulting in high levels of inflation, will be punished by the citizenry in a democratic jurisdiction (Hielscher and Markwardt, 2012). However, governments who respect the independence of central banks, will allow them to freely operate to achieve their objectives of low inflation. Economies with high political stability, also provide the needed environment for independent central banks to operate and discharge their monetary policy objectives. Frequent changes in government, may not necessarily lead to a revision in central bank laws in environments where the bureaucratic system is strong and independent of the political authorities in power to the extent that it is guaranteed by the laws of the country (Busse and Hefeker, 2007).

From the above review, it is evident that the effect of central bank independence on inflation, is still open to further examination. Particularly in Africa and the developing world, where financial systems and institutional quality differ significantly from the developed world, we can identify differences in the levels of financial development and institutional quality as accounting for the differences in the effectiveness of central bank reforms. Though legal measures of central bank independence have not been found to have significant impact on inflation in developing countries, there could be conditions under which central bank independence can have significant impact on lowering inflation. Thus we expect that, higher levels of financial development, both banking sector and stock market, would enhance the effectiveness of central bank independence in achieving lower inflation rates. We also expect that improvements in the quality of institutions through respect for rule of law and accountability, would enhance the credibility of the independent central bank through its discipline and accountability, in anchoring inflationary expectations at lower levels.'

3. Methodology

3.1. Data and sample

To investigate the effect of CBI on inflation, we utilize panel data spanning 1970–2012 on 48 African countries. Our legal CBI index is from Garriga (2016) who computes the CWN index for over the period 1970–2014. The control variables that we take into account come from the models of Campillo and Miron (1997) and Klomp and De Haan (2010). We include an indicator of openness, log of GDP per capita, an exchange rate dummy, fiscal deficit, world inflation, inflation targeting dummy, and indicators of financial development and institutional quality.

Following Klomp and De Haan (2010), our inflation variable is the modified inflation rate computed as:

$$LOG\left(1 + \pi_{GDPDf}\right)$$

where π_{GDPDf} is the annual percentage change in GDP deflator and:

$$GDPDf = Nominal\ GDP/Real\ GDP * 100$$

We adopt the use of the GDP deflator as compared to the average consumer price index, because our data provides more data points for GDP deflator than average CPI. With price increases, the transformed inflation rate takes a value from 0 to 1. This transformation of the inflation rate reduces the heteroscedasticity of the error term. In case of price decreases it ranges between −1 to 0. X_{it} is a vector of control variables. It is more useful for studies on emerging markets and developing countries, which are characterised by hyper-inflationary episodes (Arnone and Romelli, 2013). We add the lagged value of our dependent variable (y_{it-1}) to correct the potential endogeneity of inflation. It also controls for initial level effects.

CBI_{it} represents the annual legal central bank independence measure of country i in period t. Our legal CBI index is from Garriga (2016), who compute CBI index for 182 countries over the period, 1970–2014. It follows Cukierman, Webb, and Neyapti's criteria

(CWN). The CWN CBI index is based on a weighted aggregation of 16 legal indicators in four categories regarding the tenure of the bank's governor, policy formation, objectives, and limitations on lending to the government, using the criteria and weights in Cukierman, Webb and Neyapti, The index varies between 0 and 1, with larger values indicating independence. A central bank is legally more independent when the governor's term in office is longer; the appointment and dismissal procedures are more insulated from the government; the mandate is more focused on price stability; the formulation of monetary policy lies squarely with the central bank; and the provisions on direct central bank lending are restrictive. This index fails to add measures of limits on the reappointment of the CEO, and measures of provisions affecting (re) appointment of other board members similar to those affecting the CEO. It also does not consider the restrictions on government representation on the board, and intervention of the government in exchange rate policy formulation as suggested in other literature. However, it represents the most comprehensive data on CBI that spans the longest period and covers the most number of countries, useful for conducting a panel study. According to the theoretical rationale for CBI, we would expect an increase in CBI to result in a decrease in inflation, which would correspond to a negative sign of the coefficientλ_i.

FinDev is a *financial development indicator*; measured as the ratio of private credit to GDP to capture banking sector development and the ratio of stock market total value traded to GDP as a proxy for stock market sector development indicator. The bigger the ratio, the larger the size of the banking and stock market sector's opposition to inflation, and the higher increase in credibility of monetary policy institutions to focus on price stability. Though studies have shown that the bond market also plays a significant role in monetary policy effectiveness, this market is relatively under developed in Africa and developing countries. Data on the domestic bond market is unavailable for the majority of countries in Africa and the developing world for most part of the study period. With the financial markets being predominantly banks and stock exchanges and in order to facilitate comparison of our findings among Africa, developed and developing countries, the study believes using the ratio of private credit to GDP to capture banking sector development and the ratio of stock market total value traded to GDP as a proxy for stock market sector development indicator is appropriate.

InstQual is an institutional quality variable, which is proxied by political rights variable obtained from Freedom House database. Political rights (PR) variable captures the extent to which the electoral process is free and fair, the state of political pluralism and participation, and the functioning of government. The score for the variable ranges from 7 to 1, with 7 representing the least rating and 1 the highest. Following Bodea and Higashijima, 2017, we rescale the original score to range between 0 and 6, so that lower scores now correspond to lower political rights rating and higher scores correspond to higher political rights rating. In order to do this, we use the formular −1*(PRS-7), where PRS is the political right score as given by Freedom House. So countries with a rating of 6 for instance, are countries that enjoy a wide range of political rights, including free and fair elections. Those elected also actually rule and political parties are competitive; the opposition play an important role and enjoys real power, and the interests of minority groups are well represented in politics and government.

Campillo and Miron (1997) show that politically unstable countries have higher inflation rates. Hayo and Voigt (2008) also find evidence that a significant relation between CBI and inflation only exists if checks and balances are sufficiently strong. Hielscher and Markwardt (2012) argue that in a democracy, any political action bears the risk of punishment by the voters. The opportunity for punishment increases the accountability of policy-makers. Under the assumption that central bank independence is socially beneficial [see Rogoff (1985)] greater democratic accountability makes it more costly for politicians to deviate from the socially preferred central bank design and thus increases the credibility of CBI.

We also expect political rights to have an impact on the credibility of CBI. For example, frequent government changes may lead to revisions to central bank design and have a negative impact on the credibility of the legal design of monetary policy. However, even in an unstable government, the impact of government changes may be counteracted by the existence of a strong and high-quality bureaucratic system that can act as a shock absorber and minimize policy revision (Busse and Hefeker, 2007).

Financial development and institutional quality interact with CBI. The interaction model implies that the marginal effect of a CBI on inflation depends on the value of the conditioning variable. In other words, a negative δ_i indicates that for a given change in CBI, the marginal effect increases when $FinDev_{it}$ increases; i.e., the effectiveness of changes in CBI is larger for more developed financial systems or countries with higher institutional quality in the case of $InstQual_{it}$.

Our indicator of *Trade Openness* is defined as sum of exports and imports in relation to GDP.

In line with Cukierman et al. (2002), De Haan and Kooi (2000), Klomp and De Haan (2010) and Jácome and Vázquez, 2008; we include a Fixed E*xchange Regime* dummy constructed from the IMF database on de facto exchange regimes, using a one for regimes classified as:“another currency as legal tender,” “currency board,” or “conventional peg against a single currency,” and zero otherwise. This is to account for the effects of exchange rate anchoring on inflation; *World Inflation* is proxied by the average inflation rate of industrial countries, computed from the World Bank. We include the log of per capita GDP, *LGDPC* to capture several possible effects. A higher per capita GDP is likely to be associated with a more sophisticated tax system and a more developed financial system, both of which imply lower optimal inflation tax and thus a negative effect on inflation. On the other hand, high-income countries might be better at innovating technologies for reducing the costs of inflation, so their inflation aversion might be lower. This implies a positive coefficient. These variables are sourced from the World Development Indicators (2015).

3.2. Model and estimation technique

To address our research questions, we use the following procedure. We follow the approach used by Eichengreen and Dincer (2014); Klomp and De Haan (2010), Jácome and Vázquez, 2008 and Campillo and Miron (1997) and estimate the impact of CBI on inflation. Following recent literature in panel data studies (Salas and Saurina, 2002; Merkl and Stolz, 2009) and to account for the possibility of endogeneity in our model and time persistence in inflation structure, we adopt a Two Stage Least Square Instrumental Variables (2SLSIV) estimator.

The justification for using this estimator is to address issues of reverse causality and endogeneity. The decision of implementing central bank reform may be self-dependent on inflation. An instance is that a disinflationary period can result in easier implementation of central bank reforms. Secondly, the effects of central bank reforms on inflation may not be immediately realised. This is because; implementing a new institutional environment usually requires the enactment of more specific regulations, and the build-up of central bank reputation, which is the main factor from the perspective of market participants.

Table 1
Africa.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	EC2SLS1	EC2SLS2	EC2SLS3
	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation
L.Inflation	0.070***	0.072***	0.049	0.175***	0.174***	0.175***	0.174***	0.173***	0.172***	0.175***	0.174***	0.174***
	(0.026)	(0.026)	(0.032)	(0.024)	(0.024)	(0.025)	(0.025)	(0.025)	(0.025)	(0.024)	(0.024)	(0.024)
World Inflation	0.341***	0.371***	0.348***	0.235***	0.245***	0.234***	0.192***	0.205***	0.193***	0.235***	0.245***	0.235***
	(0.044)	(0.047)	(0.059)	(0.037)	(0.038)	(0.038)	(0.038)	(0.039)	(0.038)	(0.037)	(0.038)	(0.037)
Fiscal Deficit	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fixed Exchange	−0.026	−0.016	−0.023	−0.139***	−0.140***	−0.139***	−0.129***	−0.130***	−0.126***	−0.139***	−0.140***	−0.135***
	(0.037)	(0.037)	(0.037)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Inflation Targeting	0.148	0.113		0.155*	0.122	0.153*	0.160*	0.127	0.153*	0.155*	0.122	0.148*
	(0.093)	(0.095)		(0.087)	(0.088)	(0.087)	(0.087)	(0.089)	(0.087)	(0.087)	(0.088)	(0.087)
FinDev	−0.004***	−0.011***	−0.004***	−0.002**	0.001	−0.002**	−0.002**	0.001	−0.002**	−0.002**	0.001	−0.002**
	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
InstQual	0.006	0.007	0.121	−0.003	−0.002	−0.008	−0.004	0.001	−0.016	−0.003	−0.002	−0.017*
	(0.008)	(0.008)	(0.076)	(0.006)	(0.006)	(0.017)	(0.006)	(0.006)	(0.010)	(0.006)	(0.006)	(0.010)
Per Capita GDP	0.055	0.078	0.037	0.038	0.045	0.038	0.03	0.038	0.03	0.038	0.045	0.038
	(0.098)	(0.098)	(0.123)	(0.030)	(0.030)	(0.030)	(0.028)	(0.029)	(0.028)	(0.029)	(0.030)	(0.030)
CBI	0.407***	0.676***	0.134	−0.012	0.132	−0.140***	(0.020)	0.121	0.041	−0.012	0.132	0.042
	(0.149)	(0.211)	(0.221)	(0.056)	(0.089)	(0.022)	(0.057)	(0.090)	(0.066)	(0.056)	(0.089)	(0.065)
Trade Openness	0.324***	0.318***	0.501***	0.042	0.022	0.042	0.085	0.062	0.084	0.043	0.022	0.042
	(0.118)	(0.117)	(0.154)	(0.076)	(0.076)	(0.076)	(0.073)	(0.074)	(0.073)	(0.076)	(0.076)	(0.076)
FinDev*CBI		−0.010*			−0.007**			−0.007**			−0.007**	
		(0.005)			(0.003)			(0.003)			(0.003)	
InstQual*CBI			−0.212*			0.009			−0.079*			−0.073*
			(0.128)			(0.031)			(0.043)			(0.043)
Constant	0.675*	1.076***	0.561	0.464***	0.361***	0.361***	0.361***	0.209***	0.383***	0.464***	0.361***	0.531***
	(0.368)	(0.404)	(0.374)	(0.108)	(0.118)	(0.118)	(0.118)	(0.037)	(0.119)	(0.108)	(0.118)	(0.115)
Fixed Effects	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO
Random Effects	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
Estimator of Variance	S-A	S-A	S-A	S-A	S-A	S-A	B-C	B-C	B-C	B-C	B-C	B-C
Observations	939	939	889	937	937	937	939	939	939	937	937	937
Number of Countries	48	48	48	48	48	48	48	48	48	48	48	48
Ho: Difference in coef. not systematic (p-values)				0.467			0.287					

***p < 0.01, **p < 0.05, *p < 0.1.
Standard errors in parentheses.
Inflation variable is the modified inflation rate computed as: $LOG(1+\pi_{GDPDf})$ where π_{GDPDf} is the annual percentage change in GDP deflator and $GDPDf = Nominal\ GDP/Real\ GDP*100$. CBI is the annual legal CWN central bank independence index measure of a country's central bank independence. FinDev is a financial development indicator; measured as the ratio of private credit to GDP. InstQual is institutional quality variable, proxied by political rights score. Trade Openness is defined as sum of exports and imports in relation to GDP. Fixed Exchange regime is a dummy constructed from the IMF database on de facto exchange regimes, using a one (1) for regimes classified as:"another currency as legal tender," "currency board," or "conventional peg against a single currency," and zero (0)otherwise. World Inflation is proxied by the average inflation rate of industrial countries, computed from the World Bank. Per Capita Income is measures as log of the ratio of real Gross Domestic Product divided by total population. Inflation Targeting variable is a dummy constructed from the IMF database, using a one (1) for inflation targeting regimes and zero(0) for non-targeting regimes.

Subsequently, we use instrumental variables as the appropriate treatment to account for the possible endogeneity of central bank reform. Following Jácome and Vázquez, 2008, we use two alternative methods: Generalized Two Stage Least Squares (G2SLS) developed by Balestra and Varadharajan- Krishnakumar (1987) and Error Correction Two-Stage Least Squares (EC2LSL) described in Baltagi and Chang (2000). While Jácome and Vázquez, 2008 ended their analysis of the CBI-inflation nexus with the Generalized Two Stage Least Square (G2SLS) and Error Correction Two-Stage least Squares (EC2SLS), they failed to account for the effect of lagged inflation on the CBI-inflation link. This study accounts for the persistence in inflation, by introducing the lag of inflation into the model. This also helps to address further issues of endogeneity, reverse causality and omitted variable bias.

The specification is generally given by:

$$y_{it} = \phi_i y_{it-1} + \lambda_i CBI_{it} + \beta_i X_{it} + \varepsilon_{it} \quad (1)$$

To capture possible unobserved heterogeneity, and to analyze the impact of institutional quality and financial development on the CBI-inflation, we specify the following interaction model:

$$y_{it} = \lambda_i y_{it-1} + \delta_i CBI_{it} + \Omega_i FinSys_{it} + \phi_i InstQual_{it} + \Pi_i(CBI_{it}*CV_{it}) + \beta_i X_{it} + \varepsilon_{it} \quad (2)$$

where *CV* is the conditioning variable. i.e. institutional quality and financial development. We thus estimate our model in line with our objectives as follows:

$$Inf_{it} = \lambda_i Inf_{it-1} + \delta_i CBI_{it} + \Omega_i FD_{it} + \phi_i InstQual_{it} + \Pi_i(CBI_{it}* FinDev_{it}) + \beta_i X_{it} + \varepsilon_{it} \quad (2a)$$

$$Inf_{it} = \lambda_i Inf_{it-1} + \delta_i CBI_{it} + \Omega_i IQ_{it} + \Pi_i(CBI_{it}* InstQual_{it}) + \beta_i X_{it} + \varepsilon_{it} \quad (2b)$$

To properly interpret the interaction terms, we must include the level of conditioning variable i.e. institutional quality and financial sector development CV_{it} (Brambor et al. 2006). As in the case of CBI based on Eq. (3), the effect of a change in CBI on our dependent variable is given by:

Table 2
Developed countries.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	EC2SLS	EC2SLS	EC2SLS
	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation
l.Inflation	0.247***	0.246***	0.246***	0.375***	0.367***	0.373***	0.375***	0.367***	0.373***	0.375***	0.367***	0.373***
	(0.029)	(0.029)	(0.029)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
World Inflation	0.008***	0.008***	0.008***	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Fiscal Deficit	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fixed Exchange	0.011	0.01	0.007	−0.002	−0.006	−0.004	−0.002	−0.006	−0.004	−0.002	−0.006	−0.004
	(0.020)	(0.020)	(0.020)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Inflation Targeting	−0.077**	−0.067**	−0.085***	−0.027	−0.018	−0.028	−0.027	−0.018	−0.028	−0.027	−0.018	−0.028
	(0.032)	(0.032)	(0.032)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
FinDev	−0.001*	−0.001**	−0.001**	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
InstQual	−0.014	−0.014	0.02	0.006	0.005	0.038**	0.006	0.005	0.038**	0.006	0.005	0.038**
	(0.013)	(0.013)	(0.021)	(0.006)	(0.006)	(0.017)	(0.006)	(0.006)	(0.017)	(0.006)	(0.006)	(0.017)
Per Capita GDP	−0.251**	−0.204	−0.251**	−0.062**	−0.042	−0.062**	−0.062**	−0.042	−0.062**	−0.062**	−0.042	−0.062**
	(0.123)	(0.126)	(0.123)	(0.031)	(0.032)	(0.031)	(0.031)	(0.032)	(0.031)	(0.031)	(0.032)	−0.031
CBI	−0.157***	−0.085	−0.031	−0.083**	−0.004	0.016	−0.083**	−0.004	0.016	−0.083**	−0.004	0.016
	(0.056)	(0.070)	(0.082)	(0.038)	(0.049)	(0.063)	(0.038)	(0.049)	(0.063)	(0.038)	(0.049)	(0.063)
Trade Openness	(0.167)	−0.209*	(0.173)	0.010	0.000	0.010	0.010	0.000	0.010	0.010	0.000	0.010
	(0.114)	(0.116)	(0.114)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)
FinDev*CBI		−0.001			−0.001***			−0.001***			−0.001***	
		(0.000)			(0.000)			(0.000)			(0.000)	
InstQual*CBI			−0.077**			−0.066**			−0.066**			−0.066**
			(0.037)			(0.033)			(0.033)			(0.033)
Constant	1.601***	1.391**	1.559***	0.656***	0.569***	0.611***	0.656***	0.569***	0.611***	0.656***	0.569***	0.611***
	(0.531)	(0.544)	(0.531)	(0.143)	(0.147)	(0.145)	(0.143)	(0.147)	(0.145)	(0.143)	(0.147)	(0.145)
Fixed Effects	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO
Random Effects	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
Estimator of Variance	S-A	S-A	S-A	S-A	S-A	S-A	B-C	B-C	B-C	B-C	B-C	B-C
Observations	1105	1103	1105	1105	1103	1105	1105	1103	1105	1105	1103	1105
Number of Countries	47	47	47	47	47	47	47	47	47	47	47	47
Ho: Difference in coef. not systematic (p-values)				0.234			0.187					

Standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.
Inflation variable is the modified inflation rate computed as: $LOG(1+\pi_{GDPDf})$ where π_{GDPDf} is the annual percentage change in GDP deflator and $GDPDf = Nominal\ GDP/Real\ GDP*100$. CBI is the annual legal CWN central bank independence index measure of a country's central bank independence. FinDev is a financial development indicator, measured as the ratio of private credit to GDP. InstQual is institutional quality variable, proxied by civil liberties, political rights score and freedom status. Trade Openness is defined as sum of exports and imports in relation to GDP. Fixed Exchange regime is a dummy constructed from the IMF database on de facto exchange regimes, using a one (1) for regimes classified as:"another currency as legal tender," "currency board," or "conventional peg against a single currency," and zero(0) otherwise. World Inflation is proxied by the average inflation rate of industrial countries, computed from the World Bank. Per Capita Income is measures as log of the ratio of real Gross Domestic Product divided by total population. Inflation Targeting variable is a dummy constructed from the IMF database, using a one (1) for inflation targeting regimes and zero(0) for non-targeting regimes.

$$\frac{\partial \Delta y_{it}}{\partial \Delta CBI_{it}} = \delta_i + \Pi_i CV_{it} \tag{3}$$

4. Analysis and discussion of results

Our baseline results for the relationship between CBI and inflation were computed in line with equation one. We therefore considered the time and cross sectional dimensions of the data and estimate fixed and random effects models in order to control for unobserved heterogeneity in our data.In both cases, lagged values of the CBI were used as instruments for CBI. The first stage results (not reported), indicate that the instrument was appropriate, with the associated coefficient significant at the one-percent level in all cases. In columns 1 and 3, we apply the Swamy and Arora (1972) estimator (S-A), which contains a small sample corrections and in columns 7 and 12, the Baltagi and Chang (2000) estimator (B-C) is used. We apply the Hausman specification test; which does not reject the null of coefficient equality between the fixed effects and random effects model. Based on this outcome, the random effects model is preferable to the fixed effects, since the random effect is of higher efficiency.

The results of our instrumental variables regressions for African countries, are shown in columns 1–12 in Table 1. In column 1 where we estimate fixed effects G2SLS model, CBI is found to have a significant positive impact on inflation, with control variables having the expected a priori effect, except for fixed exchange rate, institutional quality, per capita GDP and inflation targeting which were not significant determinants of inflation. *FinDev* proxied by the banking sector development indicator, ratio of private credit to GDP, has a consistent negative and significant relationship with inflation. This points to the fact that more developed financial sectors, ensure effective monetary policy through more influence of policy decisions on money demand and supply in the economy. The institutional quality variable, only has a significant relationship with inflation in column 12. Therefore, countries with higher levels of respect for political rights and rule of law, do generally have lower inflation levels.

In column two, where the interaction between CBI and financial development is introduced, the marginal effect of CBI on inflation, given higher levels of financial development is negative. This supports the argument that the financial sector enhances the effectiveness of CBI on inflation and that CBI has effect on inflation only

Table 3
Developing countries.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	EC2SLS1	EC2SLS2	EC2SLS3
	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation
l.Inflation	0.126***	0.125***	0.125***	0.084***	0.090***	0.440***	0.091***	0.098***	0.440***	0.085***	0.093***	0.440***
	−0.018	−0.018	−0.018	−0.017	−0.017	−0.017	−0.017	−0.016	−0.017	−0.016	−0.016	−0.017
World Inflation	0.191***	0.202***	0.189***	0.168***	0.183***	0.173***	0.167***	0.180***	0.157***	0.165***	0.169***	0.018***
	−0.031	−0.032	−0.031	(0.028)	(0.029)	(0.027)	(0.028)	(0.028)	(0.026)	(0.028)	(0.028)	(0.002)
Fiscal Deficit	0.009***	0.009***	0.009***	0.009***	0.009***	0.001***	0.009***	0.009***	0.001***	0.009***	0.009***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Fixed Exchange	−0.044***	−0.042***	−0.043***	−0.095***	−0.094***	−0.115***	−0.097***	−0.097***	−0.115***	−0.095***	−0.097***	−0.115***
	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Inflation Targeting	−0.100***	−0.099***	−0.100***	−0.073**	−0.075**	−0.060*	−0.069**	−0.071**	−0.060*	−0.073**	−0.073**	−0.060*
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.034)	(0.032)	(0.032)	(0.034)	(0.032)	(0.031)	(0.034)
FinDev	−0.002***	0	−0.002***	0.012*	0.014*	−0.003***	0.012*	0.014*	−0.003***	0.008	0.002	−0.003***
	(0.001)	(0.001)	(0.001)	(0.007)	(0.007)	0.000	(0.007)	(0.007)	0.000	(0.005)	(0.004)	0.000
InstQual	−0.002	−0.003	0.02	0.012**	0.013**	0.017**	0.012**	0.012**	0.017**	0.01	0.01	0.017**
	(0.013)	(0.013)	(0.031)	(0.006)	(0.006)	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.006)	(0.008)
Per Capita GDP	0.159**	0.162**	0.158**	0.029	0.047**	0.077***	0.029	0.046**	0.077***	0.016	0.03	−0.163**
	(0.069)	(0.069)	(0.069)	(0.025)	(0.023)	(0.018)	(0.024)	(0.022)	(0.018)	(0.026)	(0.025)	(0.067)
CBI	−0.025	0.104	0.029	−0.06	0.204**	−0.044	−0.063	0.185*	−0.044	−0.071	0.031	−0.044
	(0.065)	(0.093)	(0.095)	(0.045)	(0.103)	(0.059)	(0.044)	(0.099)	(0.059)	(0.046)	(0.084)	(0.059)
Trade Openness	0.126*	0.12	0.124*	0.327***	0.265***	0.228***	0.323***	0.262***	0.228***	0.316***	0.260***	0.228***
	(0.074)	(0.074)	(0.074)	(0.059)	(0.053)	(0.049)	(0.058)	(0.052)	(0.049)	(0.056)	(0.052)	(0.049)
FinDev*CBI		−0.004*			−0.010***			−0.009***				0.647***
		(0.002)			(0.003)			(0.003)				(0.161)
InstQual*CBI			−0.045			−0.025**			−0.025**		−0.025**	
			(0.058)			(0.012)			(0.012)		(0.012)	
Constant	0.886***	0.674***	0.778***	0.918***	0.754***	0.778***	0.915***	0.755***	0.389***	0.788***		
	(0.226)	(0.229)	(0.229)	(0.115)	(0.120)	(0.229)	(0.112)	(0.116)	(0.070)	(0.150)		
Fixed Effects	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO
Random Effects	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
Estimator of Variance	S-A	S-A	S-A	S-A	S-A	S-A	B-C	B-C	B-C	B-C	B-C	B-C
Observations	2204	2204	2204	2269	2269	2330	2269	2269	2330	2269	2269	2330
Number of Countries	115	115	115	116	116	115	116	116	115	116	116	115
Ho: Difference in coef. not systematic (p-values)				0.267			0.235					

Standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.
Inflation variable is the modified inflation rate computed as: $LOG(1+\pi_{GDPDf})$ where π_{GDPDf} is the annual percentage change in GDP deflator and $GDPDf = Nominal\ GDP/Real\ GDP*100$. CBI is the annual legal CWN central bank independence index measure of a country's central bank independence. FinDev is a financial development indicator; measured as the ratio of private credit to GDP. InstQual is institutional quality variable, proxied by political rights score. Trade Openness is defined as sum of exports and imports in relation to GDP. Fixed Exchange regime is a dummy constructed from the IMF database on de facto exchange regimes, using a one (1) for regimes classified as:"another currency as legal tender," "currency board," or "conventional peg against a single currency," and zero (0) otherwise. World Inflation is proxied by the average inflation rate of industrial countries, computed from the World Bank. Per Capita Income is measures as log of the ratio of real Gross Domestic Product divided by total population. Inflation Targeting variable is a dummy constructed from the IMF database, using a one (1) for inflation targeting regimes and zero(0) for non-targeting regimes.

at higher levels of financial development. In column 3, the interactive term between institutional quality and CBI also produces a significantly negative coefficient. This can be explained to mean that, higher levels of institutional quality enhance the ability of independent central banks, to lower inflation. Columns 4–6, capture the results of a random effects G2SLS regression. In column 4, CBI has no significant relationship on inflation. However, at higher levels of financial development and institutional quality, more CBI has a negative impact on inflation. This is shown in columns 5 and 6 of Table 2. Past inflation, world inflation, fiscal deficit and fixed exchange rate, all have the expected impact on inflation. Whilst past inflation, world inflation and fiscal deficits result in higher levels of inflation, fixed exchange rate regimes lowered inflation compared to other exchange rate regimes.

We use the Balgati and Chang (2000) estimator (B-C) in columns 10–12 to correct for probable errors in our Swamy and Arora (1972) models. The outcome of these estimations also show that CBI has a better inflation performance in highly developed financial markets and institutions. The coefficient for the interactive terms is significantly negative for both financial development and institutional quality.

In models 10–12, we use the error correction two stage least squares instrumental variables random effects estimator, with Balgati and Chang (2000). In all four estimations, financial development has a negative and significant effect on inflation. In models 10–12, past inflation, world inflation and fiscal deficits have a positive and significant impact on inflation levels. Meaning that higher levels of past inflation, result in higher levels of present inflation. Increases in world inflation levels also significantly result in higher inflation in African countries. CBI has no significant impact on inflation in model 10. However, in higher levels of financial development, increases in CBI, result in lower inflation rate. In the same vein, higher CBI levels result in lower inflation rate in countries with high institutional quality. This is explained by the credibility that the monetary policy regime gains from the expectation that central bank laws will be respected and certain control mechanisms meant to keep the central bank on its toes, are implemented. Central banks that are independent in such environments, are more transparent and accountable, thereby enhancing their performance and the trust the markets have in their independence (Hielscher and Markwardt, 2012). This anchors inflationary expectations, which feed into lower inflation rates. This is given by the negative coefficient of the interact terms between CBI and financial development and CBI and institutional quality.

Table 4
Africa.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	EC2SLS	EC2SLS
	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation
l.Inflation	0.309***	0.091*	0.173***	0.172***	0.149***	0.172***	0.172***	0.172***
	(0.060)	(0.048)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
World Inflation	0.658***	0.390***	0.437***	0.445***	0.480***	0.445***	0.437***	0.445***
	(0.151)	(0.117)	(0.106)	(0.108)	(0.106)	(0.108)	(0.106)	(0.108)
Fiscal Deficit	0.020***	0.020***	0.020***	0.020***	0.019***	0.020***	0.020***	0.020***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fixed Exchange	−0.164***	−0.085	−0.150***	−0.148***	−0.133***	−0.148***	−0.150***	−0.148***
	(0.047)	(0.054)	(0.033)	(0.033)	(0.034)	(0.033)	(0.033)	(0.033)
Inflation Targeting	−0.078	0.015	−0.054	−0.055	−0.025	−0.055	−0.054	−0.055
	(0.101)	(0.076)	(0.071)	(0.071)	(0.072)	(0.071)	(0.071)	(0.071)
StockMkt Dev	0.002	−0.001	0.002*	0.003	0.002	0.003	0.002*	0.003
	(0.003)	(0.003)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
InstQual	−0.060***	−0.019	−0.034***	−0.036***	−0.032***	−0.036***	−0.034***	−0.036***
	(0.014)	(0.015)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Per Capita GDP	−0.249***	0.133	−0.036	−0.038	−0.061	−0.038	−0.036	−0.038
	(0.061)	(0.294)	(0.045)	(0.045)	(0.049)	(0.045)	(0.045)	(0.045)
CBI	0.194	−0.057	0.288***	0.300***	0.261**	0.300***	0.288***	0.300***
	(0.145)	(0.198)	(0.101)	(0.102)	(0.109)	(0.102)	(0.101)	(0.102)
Trade Openness	0.775***	0.352	0.176	0.173	0.143	0.173	0.176	0.173
	(0.232)	(0.324)	(0.169)	(0.168)	(0.182)	(0.168)	(0.169)	(0.168)
StockMkt Dev*CBI		0.004		−0.003		−0.003		−0.003
		(0.007)		(0.005)		(0.005)		(0.005)
Constant	1.252***	0.086	0.437**	0.436**	0.520***	0.436**	0.438**	0.436**
	(0.243)	(0.895)	(0.180)	(0.179)	(0.192)	(0.179)	(0.180)	(0.179)
Fixed Effects	YES	YES	NO	NO	NO	NO	NO	NO
Random Effects	NO	NO	YES	YES	YES	YES	YES	YES
Estimator of Variance	S-A	S-A	S-A	S-A	B-C	B-C	B-C	B-C
Observations	238	238	238	238	253	238	238	238
Number of Countries	15	15	15	15	16	15	15	15
Ho: Difference in coef. not systematic (p-values)			0.425		0.428			

Standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.
Inflation variable is the modified inflation rate computed as: $LOG(1+\pi_{GDPDf})$ where π_{GDPDf} is the annual percentage change in GDP deflator and$GDPDf = Nominal\ GDP/Real\ GDP$*100. CBI is the annual legal CWN central bank independence index measure of a country's central bank independence. StockMktDev is a stock market development indicator; measured as the ratio stock market total value traded to GDP (%). InstQual is institutional quality variable, proxied by political rights score. Trade Openness is defined as sum of exports and imports in relation to GDP. Fixed Exchange regime is a dummy constructed from the IMF database on de facto exchange regimes, using a one (1) for regimes classified as:"another currency as legal tender," "currency board," or "conventional peg against a single currency," and zero (0) otherwise. World Inflation is proxied by the average inflation rate of industrial countries, computed from the World Bank. Per Capita Income is measures as log of the ratio of real Gross Domestic Product divided by total population. Inflation Targeting variable is a dummy constructed from the IMF database, using a one (1) for inflation targeting regimes and zero(0) for non-targeting regimes.

We further examine the sensitivity of our findings to level of development of the economy in Tables 2 and 3. The results for the developed countries are different, from that of African countries, with reference to the impact of CBI on inflation.

In the developed countries' sample, CBI has a negative relationship with inflation throughout all the models. This is in line with past studies, which have found CBI to have a significantly negative impact on inflation. This points to the fact that increasing central bank independence, results in lower inflation rates in developed countries. This could be attributable to the developed nature of their financial systems and the institutions, compared to what exist in African countries.

Also, inflation targeting has the expected negative relationship with inflation, unlike in the African sample, where inflation targeting had a positive impact on inflation.

The effect of CBI at higher levels of financial development and institutional quality is negative impact on inflation in all the estimations used. This is no different from the results for African economies. Higher levels of Per capita GDP result in lower inflation levels in developed economies. This is not the case with African countries, where per capita GDP had no significant relationship with inflation.

This could be attributable to the fact the per capita GDP in African countries are relatively low thereby not being able to achieve the expected results as is in developed markets. is and that for developing economies except for institutional quality whose interaction with CBI did not produce significant results.

For the developing countries sample, the results as presented in Table 3 indicate that CBI alone, does not reduce inflation. This is in line with earlier studies which did not identify a significant negative impact of de jure CBI on inflation in developing economies. The coefficient of the lagged inflation variable point to persistence in inflation; as it is positive and significant throughout columns 1–12. World inflation, fiscal deficit and fixed exchange rate have significant impact on inflation as expected. Inflation targeting resulted in lower inflation rates in developing countries.

This contradicts the African countries sample results where inflation targeting did not have a significant negative impact on inflation. This could point to the differences that exist among developing countries when it comes to inflation targeting successes.

We therefore proceed to examine the effect of financial development and institutional quality on the CBI-inflation relationship by introducing interactive terms between CBI and financial development and CBI and our variables that capture institutional quality.

As we have argued, the effect CBI will have on inflation will depend on the levels of financial development and institutional quality in the economy. It is evident from the results that, the interactive terms between CBI and financial development and CBI and institutional quality have negative and significant coefficients except for column 3, where institutional quality and financial development term, does not have a significant negative impact on inflation. In columns 2, 5,8 and 12, the FinDev*CBI variable, has a significant negative effect on inflation; meaning that CBI leads to lower inflation levels, the higher the level of financial development in the economy.

In columns 6, 9 and 11, CBI increases lead to a reduction in inflation, where there exist higher levels of institutional quality. This is because, these arrangements increase the overall confidence of the market in the reputation of institutions and institutional arrangements in the economy.

A central bank reform alone, in an environment of weak legal and financial institutions does not engender confidence in the central bank to maintain its independence from government. In this way, the inflationary expectations of the market are not held down but exacerbated.

4.1. Relative importance of banking sector and stock market development to CBI effectiveness

We further used the ratio of stock market total value traded to GDP as a proxy for financial development and examined its impact on inflation as well as the effectiveness of CBI on inflation in Africa, developed and developing countries.

We observe in Table 4 that in Africa, stock market development does not have a significant impact on inflation. It also does not enhance the effectiveness of CBI on inflation significantly. This could be due to the fact that the stock market is not so developed on the continent and therefore does not carry the weight required to significantly influence inflation and to enhance CBI in achieving lower inflation rates.

In Table 5, which reports the results for our developed countries sample, it is observe that stock market development, improves the effectiveness of CBI. This is showed by the negative and significant coefficient of the interactive variable between stock market development and CBI. It is worth noting that in developed market, the stock market is highly developed and therefore, act as a significant conduit for monetary policy implementation as well as effective source of opposition to inflation.

In Table 6, there is s significant negative relationship between

Table 5
Developed countries.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	EC2SLS	EC2SLS
	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation
l.Inflation	0.222***	0.212***	0.067*	0.069*	0.067*	0.069*	0.065*	0.069*
	(0.043)	(0.044)	(0.038)	(0.036)	(0.038)	(0.036)	(0.036)	(0.036)
World Inflation	0.243***	0.284***	0.032	0.034	0.032	0.034	0.029	0.034
	(0.081)	(0.082)	(0.111)	(0.109)	(0.111)	(0.109)	(0.110)	(0.109)
Fiscal Deficit	0.016***	0.016***	0.107***	0.107***	0.107***	0.107***	0.107***	0.107***
	(0.001)	(0.001)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Fixed Exchange	0.002	0.006	0.029	0.028	0.029	0.028	0.029	0.028
	(0.034)	(0.034)	(0.020)	(0.019)	(0.020)	(0.019)	(0.019)	(0.019)
Inflation Targeting	−0.060	−0.066	−0.060**	−0.059**	−0.060**	−0.059**	−0.061**	−0.059**
	(0.044)	(0.044)	(0.028)	(0.027)	(0.028)	(0.027)	(0.027)	(0.027)
StockMkt Dev	−0.001*	−0.001*	0.003	0.003**	0.003	0.003**	0.003**	0.003**
	(0.001)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)
InstQual	−0.001	−0.006	−0.038*	−0.036**	−0.038*	−0.036**	−0.040**	−0.036**
	(0.056)	(0.057)	(0.021)	(0.015)	(0.021)	(0.015)	(0.016)	(0.015)
Per Capita GDP	0.659***	0.473**	−0.110*	−0.107**	−0.110*	−0.107**	−0.113**	−0.107**
	(0.226)	(0.221)	(0.058)	(0.052)	(0.058)	(0.052)	(0.053)	(0.052)
CBI	0.119	0.2	0.369	0.314	0.369	0.314	0.428	0.314
	(0.128)	(0.144)	(0.524)	(0.223)	(0.524)	(0.223)	(0.310)	(0.223)
Trade Openness	(0.226)	(0.250)	(0.041)	(0.055)	(0.041)	(0.055)	(0.026)	(0.055)
	(0.213)	(0.216)	(0.182)	(0.135)	(0.182)	(0.135)	(0.146)	(0.135)
StockMkt Dev*CBI		−0.002*		−0.004**		−0.004**		−0.004**
		(0.001)		(0.002)		(0.002)		(0.002)
Constant	−2.560**	−1.847*	0.528*	0.539*	0.528*	0.539*	0.516*	0.539*
	(0.999)	(0.987)	(0.303)	(0.286)	(0.303)	(0.286)	(0.291)	(0.286)
Fixed Effects	YES	YES	NO	NO	NO	NO	NO	NO
Random Effects	NO	NO	YES	YES	YES	YES	YES	YES
Estimator of Variance	S-A	S-A	S-A	S-A	B-C	B-C	B-C	B-C
Observations	489	488	85	85	85	85	85	85
Number of Countries	30	30	11	11	11	11	11	11
Ho: Difference in coef. not systematic (p-values)			0.175		0.287			

Standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.
Inflation variable is the modified inflation rate computed as: $LOG(1+\pi_{GDPDf})$ where π_{GDPDf} is the annual percentage change in GDP deflator and$GDPDf = Nominal\ GDP/Real\ GDP*100$. CBI is the annual legal CWN central bank independence index measure of a country's central bank independence. StockMktDev is a stock market development indicator; measured as the ratio stock market total value traded to GDP (%). InstQual is institutional quality variable, proxied by civil liberties, political rights score and freedom status. Trade Openness is defined as sum of exports and imports in relation to GDP. Fixed Exchange regime is a dummy constructed from the IMF database on de facto exchange regimes, using a one (1) for regimes classified as:"another currency as legal tender," "currency board," or "conventional peg against a single currency," and zero (0) otherwise. World Inflation is proxied by the average inflation rate of industrial countries, computed from the World Bank. Per Capita Income is measures as log of the ratio of real Gross Domestic Product divided by total population. Inflation Targeting variable is a dummy constructed from the IMF database, using a one (1) for inflation targeting regimes and zero(o) for non-targeting regimes.

Table 6
Developing countries.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	G2SLS	EC2SLS	EC2SLS
	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation	Inflation
l.Inflation	0.246***	−0.105	0.576***	0.273***	0.612***	0.395***	0.612***	0.281***
	(0.035)	(0.110)	(0.028)	(0.087)	(0.025)	(0.082)	(0.025)	(0.088)
World Inflation	0.293***	0.842**	0.139**	−0.183	0.139***	−0.047	0.139***	−0.195
	(0.070)	(0.392)	(0.059)	(0.280)	(0.048)	(0.268)	(0.048)	(0.281)
Fiscal Deficit	0.035***	0.009***	0.009***	0.009***	0.009***	0.009***	0.009***	0.009***
	(0.003)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fixed Exchange	−0.066**	−0.396**	−0.093***	−0.181*	−0.083***	−0.144*	−0.083***	−0.173*
	(0.029)	(0.169)	(0.023)	(0.093)	(0.022)	(0.083)	(0.022)	(0.093)
Inflation Targeting	−0.172***	−0.497***	−0.090***	−0.189**	−0.090***	−0.155**	−0.090***	−0.195**
	(0.040)	(0.136)	(0.032)	(0.087)	(0.031)	(0.075)	(0.031)	(0.087)
StockMkt Dev	0.001*	0.003	0.000	0.001	0.000	0.000	0.000	0.001
	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
InstQual	0.005	0.046	−0.005	0.001	−0.006	−0.01	−0.006	0.001
	−0.011	−0.029	−0.006	−0.021	−0.006	−0.019	−0.006	−0.021
Per Capita GDP	0.188	0.791	0.015	0.167	0.039	0.146	0.039	0.159
	(0.147)	(1.094)	(0.027)	(0.134)	(0.025)	(0.106)	(0.025)	(0.137)
CBI	−0.264***	−0.127	0	−0.138	−0.021	−0.14	−0.021	−0.116
	(0.097)	(0.523)	(0.053)	(0.217)	(0.050)	(0.179)	(0.050)	(0.218)
Trade Openness	0.459***	3.076**	0.325***	0.655*	0.330***	0.548*	0.330***	0.681*
	(0.165)	(1.239)	(0.080)	(0.375)	(0.077)	(0.309)	(0.077)	(0.376)
StockMkt Dev*CBI		−0.004		−0.004*		−0.003*		−0.004*
		(0.004)		(0.002)		(0.002)		(0.002)
Constant	0.09	−1.01	0.337***	0.428	0.240**	0.314	0.240**	0.441
	(0.489)	(3.692)	(0.102)	(0.509)	(0.096)	(0.428)	(0.096)	(0.522)
Fixed Effects	YES	YES	NO	NO	NO	NO	NO	NO
Random Effects	NO	NO	YES	YES	YES	YES	YES	YES
Estimator of Variance	S-A	S-A	S-A	S-A	B-C	B-C	B-C	B-C
Observations	861	115	862	115	967	115	967	115
Number of Countries	57	22	57	22	57	22	57	22
Ho: Difference in coef. not systematic (p-values)			0.421		0.423			

Standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.
Inflation variable is the modified inflation rate computed as: $LOG(1+\pi_{GDPDf})$where $\pi_{GDPDf}$is the annual percentage change in GDP deflator and$GDPDf = Nominal\ GDP/Real\ GDP*100$. CBI is the annual legal CWN central bank independence index measure of a country's central bank independence. StockMktDev is a stock market development indicator; measured as the ratio stock market total value traded to GDP (%). InstQual is institutional quality variable, proxied by political rights score. Trade Openness is defined as sum of exports and imports in relation to GDP. Fixed Exchange regime is a dummy constructed from the IMF database on de facto exchange regimes, using a one (1) for regimes classified as:"another currency as legal tender," "currency board," or "conventional peg against a single currency," and zero (0) otherwise. World Inflation is proxied by the average inflation rate of industrial countries, computed from the World Bank. Per Capita Income is measures as log of the ratio of real Gross Domestic Product divided by total population. Inflation Targeting variable is a dummy constructed from the IMF database, using a one (1) for inflation targeting regimes and zero(0) for non-targeting regimes.

the interactive variable between stock market development and CBI, and inflation. Meaning that, higher levels of CBI, in higher levels of stock market development, lead to lower inflation. On average, the stock market is developed in developing countries, than in Africa. This could potentially explain the reason why it plays a significant role in inflation reduction in developing countries than in Africa.

Comparing the effect of banking sector development and stock market development on the CBI inflation nexus, from Tables 1 and 3, we can note on the basis of the significance of the interactive variable coefficients, that banking sector development, is more effective in reducing inflation than stock market development in Africa. Comparably, the banking sector is much more developed in Africa, than the stock market.

In developed countries, from Tables 2 and 4, though both banking and stock market development enhances the effectiveness of CBI, the stock market development enhances CBI effectiveness in reducing inflation more than the banking sector. This is because, the coefficient for the interactive variable between stock market development and CBI, is higher (0.004) than that for banking sector development and CBI (0.001). This can be attributed to the dominance of the stock market in most developed countries.

In developing countries, from Tables 3 and 5, we find that the banking sector, enhances the effectiveness of CBI more than the stock market. On average, the coefficient of the interactive variable *FinDev*CBI*, is higher than that of *StockMktDev*CBI*. This can be attributed to the dominance of the banking system in most developing countries, thereby acting as a more effective tool to enhance the effectiveness of CBI.

5. Conclusion

The independence of the central bank and its effect on inflation has been examined by many studies with varying results. In earlier studies, the use of pooled OLS estimates basically failed to consider the heterogeneity of the countries sampled. This could have accounted for the negative relationship they identified between CBI and inflation. However, as Pesaran (2006) indicated, a pooled estimation procedure for (dynamic) panel models can produce inconsistent and misleading estimates of the long-run coefficients. The studies further fail to account for heteroscadasticity and autocorrelation in the data which could result in the estimates generated, being inefficient. These have been confirmed in this study as these estimation techniques provided similar findings to earlier studies.

But when these issues are addressed by more appropriate

estimators and models, taking into account the effect of endogeneity of the CBI variable as well as the effect of lagged inflation on the dependent variable, the direct negative relationship between CBI and inflation, fails to hold in African and developing countries. The relationship is however further confirmed in developed countries. The study finds evidence to the effect that, well developed financials systems and institutions improve the effectiveness of central bank independence in achieving lower inflation rates.

In Africa, where earlier studies did not identify any direct relationship between CBI and inflation, the findings of this study establish that, improving Africa's financial sector and institutions, would benefit central bank reforms objectives on the continent.

This supports the point by Posen (1993) that the financial and political system are needed to support CBI reforms to succeed in reducing inflation. This is achieved through the overall and general reputation that is created in the economy and market of institutions such as the central bank, that they would be given the free hand to be independent of government. This works to hold down inflationary expectations, resulting in low levels of inflation. A well developed financial sector also plays the role of ensuring good corporate governance practices of the central bank, to ensure that its independence from political authorities is maintained. Doing this can help African governments achieve the objective of having a monetary union and a single currency.

The results are robust to the income levels of countries as in both developed and developing countries, financial development and institutional quality were useful conditioning variables, for CBI to reduce inflation. The study also finds that, stock market development enhances the effectiveness of CBI in reducing inflation in developed and developing countries. However, this was not the case for African countries, where the stock markets are under developed relatively. Between banking sector development and stock market development, the banking sector, enhances CBIs' effectiveness in reducing inflation more than the stock market does in Africa and developing countries. In developed countries however, CBI's effectiveness in reducing inflation, is higher with stock market development than banking sector development. Therefore, independent central bankers and policy makers in Africa can focus on developing the banking sector more, as a mean of achieving lower inflation levels effectively. Future studies can further explore the robustness of the findings by considering other measures of financial development and institutional quality such as measures of size, efficiency and access to the bond market. The issue of unavailable data for most African and developing countries for the study period could not allow the study to consider that.

Appendix 1 List of countries

Africa	Developing		Developed
Algeria	Afghanistan	Libya	Antigua & Barbuda
Angola	Albania	Macedonia	Australia
Benin	Algeria	Madagascar	Austria
Botswana	Angola	Malawi	Bahamas
Burkina Faso	Antigua & Barbuda	Malaysia	Barbados
Burundi	Argentina	Maldives	Belgium
Cameroon	Armenia	Mali	Canada
Cape Verde	Azerbaijan	Mauritania	Chile
Central African Republic	Bangladesh	Mauritius	Chile
Chad	Belarus	Mexico	Croatia
Comoros	Belize	Moldova	Cyprus
Congo, Democratic Rep.	Benin	Mongolia	Czech Republic
Congo, Republic of	Bhutan	Montenegro	Denmark
Djibouti	Bolivia	Morocco	Estonia
Egypt	Bosnia-Herzegovi	Mozambique	Finland
Equatorial Guinea	Botswana	Myanmar (Burma)	France
Eritrea	Brazil	Namibia	Germany
Ethiopia	Burkina Faso	Nepal	Greece
Gabon	Burundi	Nicaragua	Hungary
Gambia	Cambodia	Niger	Iceland
Ghana	Cameroon	Nigeria	Ireland
Guinea	Cape Verde	Pakistan	Israel
Guinea-Bissau	Central African Republic	Panama	Italy
Ivory Coast	Chad	Papua New Guinea	Japan
Kenya	Colombia	Paraguay	Korea, Republic of
Lesotho	Comoros	Peru	Kuwait
Liberia	Congo, Democratic Rep.	Philippines	Latvia
Libya	Congo, Republic of	Romania	Lithuania
Madagascar	Costa Rica	Russian Federation	Luxembourg
Malawi	Djibouti	Rwanda	Malta
Mali	Dominica	Saint Lucia	Netherlands
Mauritania	Dominican Republic	Samoa	New Zealand
Mauritius	Ecuador	Sao Tome and Principe	Norway
Morocco	Egypt	Senegal	Poland
Mozambique	El Salvador	Seychelles	Portugal
Namibia	Equatorial Guinea	Sierra Leone	Qatar
Niger	Eritrea	Solomon Islands	San Marino
Nigeria	Ethiopia	Somalia	Saudi Arabia
Rwanda	Fiji	South Africa	Singapore
Sao Tome and Principe	Gabon	Sri Lanka	Slovakia
Senegal	Gambia	St. Vincent and the Gredines	Slovenia

(*continued*)

Africa	Developing		Developed
Seychelles	Georgia	Sudan	Spain
Sierra Leone	Ghana	Suriname	St. Kitts and Nevis
Somalia	Grenada	Swaziland	Sweden
South Africa	Guinea	Syria	Switzerland
Sudan	Guinea-Bissau	Tanzania	Taiwan
Swaziland	Guyana	Thailand	Trinidad and Tobago
Tanzania	Haiti	Timor-Leste	United Arab Emirates
Togo	Honduras	Togo	United Kingdom
Tunisia	India	Tonga	United States of America
Uganda	Indonesia	Tunisia	
Zambia	Ivory Coast	Uganda	
Zimbabwe	Jamaica	Ukraine	
	Jordan	Uruguay	
	Kazakhstan	Vanuatu	
	Kenya	Venezuela	
	Laos	Vietnam	
	Lebanon	Yemen	
	Lesotho	Yugoslavia (Socialist Rep)	
	Liberia	Zambia	
		Zimbabwe	

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