



# **ASHESI UNIVERSITY COLLEGE**

## **AN EMPIRICAL ANALYSIS OF CENTRAL BANK INDEPENDENCE IN SUBSAHARAN AFRICAN COUNTRIES**

### **DISSERTATION**

Thesis submitted to the Department of Business Administration, Ashesi University College, in partial fulfilment of the requirements for the award of Bachelor of Science degree in Business Administration

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**April 2018**

**DECLARATION PAGE**

I hereby declare, that this dissertation is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's signature: .....

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Date: April 2018

I hereby declare, that the preparation and presentation of the dissertation were supervised in accordance with the guidelines on supervision of dissertation, laid down by Ashesi University College.

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Date: April 2018

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**ABSTRACT**

Often, central bank independence (CBI) is seen as one of the optimal institutional devices to guarantee price stability. The ample literature on CBI suggests that CBI is negatively correlated with inflation. Consequently, the turn of the 20<sup>th</sup> century has seen several countries enshrine in their central bank's charter what its limits of independence are. Empirical studies on central bank independence, however, yield inconclusive results due, in part, to the difficulty in conceptualizing and measuring CBI. In the literature, the often-used indicators of CBI, legal-based CBI indices are based on the autonomy enjoyed by central banks as covered in their charter. Other attempts have been made to estimate the actual independence enjoyed by central banks.

Empirical studies on CBI using either legal-based indices or estimates of actual CBI have yielded unrobust results that are very sensitive to the used CBI indicator. In developing countries, this issue is more profound as most studies use legal-based CBI indices in empirical studies. This study adopts the methodology of Eijffinger, Rooij, and Schaling (1996) to estimate an empirical CBI index. Together with a legal-based index of CBI obtained, the study carries out a Pearson correlation between the two measures of CBI and inflation in 14 sub-Saharan African countries from 1990-2016.

The findings are as follows: when the legal-based CBI indicator was used, the correlation between central bank independence and inflation was almost non-existent, inconclusive and statistically insignificant. On the other hand, when the empirical CBI index was employed to perform the Pearson's correlation between inflation and central bank independence, the results were consistent with theory. More importantly, empirical results proved to be sensitive to the CBI indicator employed.

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## **CHAPTER ONE: INTRODUCTION**

### **1.1 BACKGROUND**

Since the turn of the 20<sup>th</sup> century, central bank independence (CBI) has dominated debates seeking the optimal institutional device to guarantee price stability. The case for CBI is simple: a central bank with an explicit mandate to achieve price stability together with a high level of independence is in pole position to secure price stability (Eijffinger & de Haan, 1996, p.1). Formal work in CBI only began in the 1980s with several studies developing the theories, models, and indices employed to examine CBI empirically (Rogoff, 1985; Cukierman, 1992; Persson & Tabellini, 1993; Eijffinger & de Haan, 1996). These studies primarily sought to either provide a measure or index for CBI or investigate the relationships between CBI and several macroeconomic variables notably inflation and output growth in both developing and developed countries to make a case for more independence for central banks.

#### **1.1.1 WHAT IS CENTRAL BANK INDEPENDENCE?**

As a concept, CBI is difficult to define or quantify (Eijffinger, Rooij, & Schaling, 1996). Most often however, CBI captures how a central bank relates to the government as modeled after the relation between the judiciary and the government (Eijffinger & de Haan, 1996, p.1). Such a relation should prevent the government, except in exceptional circumstances, from inhibiting the central bank from exercising its core mandates (Lucotte, 2009, p.4). This form of CBI is termed as institutional independence or legal independence as it reflects the legal guarantees a central bank has to carry its tasks and duties without political or any external interference (Issing, 2006, p.67). Legal central



bank independence is perhaps the relatively easier type of CBI to conceptualize and measure as it is based on what is enshrined in a central bank's charter.

### **1.1.2 LEGALITY ONLY GOES SO FAR**

The literature on CBI, however, makes a fine distinction between legal independence and actual independence. The former refers to the autonomy a central bank has as enshrined in its charter. The latter, on the other hand, does not only depend on legislation but also, on several factors such as such the quality of bank personnel, management style of central bankers as well as informal arrangements between the central bank and the government (Eijffinger & de Haan, 1996, p.22). Though clearly, actual independence is a more comprehensive conceptualization of central bank independence, most empirical works on central bank independence use legal-based CBI indicators as a measure of CBI when they study the relationship between CBI and inflation. This is partly because legal independence is relatively easier to measure because it is defined by legislation, which can easily be accessed in the bank's charter.

Notwithstanding, legal CBI only pertains to one aspect of actual central bank independence (Cukierman, 1991). In existing literature, empirical studies using legal-based indices of CBI yield results that are not robust as results are very sensitive to the indicator of CBI used (Lucotte, 2009). Prominent among the several reasons explaining the inconsistent empirical results based on legal CBI is the one by Cukierman, Webb, and Neyapti (1992). They argue that central bank laws do not fully define the limit of authority of central bankers. In developing countries, Cukierman et al (1992) contend that this divergence between the legal independence and the actual independence central banks enjoy is substantially higher in developing countries than in industrial countries as

legality only goes as far as a country's respect for the rule of law and studies show that developing countries tend to be more resistant to the rule of law (Weingast, 2009).

## **1.2 PROBLEM STATEMENT**

In developing countries, particularly sub-Saharan African countries with little regard for the rule of law, employing legal-based indices developed by Cukierman et al (1991) as a measure for CBI in empirical studies as done in previous works (by Presnak, 2005; Kasseeah, Weng, & Moheput, 2011) is problematic. This is because empirical results based on legal CBI indices have been inconsistent with theory (Fischer, 1995). Based on the findings of Cukierman et al (1992), who examined CBI in a group of 51 developing countries and found a positive rather than negative relationship between CBI measured with legal indices and inflation, Fischer (1995) concludes that legal-based CBI index may not be an appropriate measure of CBI for developing economies. Fischer (1995) offers a plausible explanation: Legal CBI laws are not strictly observed in these developing countries. This makes legal CBI indices poor indicators of CBI in developing economies.

Attempts have been made in the literature to capture actual CBI as opposed to legal CBI using monetary policy reaction functions. Eijffinger et al (1996) employ a panel of ten industrial countries with a monetary response function developed by Koskela and Viren (1991) to estimate CBI based on the non-legal definition. Similarly, Fry (1998) estimates actual CBI in developing countries using a monetary policy reaction function and the assumption that fiscal policy typically eclipses the other macroeconomic policies (pp. 512). This study would thus adopt a similar methodology as Eijffinger et al (1996) and Fry (1998) to estimate an index for actual CBI in sub-Saharan Africa to complement existing literature while addressing the shortcomings highlighted above.

### **1.3 RESEARCH QUESTION**

This study will attempt to answer the following question:

- What are the socio-political and economic factors that determine actual CBI in sub-Saharan Africa (SSA)?

### **1.4 RESEARCH OBJECTIVES**

This study aims

- To determine the extent that legal CBI reflects actual CBI in SSA
- To determine if CBI is correlated with inflation in SSA

### **1.5 RELEVANCE OF STUDY**

The reemergence of debates on CBI has led many to question whether CBI still matters. For sub-Saharan African economies with the mission to reform their fiscal and monetary policies to achieve economic growth, the need to join the CBI debate is more pressing. In the problem statement, the overt divide between legal CBI and actual CBI and the need for governments to do more to guarantee the actual autonomy of central banks to carry out their mandate have been highlighted, hence, the reason for this study.

This study contributes to existing literature by attempting to empirically estimate actual CBI index on a panel of 14 sub-Saharan African economies to assess the effect of central-bank independence on inflation. It also augments the aspect of the literature that solely employs legal CBI indices to evaluate the relationship between CBI and macroeconomic variables in sub-Saharan Africa. More so, the findings in this study can inform lawmakers to set up regulations to restrict governments intervention in monetary policy formation.

## **1.6 SCOPE OF THE STUDY**

This research serves to add to existing literature on the subject. It focuses on two CBI indicators, a legal index, CWN and an empirical index, and inflation between the period of 1990-2011. The data period was chosen to give a more current and objective finding as in this period, the central banks of countries under discussion began to enjoy more legal independence. Thus, the Pearson correlation undertaken in this study between CBI and inflation best explains trends within the scope of the data periods. Hence, caution must be exercised when making generalization based on findings from this paper. Findings are best limited to the selected SSA countries and to the years under review or years that are reasonably close to those observed in this paper.

## **1.7 OVERVIEW OF RESEARCH METHODOLOGY**

This study adopts the methodology of Presnak (2005), albeit on a different dataset. Using a pool of data from 14 sub-Saharan African countries, the study will estimate an empirical index of CBI, in addition to a legal index of CBI obtained from the study by Bodea and Hicks (2015) who extends the CWN index developed by Cukierman et al (1992). Similar to Presnak's (2005) research, this study carries out a Pearson correlation between the two measures of CBI and inflation.

The SSA countries under study are Angola, Botswana, Ethiopia, Ghana, Kenya, Namibia, Nigeria, Malawi, Mauritius, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe. The studies by Nhavira and Ocran (2014) and Presnak (2005) provide the basis for selecting these countries based on their relatively high level of legal independence. The methodology of this study differs from Presnak's (2005) in three dimensions: Firstly, it uses an empirical index of CBI developed using the framework of

Eijffinger et al (1996) as informal independence instead of TOR. In addition, a relatively larger sample is used. Finally, the sample period, 1990-2016 is more current and relevant.

### **1.8 OUTLINE OF STUDY**

The rest of the study is outlined as follows: Chapter 2 reviews the literature by evaluating both the theoretical underpinnings and the empirical work on CBI. Chapter 3 captures and discusses the methodology employed in the research. Chapter 4 analyzes the data collected with panel data econometric analysis and Pearson's correlation analysis. Chapter 5 discusses the key findings and provides relevant recommendations.

## **CHAPTER TWO: LITERATURE REVIEW**

### **INTRODUCTION**

In this chapter, I provide a brief review of the theories underlying central-bank independence. In addition, I review the extensive empirical studies on the central-bank independence investigating the effect of central-bank independence on policy outcomes such as inflation. Finally, I provide an overview of central-banking in sub-Saharan Africa.

### **2.1 THEORETICAL REVIEW**

The more prominent theory underlying central-bank independence stems from arguments by Kydland and Prescott (1977) and further developed by Barro and Gordon (1983) on the time-inconsistency problem of monetary policy-making. Time-inconsistency problem arises when an optimal policy planned for some future time becomes obsolete and less optimal when that future time starts (Eijffinger and de Haan, 1996, p.5). In the framework of monetary policy, time-inconsistency problem arises because there exist incentives for a politically motivated policymaker to exploit the short-run Phillips curve (Kasseeah et al, 2011). That is, as government suffers an inflationary bias to pursue expansionary policies for short-run output growth at the expense of rising inflation, year-on-year inflation becomes sub-optimal (de Haan et al, 2008, p.718).

A study by Rogoff (1985) affirms that, indeed, inflationary bias resulting from time-inconsistency problem exists when central banks are under government influence. Thus, delegating monetary policy to a more conservative and independent central bank, which is often inflation-averse than the government can reduce this inflationary bias (Rogoff, 1985; de Haan et al, 2008; Nhavira & Ocran, 2014). Eijffinger and de Haan (1996)

further identify two other theoretical arguments made for why central bank independence is desirable: the public-choice view and arguments based on the analysis of Sargent and Wallace (1981) (p. 4).

The public-choice view, according to Eijffinger and de Haan (1996), suggests that central banks will render above optimal inflation when they are exposed to strong political pressures to act in accordance with government's preference. In contrast, Sargent and Wallace (1981) suggest that the extent to which central banks can finance government deficit without compromising achieving their mandate determines the level of inflation. The conclusion thus far is simple: the more independent a central bank, the less compelled it is to finance government deficit through seigniorage (Kasseeah et al, 2011). All these theoretical grounds simply answer the question why central-bank independence would yield lower rates of inflation, *ceteris paribus* (Eijffinger & de Haan, 1996).

## **2.2 EMPIRICAL REVIEW**

Empirical evidence shows that industrial countries with independent central banks tend to have lower inflation. In developing countries, empirical results are not robust.

### **2.2.1 EMPIRICAL STUDIES ON OECD COUNTRIES**

Most of the significant empirical work in this literature was published in the 1980s: seminal articles by (Bade & Parkin, 1988; Grilli, Masciandaro & Tabellini, 1991; Cukierman, Webb & Neyapti, 1992; Alesina & Summers, 1993) form the basis for empirical analysis on CBI. Most empirical studies usually explore the relationship between central bank independence and a policy outcome such as inflation outcome, budget deficit, and output growth. Measuring or choosing an appropriate measure of

central-bank independence for empirical studies still remains the first and main challenge of undertaking empirical studies on CBI (Lucotte, 2009).

The first paper, by Bade and Parkin (1988), regresses inflation on a legal index of CBI capturing only political independence. They develop a (1-4) scale of legal index of CBI by examining the characteristics of central bank laws of twelve OECD countries. Their results were consistent with theory: they found that countries with highly independent central banks had significantly lower average rate of inflation. Similarly, Grilli, Masciandaro, and Tabellini (1991) investigate whether inflation is related to central-bank independence in 18 OECD countries. Unlike Bade and Parkin (1988), Grilli et al (1991) distinguish between, and develop two indexes for, economic independence and political independence of central banks: The former borders on freedom of a monetary authority to choose the final goals of policy while the latter refers to the central bank's autonomy to choose their preferred instruments of monetary policy (Grilli et al, 1991, p.368).

Grilli et al estimate the effect of the two indexes of CBI: indexes for economic and political independence respectively on inflation rate over the sample period of 1950-1989. Similar to Bade and Parkin (1988), their result is consistent with theory: the two indicators of central-bank independence have the expected (negative) sign. The methodology employed by Grilli et al allows them to make yet a significant observation: Grilli et al divide the sample period into four decades and estimate, using seemingly unrelated regressions, the effect of the indicators of central-bank independence on inflation over the four decades. They found that the indicator of political independence is



significant only in the 1970s while the indicator of economic independence is significant only in the periods of high inflation (Grill et al, 1991).

A study by Alesina and Summers (1993) goes beyond investigating the relation between inflation and CBI to finding the correlation between CBI and levels of real economic growth such as output, unemployment, and real interest rates. Their measure of CBI is the average of the legal indicators developed by Bade and Parkin (1988) and Grilli, Masciandaro, and Tabellini (1991). With data from 16 OECD countries over a sample period of 1955-1988, Alesina and Summers (1993) plot the various measures of economic performance against their measure of CBI. They found the following: inflation and central bank independence are near perfect negatively correlated. There appears to be no correlation between central-bank independence and economic growth measured with Real GNP growth. Similarly, they found that unemployment and real interest rate have no clear relation with their measure of CBI.

The fourth, and quite comprehensive, seminal paper in this literature, by Cukierman, Webb, and Neyapti (1992) undertakes a similar exercise relating inflation to central-bank independence. The study by Cukierman et al differ from earlier studies (Bade & Parkin, 1988; Grilli, Masciandaro & Tabellini, 1991) in three dimensions: Firstly, their study employs a larger set of countries (21 industrial and 51 developing countries. In addition, the sample period goes as far back to the 1950s. Finally, they develop, in addition to a more comprehensive legal index of CBI, three other measures of CBI to capture actual CBI in practice.

In developing their legal index of CBI, Cukierman et al aggregate sixteen legal variables based on information from central banks' charter. The more prominent measure among the other three indicators is the Turnover Rates (TOR) of central bank governors as it is often used as a proxy for actual central-bank independence (Lucotte, 2009). Cukierman et al (1992) estimate the effect of the four indicators of CBI on inflation rate over the sample period of 1950-1989 by running regressions on inflation with the indicators of central-bank independence over the entire dataset. They also run regressions on two subsamples including only industrial countries and only developing countries respectively. For industrial countries, the aggregate legal index has statistically significant coefficient with the expected (negative) sign. This is in stark contrast to results on developing countries: the aggregate legal index is statistically insignificant. Uncharacteristically, the expected sign of the coefficient of the aggregate legal index is also positive, which suggests that the higher the independence, the higher inflation. This is inconsistent with theory.

Fischer (1995) offers some insight to explain these anomalous empirical results by Cukierman et al's (1992) on developing countries. In his view, central bank laws are often not observed in these countries. In short, the independence of central banks, as enshrined in their charter, does not reflect what occurs in practice. Thus, legal index of central-bank independence may differ greatly from actual CBI resulting in inconsistent empirical results. In their study, Cukierman et al (1992) offer a more comprehensive criticism of legal indicators of central-bank independence: They identify two fundamental shortcomings of indicators based on law:

First, the laws [central bank laws] are incomplete in that they cannot specify explicitly the limits of authority between the central bank and the political authorities under all contingencies. These voids are filled by tradition at best and by power politics at worst.

Second, even when the law is quite explicit, actual practice may deviate from it (Cukierman et al, 1992, p.355).

To address the above shortcomings of legal indicators of CBI identified by Cukierman et al (1991), Eijffinger, Rooij, & Schaling (1996) adopts a somewhat different approach to measure CBI. The authors pool quarterly data from 1977 to 1990 for 10 OECD countries and regress interest rate on inflation, GDP growth rate, current account balance as a percentage of GDP. Using panel data regression techniques, they extrapolate unobserved heterogeneity across countries that they interpret as an empirical index of central-bank independence. To them, the unobserved heterogeneity across countries capture structural differences that affect monetary authorities' ability to respond to inflation, output, and current account surplus. The empirical results of their study are consistent with theory: They found that their empirical index for actual CBI showed a significant negative relationship between CBI and inflation.

### **2.2.2 EMPIRICAL EVIDENCE IN DEVELOPING COUNTRIES**

Following the studies of Cukierman et al (1991) which provided inconsistent results, studies, such as Presnak (2005), Lucotte (2009) and Kasseeah et al (2011), have investigated the effect of CBI on inflation in developing economies and particularly, in sub-Saharan Africa. For these studies, the legal index of CBI developed by Cukierman et al (hereafter CWN) remains the more widely used indicator of CBI. Few employ TOR as an alternative measure of CBI. Generally, empirical results in this part of the literature are

contradictory. In one study, results are consistent with theory; in another, results are inconsistent.

A study by de Haan and Sikken (1998) employs various indicators for central bank independence to examine the relationship between central bank independence and government budget deficits. Their research tests the fiscal dominance theory developed by Sargent and Wallace (1988). With data on 30 developing countries for the sample period 1950-1994, they regress the average budget surplus as a percentage of GDP on the various measures of central-bank independence. Their findings suggest that legal indicators of independence are not related to policy performance. The coefficient of TOR was consistent with theory.

Similarly, Lucotte (2009) investigates the influence of central bank independence on budget deficits in developing country. He employs both CWN and TOR as the measures of CBI to analyze a panel of data between 1995-2004. The empirical model he specifies defines budget surplus as a function of GDP, CBI, agriculture as a percentage of GDP and other regional dummies. He estimates a panel regression of the empirical model using random effects models. His results were as follows: the estimated coefficient of CWN was statistically insignificant (Lucotte, 2009, p.16). The estimated coefficient of TOR was however significant and had the expected sign. His results confirm that legal indices are not appropriate for developing countries. Like Fischer (1995), he ascribes this the existence of weak institutions in developing countries which deviate from the law (Lucotte, 2009).

### **2.2.3 EMPIRICAL EVIDENCE IN AFRICA, PARTICULARLY SSA**

Narrowing down to Africa and particularly, sub-Saharan Africa, very few empirical studies have been undertaken on central-bank independence (Kasseeah et al, 2011). The study of Presnak (2005) is by far the more comprehensive empirical study of central-bank independence in sub-Saharan Africa. She examines both informal and legal independence of central banks in eleven sub-Saharan African countries including Tanzania, Kenya, Zaire, Ethiopia, Uganda, Nigeria, Botswana, Zambia, Ghana, South Africa, and Zimbabwe (Presnak, 2005). She develops a legal indicator of central-bank based on the study of Cukierman et al (1991) in addition to using a proxy of actual independence, TOR developed also by Cukierman et al (1991).

The methodology employed by Presnak is as follows: First, she runs a bivariate analysis on the two indexes of central-bank independence (CWN and TOR) to determine whether legal independence reflects actual independence in the sample of sub-Saharan African countries using data from 1960-1980. Her study then examines the relationship between the legal indicator of CBI and inflation as well as the relationship between debt and TOR using Pearson's correlation. Her findings are as follows. Pearson coefficient of correlation for legal independence (CWN) and informal independence (TOR) is statistically insignificant reinforcing Cukierman et al's (1991) view that legal independence does not reflect actual, (in this case, informal) independence. Pearson coefficient of correlation for central bank independence and Inflation is insignificant for both indicators of CBI.

Not only does her findings affirm the concurrent findings that using legal independence renders inconsistent empirical results, they also contradict Cukierman et

al's findings that high informal independence (as measured by TOR) leads to low inflation rates in developing countries (Cukierman et al, 1991, p.372). Unlike Presnak (2005), the empirical study by Kasseeah et al (2011) on central bank independence in Africa renders more consistent results with theory. They collect a panel of data on 20 countries from 1988 to 2007 and regress inflation rate on the exchange rate, GDP growth rate, unemployment, and either one of the two proxies of central-bank independence, TOR, and government deficit. Kasseeah et al found that TOR had the expected sign and was also statistically significant.

To further affirm the wide discrepancy between legal independence and actual independence in sub-Saharan Africa, Tindleni (2006) assesses the central-bank independence in South Africa after it had adopted Inflation Targeting. He adopts the procedure of Cukierman et al (1991) to develop a legal indicator of CBI. In addition, he uses responses from structured interviews with South African Reserve Bank (SARB) as well as eleven economists to develop two proxies of actual CBI. He finds that the SARB has a significantly higher actual independence than legal independence. Though this result affirms that legal independence differs from actual independence in developing countries, the methodology to develop the two indicators of actual central-bank independence is problematic for two reasons: First, there is a lot of subjectivity in weighing the responses from the structured interviews. In addition, the views of eleven economists, mainly economists in the private sector, may not be representative of all economists in South Africa, which may distort results.

### **2.3 OVERVIEW OF CENTRAL BANKING IN SSA**

At the preliminary stages of central banking in SSA, monetary policy was subordinated to fiscal policy (Ajakaiye & O'Connell, 2011). Between 1960-1989, central banks in SSA had functioned within a developmental agenda dictated by fiscal authorities. Thus, the whole object of central banking in SSA was to fill chronic financing gaps of fiscal authorities while employing direct controls to provide insulation of inflation (Ajakaiye & O'Connell, 2011, p. 4). As a result, central banks in SSA economies were largely undeveloped and lacked the capacity to protect themselves from government intervention (Presnak, 2005). That is, governments, seeking considerable freedom to manipulate monetary policy, established weak central banks to finance government deficits through seigniorage (Presnak, 2005; Kasseeah et al, 2011). This unsurprisingly limited CBI in SSA and inhibited the ability of central banks to implement inflation-fighting policies.

In contrast to the above, the turn of 1990 witnessed the evolution of monetary policy in SSA. Central banks in SSA economies have covered extraordinary distance to reform their monetary policy. Chief among these reforms is the revision of the central banks' charter to increase priority allotted to maintaining price stability. That is, countries in SSA elevated inflation control as the dominant objective of monetary policy (Ajakaiye & O'Connell, 2011, p.5). The obvious conclusion thus far is that such reforms should improve the independence of the central banks in SSA economies. Consequently, these reforms should keep inflation low and stable to reaffirm the popular consensus that the higher the degree of central bank independence, the lower the inflation level and its variability (Eijffinger & de Haan, 1996).

## **CHAPTER THREE: METHODOLOGY**

### **INTRODUCTION**

The purpose of this study is to empirically assess central-bank independence in sub-Saharan Africa. In this chapter, I provide a detailed description of the research design adopted to investigate the relationship between central-bank independence and policy outcomes such as inflation. The data, period, and interval, as well as the data collection procedure, are discussed in this chapter. I also highlight in this chapter the methods of data analysis employed and the statistical tools used. I conclude with some limitations of my methodology.

### **3.1 RESEARCH DESIGN**

This study uses regression and Pearson correlations to investigate the relationship between central-bank independence and inflation in sub-Saharan Africa. This study will adopt two measures of central-bank independence: the CWN legal index of CBI developed by Cukierman et al (1992) and an empirical index of CBI (hereafter, EMP) this paper estimates using a conceptual framework developed by Eijffinger et al (1996). The approach employed to estimate the empirical index of CBI will be further expounded in the chapter. This study systematically employs econometric techniques to estimate an empirical index of central-bank independence by pooling data on 14 sub-Saharan African (SSA) countries and using the fixed-effects regression models to extrapolate unobserved heterogeneity across countries, which it interprets as the empirical index of CBI as per the adopted conceptual framework.

After estimating the empirical index of CBI, the research adopts the correlational approach to doing quantitative research. This allows the study to explore the relationship



between central-bank independence and policy outcomes such as inflation using the two measures of central-bank independence, CWN, and EMP with Pearson's Correlation.

### 3.2 HYPOTHESIS

This study develops an empirical index of CBI, in addition to CWN, to assess the relationship between CBI and inflation. The theoretical review in Chapter 2 suggests that a higher degree of CBI yields lower rates of inflation. The hypotheses to be tested in this study is defined as follows.

$H_0$ : Central bank independence is not correlated with inflation.

$H_1$ : Central bank independence is correlated with inflation.

### 3.3 DATA

The data primarily consists annual data on interest rates, inflation rate, GDP growth rate and current account balance as a percentage of GDP. An index for democracy and an election dummy based on years when the election took place are also gathered. This type of data collected for the study is secondary in nature. As such, data were consolidated from multiple secondary sources, notably the official websites of the World Bank and International Monetary Fund (IMF). The panel of data is from the 14 SSA countries under consideration.

The countries included in this study was informed by the work of Nhavira and Ocran (2014) measuring legal independence based on the CWN (1992) approach as well as the study of Presnak (2005). The sampled SSA countries are as follows: Angola, Botswana, Ethiopia, Ghana, Kenya, Malawi, Mauritius, Namibia, Nigeria, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe. These countries were chosen based on the provisions in

their central bank charters which presuppose that these countries have instrument independence to choose or manipulate a monetary policy instrument to achieve its goals. More so, most of the countries have adopted inflation targeting which means the go-to monetary policy instrument of the central banks in the sample is the interest rate.

The period under consideration begins from 1990-2016. This period was chosen due to the availability of data on all the variables in the model. More so, the 21-year period was chosen to increase the number of observations in the panel of data since high-frequency data such as quarterly data was not available for the sampled SSA countries. This yields a total of 378 observations if the panel of data is completely balanced.

### **3.4 DATA ANALYSIS**

This study carries out a Pearson Product-moment correlation to assess the relationship between central-bank independence and inflation using R. The following will be verified or tested to ensure that the Pearson's correlation may lead to valid results.

- Assumption 1: There needs to be a linear relationship between the two variables—CBI and inflation. This study will use scatterplots to check for linearity.
- Assumption 2: There should be no significant outliers. If there exist outliers, this study would transform the data using double-log specification.
- Assumption 3: The two variables must be approximately normally distributed. The Shapiro-Wilk test of normality will be undertaken to test for bivariate normality.

### **3.5 INDICATORS OF CENTRAL BANK INDEPENDENCE USED**

This study adopts two measures of central bank independence: the CWN and the EMP.

#### **3.5.1 CWN**

CWN is a legal index of CBI developed by Cukierman et al (1992). It aggregates 16 legal variables to reflect legal independence of central banks. The CWN index employed in this research is obtained from the study by Bodea and Hicks (2015) who extends the CWN index developed by Cukierman et al (1992) for 144 countries covering the years 1972 to 2015.

#### **3.5.2 EMP**

The EMP is the empirical index of CBI to be estimated by this study. The study adopts a conceptual framework developed by Eijffinger et al (1996) to estimate the EMP. It is based on the work of Koskela and Viren (1991) on monetary policy reaction functions. Monetary policy reaction function relates a “policy instrument to a set of internal and external (current and lagged) target variables” (Koskela & Viren, 1991, p.454). The monetary policy reaction function specified in Koskela and Viren (1991) assumes that monetary authorities act to maximize an intertemporal welfare function, which is subjected to an implicit perceived (econometric) model of the economy and considers the lagged effect of policies. Thus, monetary authorities would either increase or decrease interest rate as a response to either a rise or fall in inflation, unemployment, or current account (Koskela & Viren, 1991).

The monetary policy reaction function specification adopted by Koskela and Viren (1991) is as follows:

$$\Delta r_t = b_0 + b_1 p_t + b_2 p_{t-1} + b_3 y_t + b_4 y_{t-1} + b_5 ca_t + b_6 ca_{t-1} + e_t$$

where  $r$  is interest rate,  $p$  is inflation rate,  $y$  is output rate and  $ca$  is current account surplus as a percentage of GDP.

It is this specification above that Eijffinger et al (1996) extend as they estimated an empirical index of central-bank independence by estimating monetary policy reaction functions for ten OECD countries. They argue that central banks' reaction to inflation, economic growth and current account surplus using interest rate not only depend on these variables, but also on unobserved heterogeneity across countries. In their view, the unobserved heterogeneity across countries capture the “different structural pressures” central banks face to either raise or lower interest rates and can be interpreted as actual central bank independence.

### 3.5.2.1 MODEL SPECIFICATION

The econometric specification employed to estimate the EMP is expressed in the reduced form that fits the data as follows.

$$\begin{aligned} \Delta r_{i,t} = & b_0 + b_1 p_{i,t} + b_2 p_{i,t-1} + b_3 y_{i,t} + b_4 y_{i,t-1} \\ & + b_5 ca_{i,t} + b_6 ca_{i,t-1} + CBI_i + e_t \end{aligned} \quad (1)$$

WHERE  $r_{i,t}$  is interest rates of country  $i$  at any time  $t$ ,  $p_{i,t}$  is current value of annual inflation rate,  $p_{i,t-1}$  is lagged value of annual inflation rate,  $y_{i,t}$  is current value of annual GDP growth rate,  $y_{i,t-1}$  is lagged value of annual GDP growth rate,  $ca_{i,t}$  is current value

of annual current account balance as a percentage of GDP,  $ca_{i,t-1}$  is lagged value of annual current account balance as a percentage of GDP, and  $CBI_i$  is the unobserved heterogeneity for each country  $i$ . The  $CBI_i$ , according to Eijffinger et al (1996), captures the structural differences between the countries in the sample with respect to implementing monetary policy, which this study infers as an empirical index of CBI. However, such structural differences across individual countries cannot be observed directly and thus, cannot be included in the model as an observed independent variable.

To estimate this unobserved heterogeneity across individual countries, one has to run a simple regression with variable intercepts (Hsiao, 2014). Specification (1) above can further be rewritten into a variable-intercept model as shown below.

$$\Delta r_{i,t} = EMP_i + \beta' x_{i,t} + e_{i,t} \quad (2)$$

where the  $EMP_i$  equals  $CBI_i + b_0$  as both  $CBI_i$  and  $b_0$  are constants and cannot be identified or estimated separately (Eijffinger et al, 1996, pp. 167-169).  $X_i$  is the proxy for all the independent variables employed in this model and  $e$  captures the error term. With variable-intercept models, the unobserved heterogeneity across individuals can either be driven by individual time-invariant variables, period individual-invariant or individual time-varying variables (Hsiao, 2014, p. 31). Eijffinger et al (1996) assume that the  $CBI_i$  is driven by individual time-invariant variables. Thus, unobserved heterogeneity across countries are fixed over time. Fixed-effects regression analysis will be used to estimate the  $EMP_i$ .

### 3.5.2.2 ESTIMATING THE EMP

The variable-intercept model specified in specification (2) can be estimated in R using either the least-square dummy variable (LSDV) approach or the fixed effects estimator approach. Either approach includes a dummy variable for each individual country in the panel to capture the time-invariant unobserved heterogeneity across individual countries. This study adopts the fixed effects estimator approach similar to Eijffinger et al (1996). As the fixed effects estimator concentrates exclusively on variations within the individual countries to estimate the coefficient of intercept term for each country, the estimation of EMP will be more efficient and the interpretation of it will come forward in a more natural way (Eijffinger et al, 1996).

The independent variables of concern in specification (2) are current and lagged values of inflation rates, GDP growth and current account balance as a percentage of GDP which allows this study to extrapolate the  $EMP_i$ . Lagged values of the independent variables are included to account for the “potential delayed effects” of the dependent variable (Koskela & Viren, 1991, p.445). The expected sign for inflation and output growth, according to Koskela and Viren (1991), is positive as higher inflation and economic growth demand tighter monetary policy, all else held constant. A current account deficit might also lead to tighter monetary policy, *ceteris paribus*. The following control variables may be included in the model: a polity index and an election timing dummy variable.

To estimate the main variable of interest  $EMP_i$ , I generate the coefficients of the dummies for each country included in the model by the fixed effects estimator.

### **3.6 LIMITATION OF METHODOLOGY**

The inference of unobserved heterogeneity across countries as the empirical index of CBI could be farfetched as country-specific effect is a catch-all proxy and may capture unobserved variables unrelated to CBI. The study may attempt to further refine the unobserved heterogeneity across countries to only reflect structural pressures on central banks to lower or raise the interest rate. In addition, the unavailability of high-frequency data such as quarterly data on the independent variables forces this study to include periods where central banks in the sample SSA countries have no legal provisions of independence or had not adopted inflation targeting.

## CHAPTER 4: RESULTS

### 4. INTRODUCTION

This chapter presents the findings obtained from the research through statistical and empirical analysis of the data. A thorough discussion of the findings is undertaken to answer the research questions posed in chapter 1. The purpose of this chapter thus is to examine the explanatory power of two measures of central bank independence: CWN and EMP on inflation in sub-Saharan Africa.

#### 4.1 DESCRIPTIVE STATISTICS

Table 1 below captures the summary statistics of variables used in the study.

Variable	Obs	Mean	Std. Dev.	Median	Min	Max
<b>GDP (growth in %)</b>	367	4.53	4.83	4.64	-23.98	22.59
<b>INF-YOY (%)</b>	370	46.93	249.12	9.61	-9.00	3792.92
<b>Current Account (% of GDP)</b>	378	-2.69	7.89	-3.22	-28.70	49.98
<b>Discount Rate (%)</b>	282	30.91	75.80	16	2.00	975.00
<b>CWN_W</b>	344	0.42	0.10	0.40	0.22	0.63
<b>Polity Index</b>	378	2.72	5.34	4	-9.00	10.00
<b>Election Dummy</b>	378	0.20	0.40	0	0.00	1.00

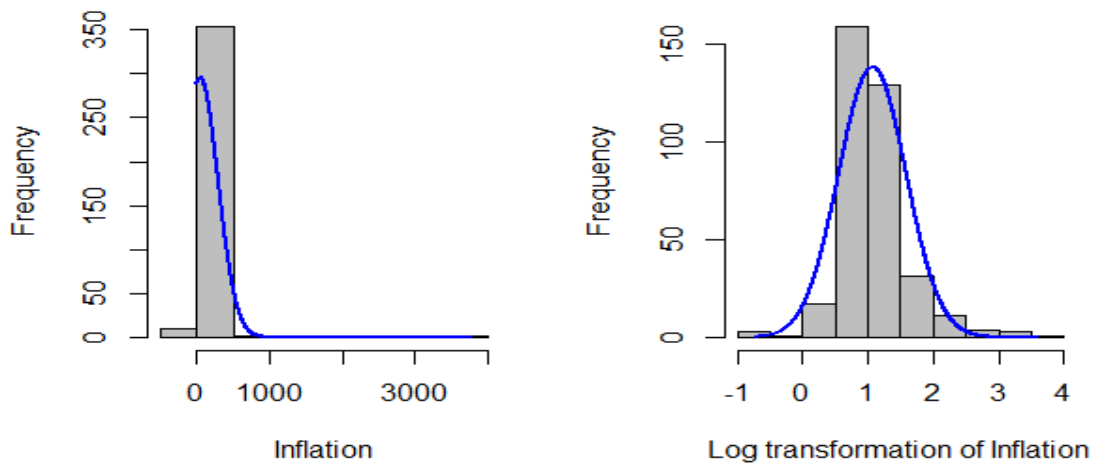
Source: Author's estimates from R

Descriptive analysis of the data revealed the following: Over the sample period of 1990-2016, the 14 SSA economies under discussion had an average annual GDP growth rate of 4.53%. Year-on-year inflation averaged 46.93% with a staggering standard deviation of about 249.12. This suggests that central banks have not been able to achieve steady inflation over the period under discussion. With a wide gap between its median



and mean, the distribution of year-on-year inflation is skewed-to-the-right. Angola and Zimbabwe, with an average year-on-year inflation rate of about 381.69% and 160.83%, are solely responsible for the skewed distribution of inflation. I thus take the log of year-on-year inflation for all subsequent analysis requiring the inclusion of year-on-year inflation. The purpose of this transformation is to bring year-on-year inflation within the range of skewness for a normal distribution. This can be seen below in figure 1 below.

**Figure 1: Before and After Taking Log of Year-on-Year Inflation**



Similarly, the central bank discount rate is also slightly skewed-to-the-right. Zimbabwe's spell of hyperinflation from 2007 accounts for this. Overall, the current account balance of the 14 SSA economies has been negative. This suggests that over the period of 1990-2016, the 14 SSA economies have imported more goods, services, and capital than they exported. The polity index, a measure of democracy averages about 2.72 suggesting that the sample SSA economies has had a blend of democratic and autocratic regimes.

#### 4.2 PRELIMINARY ANALYSIS OF CBI USING LEGAL-BASED CBI INDEX

The legal measure of CBI, CWN employed is based on the works of Cukierman et al (1992). Only the weighted index of the CWN was collected and used in my analysis. I begin the preliminary analysis hereafter by ranking the 14 SSA economies in their degree of central bank independence based on their mean CWN index over the sample period. Ethiopia, Mauritius, Zambia, and Zimbabwe have the least independent central banks.

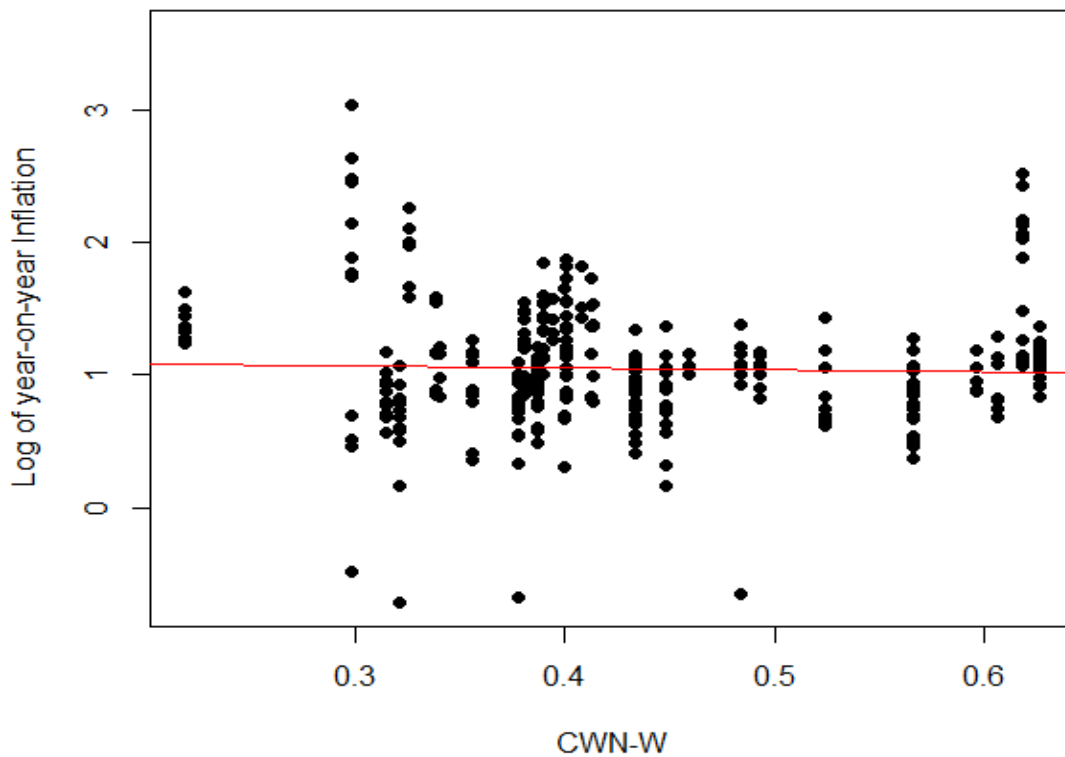
**Table 2: Rank of countries legal central bank independence**

	<b>Country</b>	<b>CWN-W</b>
<b>1.</b>	Angola	0.6120
<b>2.</b>	Kenya	0.5289
<b>3.</b>	Tanzania	0.5279
<b>4.</b>	Ghana	0.5128
<b>5.</b>	Nigeria	0.4723
<b>6.</b>	Uganda	0.4435
<b>7.</b>	Namibia	0.4339
<b>8.</b>	Malawi	0.4032
<b>9.</b>	Botswana	0.3873
<b>10.</b>	South Africa	0.3691
<b>11.</b>	Zambia	0.3674
<b>12.</b>	Ethiopia	0.3578
<b>13.</b>	Mauritius	0.3173
<b>14.</b>	Zimbabwe	0.2697

Source: Author's estimates from R

From the estimates, Angola, Kenya and Tanzania have the relatively stronger legal CBI in the sample. Ghana, Nigeria, Uganda, Namibia, Malawi, Botswana and South Africa have intermediate independent central banks. I further run a Pearson product-moment correlation to compute the relationship between the CWN-W and year-on-year inflation. With a Pearson correlation coefficient of -0.03, the correlation between the legal measure of CBI and inflation is almost non-existent as the Pearson's correlation coefficient is close to zero. Figure 2 below graphically depicts the relationship between CWN-W and year-on-year inflation. The line of best fit, which is the best possible straight line that fits the data, fitted in Figure 2 is almost horizontal with near-zero slope. This suggests that there is almost no relationship between CWN-W and inflation.

**Figure 2: Correlation between CWN-W and Inflation**



For further analysis of CBI using CWN-W, I perform a correlation test to assess the significance of the correlation between CWN-W and year-on-year inflation. The correlation test, presented in Table 3 below, failed to produce any statistically significant result similar to the findings of Presnak (2005).

**Table 3: Correlations for Legal Independence measure CWN-W and Inflation**

Pearson's Coefficient	Significance (Two-tailed)
<b>-0.03</b>	<b>-0.54309 [0.5874]</b>

\*P-value in bracket

From the results in Table 3 above, the p-value is greater than the significance level of 5%. Thus, I fail to reject the null hypothesis that the true correlation between inflation and the legal-based CBI index, CWN-W is zero. That is, the correlation between the legal measure of CBI and inflation is almost non-existent, inconclusive and statistically insignificant. This conclusion is consistent with the findings of Presnak (2005). Yet, the conclusion above does not coincide with our intuition that with the improved legal CBI in SSA over the sample period, inflation and legal CBI would at least have a statistically significant negative relationship.

I hereafter estimate an empirical index of CBI for further analysis of CBI.

#### **4.3 EMPIRICAL RESULTS: ESTIMATION OF EMPIRICAL INDEX OF CBI**

In this section, I estimate the EMP, the empirical index of CBI. Similar to Eijffinger et al (1996), I start of the estimation of the empirical index on the assumption that the unobserved heterogeneity across countries is time-invariant. I employ the fixed effects estimator approach to panel data analysis. Prior to that, I run a series of pre-estimation tests on the data in order for estimates to be robust and reliable.

### 4.3.1 UNIT ROOT TEST

A Fisher-type unit-root test based on augmented Dickey-Fuller (ADF) was performed on each of the variables in the model to test for stationarity. The hypothesis tested under the ADF unit root test is as follows.

$H_0$ : All panels contain unit roots

$H_a$ : At least one panel is stationary

**Table 4.1 below has a summary of the Fisher-type unit root test results.**

Variable	Inverse chi-squared statistic	P-value
Discount Rate	47.4258	0.0123
INF-YOY	142.3856	0.0000
GDP	173.9386	0.0000
Current Account (% of GDP)	54.4849	0.0020

Source: Author's estimates from Stata

From Table 4.1, the estimated p-values of the Fisher-type panel-data unit-root test on all the variables are less than 0.05. Based on that, I reject the null hypothesis that unit root exists in any of the variables.

### 4.3.2 CORRELATION MATRIX (MULTICOLLINEARITY)

This section assesses to what extent is multicollinearity a problem in the regression analysis. Multicollinearity exists whenever an independent variable employed in a multiple regression model has a very high correlation with one or more of the other independent variables (Allen, 1997). All else being equal, an independent variable which is highly correlated with other independent variables will have relatively large standard errors, thereby undermining the statistical significance of that independent variable

(Allen, 1997, p. 177). Near-perfect collinearity, however, makes the estimation of coefficients indeterminate as it becomes impossible to compute the inverse of the matrix of covariances among the independent variables.

If one suspects the existence of multicollinearity in a regression model, one can inspect the matrix of correlations among the independent variables. Low pairwise correlations may indicate that multicollinearity may not be an issue in the regression model. Table 4.2 below presents a correlation matrix containing the correlations coefficients between all possible pairs of the independent variables in the regression model.

**Table 4.2: Correlation matrix of independent variables**

	<b>GDP</b>	<b>INF-YOY</b>	<b>CUR_ACC_BAL</b>
<b>GDP</b>	1.00		
<b>INF-YOY</b>	-0.22	1.00	
<b>CUR_ACC_BAL</b>	0.12	-0.06	1.00

From the Table 4.2 above, none of the correlations estimates are near-perfect (that is, close to 1 or -1). Due to the low pairwise correlations in Table 4.2 above, which may indicate that multicollinearity may not be an issue in the model, I retain all the variables in the model for subsequent analysis.

### 4.3.3 THE REGRESSION OUTPUT

In chapter 3, we specified the model below as the variable-intercept model used to estimate the EMP.

$$\Delta r_{i,t} = EMP_i + \beta' x_{i,t} + e_{i,t}$$

Table 5.1 presents initial estimations of the coefficients of the independent variables used in the model. I ran two separate regressions in a bid to select the best specification that fits the data. Regression (1) is based on the monetary policy reaction function specified by Eijffinger et al (1996). In regression (2), I include a polity index and an election dummy as control variables. The results of regression (1) differ slightly from regression (2).

In both regressions, the signs of the coefficients of current and lagged year-on-year inflation variables, lagged GDP variable and current account balance conform to theory. The coefficients of these variables except current account balance have positive signs. This suggests that central banks respond to inflation and economic growth by implementing a more restrictive monetary policy. From regression (1), when previous year's GDP growth rate increases by one percentage point, the central bankers respond by hiking rates by 0.0029 percentage point, all else constant and controlling for country fixed effects. Both variables of GDP growth rate are not significant at a 5% significance level.

The response to current and lagged inflation is significant at both 5% and 1% significance level. The significance of current and lagged inflation variables suggests that both current and historic values of inflation are important in determining the discount rate for the sample of countries. Both current and lagged variables of the current account balance as a percentage of GDP have coefficients which are significant on 0.1% level. Current account balance as a percentage of GDP variable has a negative coefficient while the coefficient of the lagged variable is positive. To estimate the coefficients of our variable of interest, EMP which captures the unobserved heterogeneity across countries, I

**Table 5.1: Panel data estimation of central bank independence**

<b>Variable</b>	<b>Regression (1)</b>	<b>Regression (2)</b>
<b>INF-YOY</b>	0.7653** (2.6758)	0.7931** (2.7414)
<b>INF – YOY<sub>T-1</sub></b>	0.8568** (3.2579)	0.8681** (3.2707)
<b>GDP</b>	-0.0135 (-0.5696)	-0.0157 (-0.6548)
<b>GDP<sub>T-1</sub></b>	0.0029 (0.1237)	0.0010 (0.0452)
<b>CUR_ACC_BAL</b>	-0.0867*** (-6.1421)	-0.0869*** (-6.7025)
<b>CUR_ACC_BAL<sub>T-1</sub></b>	0.1351*** (9.5344)	0.1361*** (9.5398)
<b>POLITY INDEX</b>		0.0307 (0.7960)
<b>ELECTION DUMMY</b>		-0.0721 (-0.3266)
<b>R-SQUARED</b>	0.3631	0.3651
<b>ADJ R-SQUARED</b>	0.3093	0.3053
<b>F-STATISTIC</b>	21.3769	16.0281
<b>SUM SQR. RESID</b>	403.19	401.93
<b>AIC</b>	134.05	138.50
<b>SAMPLE SIZE</b>	245	245

T statistics in parenthesis. Significance codes: ‘\*’  $p < 0.05$ , ‘\*\*’  $p < 0.01$ , ‘\*\*\*’  $p < 0.001$ .

choose between regression (1) and regression (2) for the specification which best fits the



data. With the help of the F-Statistic, Adjusted R-Squared, Sum of Residual Squared and a manually computed AIC<sup>1</sup>, I make the selection.

Based on results in Table 5.1, I choose regression (1) as the model to be used to estimate the unobserved heterogeneity across countries. This is because regression (1) has the bigger F-Statistic, explains the variations in the dependent variable better and has the lower AIC. More so, adding the additional two control variables in regression (2) did not significantly reduce the sum of residual squared while reducing the degrees of freedom. Now that I have selected regression (1) as the model that best fits the data, I move on to perform some post-estimation tests.

#### 4.3.4 BREUSCH-GODFREY TEST FOR SERIAL CORRELATION

In this section, I test whether there exists a relationship between the error term and itself over the various time intervals. I use the Breusch-Godfrey test for serial correlation. The hypothesis tested under the Breusch-Godfrey test is as follows:

$H_0$ : no serial correlation in idiosyncratic errors

$H_a$ : serial correlation in idiosyncratic errors

**Table 5.2: Results of the test for serial correlation.**

Model	Chisq	P-value
<b>Regression (1)</b>	14.427	0.0131

Source: Author's estimates from R

From the table above, the p-value is significant on a 5% significance level. I therefore reject the null hypothesis that no serial correlation exists in the idiosyncratic errors.

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<sup>1</sup> AIC =  $2k + n \text{Log}(\text{RSS}/n)$ , where k is number of independent variables, n is number of observations and RSS is the sum of residual squared

### 4.3.5 BREUSCH-PAGAN TEST FOR HETEROSKEDASTICITY

In this section, I test for heteroscedasticity. Heteroscedasticity exists when the variance of the error term is not constant for all observations. I ran a Breusch-Pagan test to check for the presence of heteroscedasticity. The hypothesis tested under the Breusch-Pagan test is as follows:

$H_0$ : assumption of homoscedasticity

$H_a$ : the presence of heteroscedasticity

**Table 5.3: Result of Breusch-Pagan test for heteroscedasticity**

Model	BP Statistic	P-value
Regression (1)	2483.6	2.2e-16

Source: Author's estimates from R

From the table above, the p-value is significant on a 5% significance level. I therefore reject the null hypothesis that assumes homoscedasticity.

### 4.3.6 CORRECTING SERIAL CORRELATION AND HETEROSCEDASTICITY

To address the presence of serial correlation and heteroscedasticity, I re-ran regression (1) using a robust estimation of the covariance matrix of coefficients. The R software package for panel data analysis, '*plm*' provides three flavors of White's heteroskedasticity-consistent covariance matrix (also known as the sandwich estimator) for estimating robust coefficients (Croissant and Millo, 2008). The three versions: White1, White2, and Arellano assume no correlation between errors of different groups in the panel data. This allows for the estimation of the covariance matrix of coefficients which proves consistent vs. heteroscedasticity and serial correlation. For fixed effects

however, Arellano's version proves more consistent. Croissant and Millo (2008) explains that, with fixed effects, demeaning induces serial correlation in the errors which the two other versions of the sandwich estimator turn out to be inconsistent. The results of the regression (1) using Arellano's version of the sandwich estimator is presented below.

$$\begin{aligned} \Delta r_{i,t} = & EMP_i + 0.765p_{i,t} + 0.857p_{i,t-1} - 0.014y_{i,t} + 0.003y_{i,t-1} \\ & [2.4159] \quad [1.3692] \quad [-0.4516] \quad [0.1954] \\ & - 0.087ca_{i,t} + 0.135ca_{i,t-1} + e_t \\ & [-4.7805] \quad [2.8288] \end{aligned}$$

T-values for the estimated coefficients are given in brackets. Only the coefficients of current year-on-year inflation variable, current and lagged current account variables were significant at a 5% significance level after using robust standard errors. The coefficients of EMP, our variable of interest is hereafter estimated.

#### 4.4 ANALYSIS OF CBI USING EMPIRICAL CBI INDEX

In chapter 3, I explain that the structural differences among the 14 SSA countries with respect to how they respond to inflation, economic growth and current account surplus come out as unobserved heterogeneity across countries. Like Eijffinger et al (1996), I will infer these structural differences among the 14 SSA countries as a measure of their actual CBI. I have assumed from the start of this analysis that these unobserved heterogeneities are fixed over time. By using a fixed-effect estimator to regression (1), I include dummies for each country to capture each country's unobserved heterogeneity. These dummies, collectively, is the variable of interest,  $EMP_i$  (for each country). The coefficients of the  $EMP$  variable is presented in Table 6 below.

From Table 6 below, the EMP is statistically significant at a 5% significance level for all countries except for Ethiopia, Tanzania and Uganda. That is, at a 5% significance level, the coefficient of EMP is significantly different from zero for all countries except Ethiopia, Tanzania and Uganda. I further test the robustness of the  $t$ -statistic for the EMP using a robust covariance matrix estimation and present the results in the Appendix. Using robust standard errors, the coefficients of EMP is statistically significant for only a few countries in the sample at a 10% significance level. Such a result is not surprising as Eijffinger et al (1996) explains that it would be too much to expect the included country dummies to differ significantly from one another<sup>2</sup>. For ease of comparison, I rank the 14 SSA countries on their degree of independence using the EMP in Table 6 below.

Based on the ranking in Table 6, Ethiopia, Tanzania and Uganda rank higher with respect to the EMP. I dub these countries as having strongly independent central banks. Relatively then, Botswana, Zambia and Zimbabwe have the least independent central banks. All the other countries have intermediate independent central banks based on the EMP. The ranking in Table 6 above differs slightly from that in Table 2. The central bank of Tanzania maintained its ranking as strongly independent. Surprising, Ethiopia, with a relatively dependent central bank based on CWN-W, has the most independent central bank. Ghana, Nigeria, Malawi and South Africa maintain their rank as having moderately independent central banks. Unsurprising, Zimbabwe has the least independent central bank whether ranked with the legal-based CBI index or the EMP. Among the countries in the sample, Zimbabwe has least reformed central bank (Nhavira and Ocran, 2014). The recent economic meltdown and hyperinflation in 2008 add credence to this conclusion.

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<sup>2</sup> See Eijffinger et al (1996, p.179) for further explanations

**Table 6: Rank of empirical CBI index, the EMP**

	<b>Country</b>	<b>Empirical Independence</b>
<b>1.</b>	Ethiopia	-0.7356 [-1.1270]
<b>2.</b>	Tanzania	-0.8402 [-1.7779]
<b>3.</b>	Uganda	-0.9760 [-2.0310]*
<b>4.</b>	Mauritius	-1.1316 [-1.9625]
<b>5.</b>	South Africa	-1.2220 [-3.2189]**
<b>6.</b>	Kenya	-1.5284 [-2.8489]**
<b>7.</b>	Malawi	-1.5687 [-3.1220]**
<b>8.</b>	Nigeria	-1.5985 [-2.8488]**
<b>9.</b>	Angola	-1.6068 [-2.4848]*
<b>10.</b>	Ghana	-1.6113 [-3.1598]**
<b>11.</b>	Namibia	-1.6950 [-2.8488]***
<b>12.</b>	Botswana	-1.7472 [-4.1421]***
<b>13.</b>	Zambia	-1.7758 [-3.5084]***
<b>14.</b>	Zimbabwe	-2.1725 [-2.6802]**

T statistics in parenthesis. Significance codes: '\*'  $p < 0.05$ , '\*\*'  $p < 0.01$ , '\*\*\*'  $p < 0.001$

In Table 7 below, I test whether the legal-based CBI index (CWN-W) is correlated with this study's estimated empirical CBI index (EMP). The Pearson's product-moment correlation coefficient between the EMP and CWN-W is 0.135 suggesting a positive correlation between the legal-based independence and the empirical index of CBI. Such a correlation is also significant at a 5% significance level. However,

the correlation is very weak and thus, the CWN-W is not the best proxy for the empirical CBI index.

**Table 7: Correlation test for positive correlation between the EMP and CWN-W**

Pearson's Coefficient	Significance (Two-tailed)
<b>0.145</b>	<b>2.7167 [0.006]**</b>

P-value in bracket. \*\*Significant for  $\alpha = 0.05$ ;

I hereafter test the relationship between the empirical CBI index and year-on-year inflation. Table 8 below presents the correlation results between the EMP and year-on-year inflation.

**Table 8: Correlation for empirical CBI index and year-on-year Inflation**

Pearson's Coefficient	Significance (Two-tailed)
<b>-0.278</b>	<b>-5.475 [8.262e-08]***</b>

Source: Author's estimates. P-value in bracket. \*\*\*Significant for  $\alpha = 0.001$

The results in Table 8 above is consistent with the majority consensus in the literature suggesting a negative correlation between CBI and inflation. Even though the correlation coefficient shows a weak relationship, it nonetheless statistically significant. The implication of this result is as follows.

In chapter 2, I outline that since 1990s SSA countries have reformed their central banks' charters to elevate inflation control as the core objective of monetary policy. With these reforms came improved autonomy of central banks in the sample countries. Thus, we should at least expect a negative relationship between CBI and inflation as informed

by the literature. From the discussion thus far, this paper has conjectured that the EMP could be a better proxy for CBI in SSA. Thus, we expected a more pronounced results with respect to the relationship between CBI and inflation using the EMP.

Comparatively, the Pearson's coefficient between the EMP and inflation is of a higher magnitude than that of the relationship between the CWN-W and inflation. Because this study undertakes only correlation tests for the relationship between CBI and inflation using the CWN-W and EMP, this study cannot impose a causal relation between either of the CBI indexes and inflation. However, the inverse relationship between EMP and inflation affirms our intuition that a higher degree of CBI reflects in a low and stable inflation. The statistical significance of the result in Table 8 suggests that the reforms undertaken by the central banks in the 14 SSA economies have improved inflation-fighting policies. We could not however draw the same conclusion with the correlation test between the legal-based CBI index and inflation.

#### **4.5 FURTHER REFINING OF THE ESTIMATION OF EMP**

From the discussion thus far, I assume that the unobserved heterogeneity across countries is fixed over time. Similar to Eijffinger et al (1996), I ran the fixed effects estimator on my model to estimate the EMP by implicitly assuming that the unobserved heterogeneity across countries is related with the independent variables in the monetary policy reaction function. What if, the unobserved heterogeneity across countries is uncorrelated with the independent variables in the model. Then, the fixed effects model employed thus far is not the more consistent and efficient model. I now test whether the fixed effects estimator is consistent.

I run a Hausman test to evaluate whether using a fixed-effects estimator is consistent with the data. The hypothesis of the Hausman test is as follows.

$H_0$ : random effect (RE) estimator is consistent

$H_a$ : fixed effect (FE) estimator is consistent

The Hausman test evaluates whether or not the unobserved heterogeneity across countries and time are correlated with the independent variables. The null hypothesis assumes that the unobserved heterogeneity across countries and time are uncorrelated with the independent variables. If the null hypothesis is true, the fixed effects estimator is inefficient. On the other hand, the random effects estimator is efficient under the null hypothesis (Baltagi, 1998). The results of the Hausman test is presented in Table 9 below.

**Table 9: Results of Hausman Test**

	<b>Chisq</b>	<b>P-value</b>
<b>FE vs RE</b>	5.1372	0.5263

Source: Author's estimate from R.

From Table 7 above, the p-value from the Hausman test is insignificant at a 5% significance level. Thus, I fail to reject the null hypothesis that the random effect estimator is the more consistent estimator. The Hausman test above suggests that the fixed effects estimator used thus far may be inconsistent. Nonetheless, there is a possibility that the fixed effects estimator may actually be the more consistent and efficient estimator. This is because, according to Baltagi (1998), if either serial correlation or heteroskedasticity is present in a model, the variances of fixed effects and random effects estimators are not valid. This consequently renders the Hausman test



statistic inappropriate (Baltagi, 1998). From the post-estimation regression diagnostic tests for serial correlation and heteroskedasticity carried out in sub-sections 4.3.4 and 4.3.5 respectively, serial correlation and heteroskedasticity are present in my model. Thus, the possibility of the fixed effects estimator being the more consistent and efficient estimator is not far-fetched.

In the presence of either serial correlation or heteroskedasticity, either an Ordinary Least Squares (OLS), a Generalized Least Squares (GLS) or Feasible Generalized Least Squares (FGLS) estimator can be used to estimate the model. With the OLS estimator, robust standard errors are used for estimates to be unbiased and consistent. GLS and FGLS estimators are more suited in the event where the error term has non-constant variance (heteroskedasticity) or the errors are correlated (serial correlation). That is, GLS and FGLS estimators incorporate the information about serial correlation and heteroskedasticity while the OLS estimator does not. Thus, they provide a general structure for estimating unbiased and consistent estimates under the assumption of heteroskedasticity. When serial correlation and heteroskedasticity are present in a model, the GLS and FGLS estimators yield better estimates than the OLS estimator (Barreto & Howland, 2006, p. 599).

To run GLS, one has to transform the regression model to correct for first-order serial correlation such that errors that are systematically related to previous errors are eliminated (Barreto & Howland, 2006). For instance, in a first-order serial correlation error model,

$$Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t, \text{ where } \varepsilon_t = \rho \varepsilon_{t-1} + v_t$$

The whole object of GLS is to remove  $\rho\varepsilon_{t-1}$  leaving only the pure error term,  $v_t$  (Barreto & Howland, 2006, p. 589).  $\rho$  thus is a crucial piece of information for the transformation of the data by the GLS or FGLS estimator. In practice however, Barreto and Howland (2006) intimate that  $\rho$  is unknown for most cases. Thus, GLS becomes unattainable in cases where  $\rho$  is unknown. With FGLS, the estimator runs an OLS regression initially to estimate  $\rho$ , which it uses to transform the model for further analysis. Given  $\rho$  is unknown in most cases, FGLS becomes the more viable alternative for estimating a model that accounts for serial correlation when  $\rho$  is unknown.

Deciding which estimator to choose among the GLS and FGLS estimators also depends on varying factors like whether the true structure of the heteroskedasticity is known or whether or not the error covariance matrix is known. When the error covariance matrix is known, the GLS estimator is the more unbiased and consistent estimator. On the other hand, the FGLS estimator is the more unbiased and consistent estimator when the error covariance matrix is unknown. As in practice most models have heteroskedasticity with unknown error covariance matrix, I run FGLS on my model, as an improvement on the estimation in sub-sections 4.3.6.

I perform a Hausman test on whether to use a fixed-effects or random-effects FGLS estimator. Results of the Hausman test presented in the Appendix point to fixed-effects FGLS estimation. The fixed-effects FGLS estimator estimates the error covariance matrix using fixed effects estimation. The results of the FGLS regression is presented below.

$$\Delta r_{i,t} = 0.488p_{i,t} + 0.259p_{i,t-1} - 0.026y_{i,t} + 0.001y_{i,t-1}$$

$$\begin{array}{cccc}
[22.4862] & [7.5497] & [-8.8416] & [0.4634] \\
-0.064ca_{i,t} + 0.08ca_{i,t-1} + EMP_i + e_t \\
[-44.7713] & [35.4209] & & 
\end{array}$$

Absolute  $z$ -statistic for the coefficients are presented in brackets. I estimate the unobserved heterogeneity across countries in Table 8 below. For ease of comparison, I rank the 14 SSA economies based on the estimated EMP using FGLS.

**Table 10: FGLS estimation of the EMP**

	Country	Estimate
1	Angola	0.036[0.116]
2	Ethiopia	0.011[0.018]
3	Tanzania	-0.226[-0.798]
4	Uganda	-0.261[-0.845]
5	Zimbabwe	-0.290[-0.555]
6	Mauritius	-0.367[-0.756]
7	Nigeria	-0.535[-1.230]
8	South Africa	-0.545[-1.858]*
9	Kenya	-0.565[-1.302]
10	Ghana	-0.666[-2.421]**
11	Botswana	-0.666[-2.485]**
12	Malawi	-0.666[-2.428]**
13	Zambia	-0.693[-2.276]**
14	Namibia	-0.703[-2.161]***

Source: Author's estimates from R. Significance codes: '\*'  $p < 0.1$ , '\*\*'  $p < 0.05$ ,

The estimates in Table 10 above is consistent with that of Table 6. Only Zimbabwe has an improved CBI moving from a least CBI zone to an intermediate CBI zone. These few estimates are however statistically significant at a significance level of 5%.

**Table 11: Correlation for EMP estimated with fixed effects FGLS and YOY**

**Inflation**

<b>Pearson's Coefficient</b>	<b>Significance (Two-tailed)</b>
<b>0.177</b>	<b>3.4035 [0.00074]***</b>

Source: Author's estimates. P-value in bracket. \*\*\*Significant for  $\alpha = 0.001$

The results in Table 11 above is consistent with the majority consensus in the literature suggesting a negative correlation between CBI and inflation. Similar to Presnak's (2005), this study finds a positive relationship between CBI and inflation with the EMP estimates from fixed effects FGLS estimation.

This study thus far has investigated the relationship between CBI and inflation. The results however seem inconsistent at best. The relationship between CBI and inflation depends on the CBI indicator employed. The legal-based CBI index renders the relationship between CBI and inflation insignificant. The estimated CBI index based on Eijffinger et al's (1996) renders a more consistent result as informed by literature. Further refinement of Eijffinger et al's (1996) methodology with respect to the econometric technique employed also renders the relationship inconclusive. The result thus far confirms Lucotte's (2009) conclusion that empirical results on CBI in SSA are sensitive to the CBI index used.

## CHAPTER 5: CONCLUSION

In this section, I will summarize the findings and the conclusions drawn from this study.

### 5.1 SUMMARY OF FINDINGS

From the onset, this study sought to empirically investigate the relationship between inflation and central bank independence. Two CBI indicators were used: a legal-based CBI indicator as well as an empirical CBI index estimated by this study. The hypotheses that were tested in this study is as follows.

$H_0$ : Central bank independence is not correlated with inflation.

$H_1$ : Central bank independence is correlated with inflation

Findings from this study showed the following. When the legal-based CBI indicator was used, the correlation between central bank independence and inflation was almost non-existent, inconclusive and statistically insignificant. On the other hand, when the empirical CBI index was employed to perform the Pearson's correlation between inflation and central bank independence, the results were consistent with theory. That is, central bank independence and inflation were negatively correlated as informed by literature.

Upon further refinement of the estimation process of the empirical index of CBI, the relationship between inflation and central bank independence, though statistically significant, was positive. This result is anomalous as it is contrary to theory which suggests that the higher the degree of central bank independence, the lower and more stable the inflation rate, all else being equal.

## **5.2 CONCLUSIONS**

The evidence from this study suggests that legal CBI indicators have little or no explanatory power with respect to level and variability of inflation in the sample SSA countries. The relationship between inflation and central bank independence comes out more conclusively when the empirical CBI index estimated in this study is used. As the literature informs that there exists an actual negative relationship between CBI and inflation, this study concludes that, the empirical CBI index more appropriately captures CBI in SSA. As the relationship between CBI and inflation from the findings tend to be very sensitive to the CBI indicator used, this study fails to refute Lucotte's (2009) claim that empirical results on CBI in SSA are sensitive to the CBI index used.

## **5.3 RECOMMENDATION**

In the literature review, I outline some reforms undertaken by economies in SSA to improve monetary policy implementation. Results from this study, though not robust, suggesting that indeed, these reforms have improved the relationship between CBI and inflation in SSA. With more reforms thus, we expect the level and variability of inflation to be low and more stable, all else being equal. Policy makers should thus expend more efforts to maintain, reform and improve central banking in SSA.

## **5.4 DIRECTIONS FOR FUTURE STUDIES**

Further studies on the central bank independence would face the inevitable difficulty of choosing the appropriate measure of CBI for empirical studies. Until legal based CBI indicators actually reflect CBI in SSA, further improvement can be made to the empirical CBI index in this paper. For starters, a larger sample of countries as well as advanced econometric techniques would be more helpful in estimating robust results.

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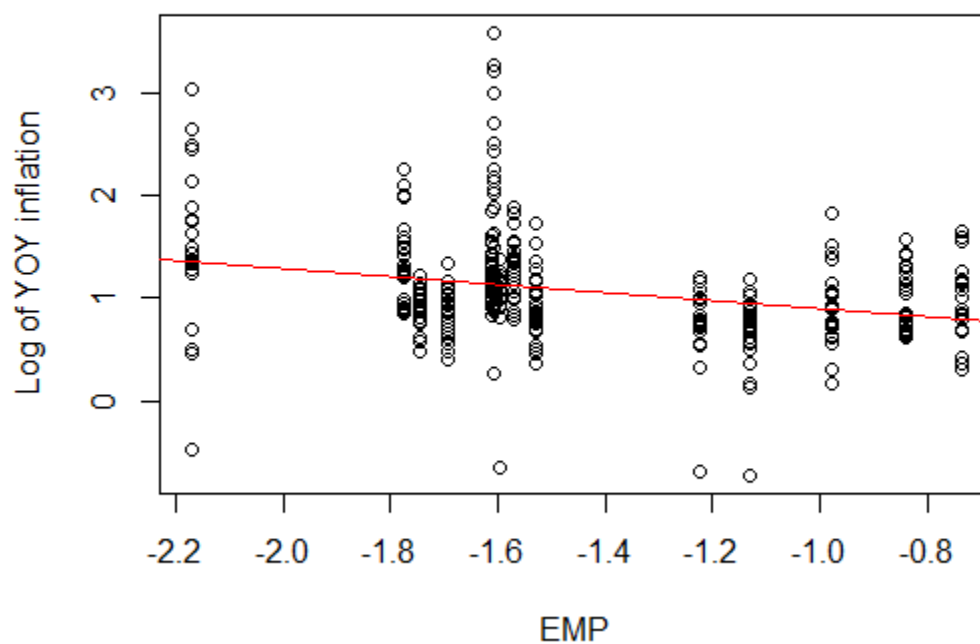
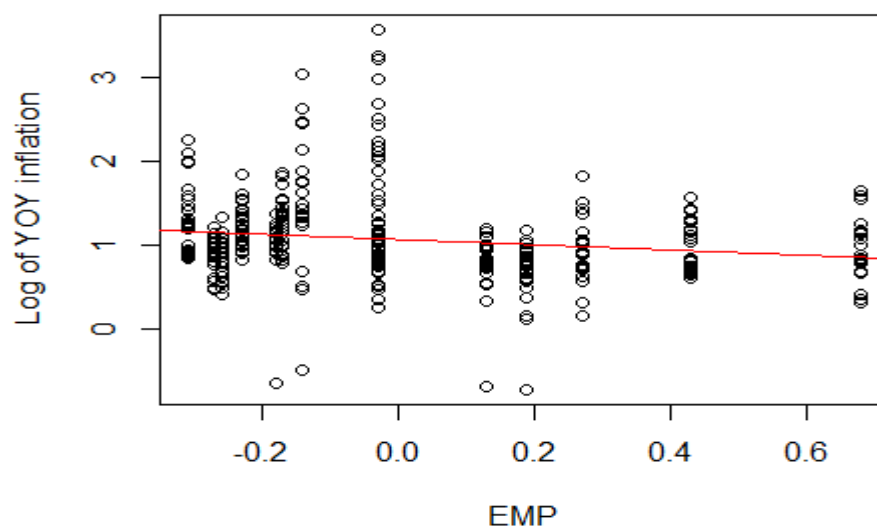
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## APPENDIX

**Table A1: Rank of empirical CBI index, the EMP—Robust Covariance Matrix****Estimation**

	<b>Country</b>	<b>Empirical Independence</b>
<b>1.</b>	Ethiopia	-0.7356 [-0.7825]
<b>2.</b>	Tanzania	-0.8402 [-1.7779]
<b>3.</b>	Uganda	-0.9760 [-1.3490]
<b>4.</b>	Mauritius	-1.1316 [-1.3319]
<b>5.</b>	South Africa	-1.2220 [-1.7531].
<b>6.</b>	Kenya	-1.5284 [-1.4958]
<b>7.</b>	Malawi	-1.5687 [1.7432].
<b>8.</b>	Nigeria	-1.5985 [-1.5171]
<b>9.</b>	Angola	-1.6068 [-1.0434]
<b>10.</b>	Ghana	-1.6113 [-1.7383].
<b>11.</b>	Namibia	-1.6950 [-1.7531].
<b>12.</b>	Botswana	-1.7472 [-1.6951].
<b>13.</b>	Zambia	-1.7758 [-1.6791].
<b>14.</b>	Zimbabwe	-2.1725 [-1.0715]

T statistics in parenthesis. Significance codes: ‘.’  $p < 0.1$ , ‘\*’  $p < 0.05$ , ‘\*\*\*’  $p < 0.01$ ,

**Figure A1: Correlation between EMP and Inflation****Figure A1: Correlation between EMP, estimated with FGLS and Inflation**

**Table A2: Hausman Test: fixed-effects FGLS vs random-effects FGLS**

	<b>Chisq</b>	<b>P-value</b>
<b>FE vs RE</b>	2763.9	2.2e-16

Source: Author's estimate from R.

**Table A3: Correlation matrix of independent variables**

	<b>EMP</b>	<b>CWN-W</b>	<b>EMP-FGLS (fixed)</b>	<b>EMP-FGLS (random)</b>
<b>EMP</b>	1.00			
<b>CWN-W</b>	0.13	1.00		
<b>EMP-FGLS (fixed)</b>	0.47	0.07	1.00	
<b>EMP-FGLS (random)</b>	0.90	-0.02	0.72	1.00

Source: Author's estimate from R.

**Table A4: Correlation for EMP estimated with random effects FGLS and YOY****Inflation**

<b>Pearson's Coefficient</b>	<b>Significance (Two-tailed)</b>
<b>-0.178</b>	<b>-3.4244 [0.00069]***</b>

Source: Author's estimates. P-value in bracket. \*\*\*Significant for  $\alpha = 0.001$