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A CURRENCY UNION ODYSSEY: MONETARY POLICY IN THE CFA ZONE

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ABSTRACT

This thesis focuses on one of the most important currency unions in the world known as the CFA zone. The goal of this thesis is to draw a comparison of African countries with their own national currencies to African countries that are part of the CFA zone and examine how this affects their macroeconomic performance in terms of GDP growth, inflation or trade. The thesis has 3 chapters. The reader should view each chapter as stand-alone papers.

Chapter 1 develops a new de facto measure of central bank independence (CBI) based on two recent measures of the turnover rates of central bank governors introduced by Vuletin and Zhu (2011), complemented with measures of alliance with the government in power, captured by prior executive appointment, tribe proximity, and political party affiliation. Using 1980-2009 data from 12 countries from the CFA zone (a currency union) and 18 non-CFA countries, the new index is used to 1) show how CBI affects countries that are part of a monetary union and 2) examine whether CBI can help achieve price stability in Africa.

The results suggest that CBI works differently for countries that are currency union members. Unlike countries with monetary independence, where premature removals of central bank governors lead to higher inflation rates. We see the opposite trend for countries that are part of a currency union; this study suggests that premature removals of central bank governors instead lead to lower rates of inflation. This is due to the fact that one of the gains of currency union memberships is discipline in monetary policy where the central banker's role is to implement monetary policy that ensures the stability of the zone rather than one's country. So, in cases where the central banker attempts to privilege one country, other member countries can force him out to protect the economic integrity of the union.

Chapter 2 examines the benefits of CFA zone membership by estimating the effects of joining the CFA zone on short run business cycles indicators such as income per capita and inflation as well as long-term economic indicators such as trade relations with France and foreign direct investment (FDI) in Mali. Using the synthetic control method (SCM), we show that Mali's CFA membership has a positive effect on its income, inflation, and foreign direct investment (FDI) but no discernible effect on trade relations with France. We conclude that joining the CFA zone can generate potential economic gains for countries seeking membership by fostering growth and providing price stability but does not necessarily increase trade relations with France even though the CFA is a former French colonial currency.

Using data from 1980 to 2009 for 23 African countries (9 CFA countries and 14 non-CFA countries), Chapter 3 examines the effect of commodity price shocks on the likelihood of a central bank governor removal. Governor removals are decomposed into premature removals and ally replacements. Our conditional fixed effects logit models show that commodity price shocks have no effect on the probability of a central bank governor's premature removal but lead to a statistically significant increase in the likelihood of an ally replacement and this is true for both non-CFA and CFA countries. This trend holds when commodities price shocks are separated into oil/mineral shocks but not for agricultural commodities shocks.

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CHAPTER 1: The Inflationary Cost of Central Bank Independence in Africa: Monetary Servitude or Monetary Freedom?

1.1 Introduction

Central bank independence (CBI) has traditionally been defined as the ability of a central bank to conduct monetary policy without political interference. Independence implies that a central bank can choose the goals of monetary policy, the tools necessary to achieve those goals or both. Today, CBI is often seen as an important signal of a central bank's credibility in its conduct of monetary policy (Arnone et al. (2009). Most studies of CBI have however looked at how independence affects the monetary authority's behavior for individual countries. However, it is not always clear how CBI operates in different contexts; specifically in the case, where countries belong to a monetary union.

This paper revisits the relationship between CBI and inflation but extends the analysis to an African currency union known as the CFA zone[1]. The focus of the paper is to compare how CBI works for African countries with their own currency to how it works for African countries that belong to this union, using newly constructed measures of CBI. Africa is of particular interest first, because governments there have a long history of monetizing their debts and engineering inflation surprises through expansionary monetary policy. High inflation has constantly plagued African economies, which tend to rely too heavily on monetization to offset fiscal deficits (Aghevli and Khan (1978)). Increased central bank independence may help reduce the temptation to repeatedly impose an inflation tax, and thus, dampen the adverse effects of high inflation.

[1] CFA stands for African Financial Community. The CFA zone is a monetary union consisting of 2 zones and the Comoros. The currency for the union is known as the CFA Franc and is pegged to the euro at a fixed rate. A further description of the zone will be provided later in the paper. Also, see appendix Figure A3 for more details.

Secondly, traditional measures of de facto CBI often fail to account for the socio-political climate in African countries where the fiscal authority is sometimes inseparable from the monetary authority. This implicitly suggests a certain level of alliance between the head of the executive branch and the central banker, which old measures of CBI thus far have failed to incorporate but our new measures do. These novel measures rely first, on the de facto CBI, a measure first introduced by Cukierman et al. (1992) and second, on the alternative measures introduced by Vuletin and Zhu (2011).

De facto CBI, a measure that is proxied by the turnover rate of central bank governors (TOR) shows that above a certain threshold (a TOR of 0.20 or 0.25) a frequent turnover of central bank governors indicates a lower level of independence.[2] Using this measure of CBI, studies have shown that higher turnover rates are associated with higher inflation rates (Ex., Cukierman et al. (1992) and De Haan et Kooi, (2000)).

The new measures of CBI, introduced in this paper, examine whether the turnover of a central bank governor occurs before the end of the first term (*premature variable*) and whether the replacement of a central bank governor is an ally (*ally variable*). In Vuletin and Zhu (2011), a central bank's governor is considered an ally if he or she was the highest official in any ministry or top government agency that pertains to the economy or a similar field during the previous year before his or her nomination as central bank governor. Our paper, however, modifies this definition of the *ally* measure by relaxing the one-year restriction. We argue that because of the dictatorial nature of some African countries, a newly-appointed governor can be considered an *ally* as long as he or she occupied an executive position under the same president, regardless of the time period. Our paper also classifies a person as an ally if 1) he or she occupies a high

[2] The threshold is calculated by assuming the average electoral cycle is around four or five years. Note that a low turnover rate does not necessarily imply a higher level of CBI.

position in the ruling party of the government in power or 2) if he or she is a member of the same tribe as the president[3].

Few papers have conducted CBI studies concentrated solely on Africa. Presnak (2005) analyzes the relationship between the Cukierman index and inflation in 11 African countries over the period 1960-1989. The paper finds that de facto CBI explains little to no variation in the inflation rates for these 11 countries. Kasseeah et al. (2011) uses two proxies for CBI: TOR and the relative size of the government budget deficit, on 20 African countries over the period 1988-2007. Their results indicate that de facto CBI is positively related to inflation and explains around 30% of the variation in the inflation rate. Agoba et al. (2017), using 48 African countries, find that in the presence of high banking sector development and institutional quality, legal CBI lowers inflation.

This paper contributes to the literature in four ways: One, our paper is the first to examine the relationship between CBI and inflation in a monetary union context. Second, new CBI measures are created that take into account the close alliance between the fiscal authority and the monetary authority in African countries. An important distortion that often leads to issues of commitment in monetary policy for African central banks. Third, our analysis allows us to compare the relationship between CBI and inflation between countries that are part of a monetary union to countries that are not. Finally, including an analysis of central banking in Africa, specifically the CFA zone, brings light to the fact that some African countries belong to a monetary union, a dimension that previous papers have often failed to account for in their analysis.

Using the criterion discussed above, we construct a CBI index for 30 African countries (12 CFA zone countries and 18 non-CFA countries) over the period 1980-2009. We then investigate the

[3] We classify a change in central bank governor as ally under any of the dimensions cited above, or two or all three.

relationship between CBI and inflation for the whole sample and then repeat the analysis for two sub-samples: CFA countries and non-CFA countries. Our findings can be summarized as follow:

i. Central bank governors in non-CFA countries are 2.4 times more likely to be prematurely removed than governors in CFA countries (39.8% versus 16.7%).

ii. A higher turnover rate of central bank governors (as measured by our four-year rolling average) leads to an increase in inflation in both the full sample and the non-CFA countries.

iii. Our *ally* and *premature* measures are statistically significant determinants of inflation for the CFA countries. In CFA countries, the premature removal of a central bank governor who is perceived as a challenger leads to a decrease in inflation, particularly when that governor is replaced by an ally.

iv. There is an inverse relationship between de facto CBI and inflation when countries belong to a monetary union due to monetary discipline required to sustain the credibility of the union.

The paper is organized as follows. Section 2 describes the CFA zone. Section 3 elaborates on the old and new measures of CBI. Section 4 discusses our variables and methodology. Section 5 presents our results, and section 6 concludes.

1.2 Background of the CFA zone

At to the end of WWII, several colonial powers formed monetary arrangements (e.g., CFA zones) whose sole purpose was to strengthen the ties between the colonies and the metropole. These arrangements included the creation of monetary institutions that served as the foundations

for today's African monetary institutions. The CFA[4] Franc was introduced in 1945 and was pegged to the French Franc at a rate of 1 CFA franc for 1.7 French Francs.[5] Today, however, the CFA zone is a monetary union consists of two zones, each with its own regulating agency: they are the Central African Economic and Monetary Community (CAEMC) which includes the countries of Cameroon, Central African Republic, Chad, Equatorial Guinea, Gabon, and Congo and uses a currency denoted XAF issued by their region's central bank (BEAC) and The West African Economic and Monetary Union (WAEMU) which encompasses Benin, Burkina-Faso, Guinea-Bissau, Ivory Coast, Mali, Niger, Senegal, and Togo and uses a currency denoted XOF issued by their region's central bank (BCEAO).[6]

The most noteworthy feature of this monetary union is the *operations account system*.[7] The role of the operations account is to guarantee unlimited access of the two central banks to the French Franc prior to 1999 and to the Euro thereafter, via the Bank of France. For most countries with fixed exchanges rates, the national central banks are required to maintain the announced fixed rate. This is done by ensuring that the central bank maintains a sufficient reserve of foreign currencies.

For CFA zone countries, in contrast, the parity of the CFA with the Euro is maintained by the French Treasury which essentially eliminates the potential problem of having too few foreign reserves. In exchange, the CFA zone countries are required to deposit all their external assets and earnings in their operations account at the French Treasury. 50% for the Central African countries and 60% for the West African countries, of their earnings. Other notable features of the

[4] CFA in French means Colonies Francaises d 'Afrique or French colonies of Africa.
[5] Masson and Pattillo (2005, p. 15).
[6] BEAC stands for *Banque des Etats de l'Afrique* Centrale and BCEAO stands for *Banque Centrale des Etats de l'Afrique de l'Ouest* in French.
[7] It is important to note that both BEAC and BCEAO maintain separate operations account with the French treasury.

CFA zone include: 1) The board of directors for each central bank must include French representatives (i.e., 2 for the BEAC, 3 for BCEAO, and 4 for the Central bank of Comoros); 2) The CFA currencies are legal tenders only in their respective zones; 3) Free capital mobility[8] exists between the two zones and France; and 4) The CFA is pegged to the euro at a fixed rate of 1 euro=655,957 CFA Franc.

Central banks in the CFA zone have a dual mandate which consists of maintaining low and stable inflation and sufficient foreign reserves. Moreover, because the CFA zone is a monetary union with a fixed peg, one might wonder if there room for monetary policy in the zone. In fact, there is scope for monetary policy in the union because of the limited de facto capital mobility that has persisted. Short-intervention is often needed in the CFA zone countries because of fluctuations in the U.S. Dollar-Euro exchange rate or in output or terms of trade that are due to commodity price shocks. The main monetary policy instruments used in the zone are reserve requirements (BEAC) and open-market operations (BCEAO).

Another important question to raise concerns the source of inflation in the CFA zone. Inflation in the region is a result of both money creation and inflation in the Eurozone. Money creation comes from direct central banking financing through statutory advances and the spending of commodity-based revenues. Although central bank charters limit credit advances to 20% for each member country. De facto, credit advances are much higher. For instance, between 1994 and 1998, credit advances to Ivory Coast fluctuated between 32.7 % and 49.3%.

[8] Our reader should keep in mind that de facto capital mobility is practically non-existent in the zone.

1.3 Old and new measures of de facto CBI

The level of central bank independence conferred by law often differs from the level of independence in practice (i.e., the de facto CBI). The measure of the average turnover rate of central bank governors[9] is known as the Cukierman index. Table 2 shows the average TOR for each country, as well as its frequency of central bank governor replacements. Mauritania has the highest TOR, where a governor is replaced on average every two years (TOR = 0.5). The lowest TOR, 0.067, is in the Central African CFA countries, where a central bank governor is replaced on average every 15 years. A low turnover rate does not necessarily mean that a country has a higher level of CBI, but instead, could indicate a central bank governor remained in office for a long time by simply accommodating the fiscal needs of the executive branch.

Cukierman et al. (1992) conducted their analysis of the relationship between CBI and inflation by calculating the average turnover rate for each decade. The drawback with using decade averages to calculate the turnover rate is that it is sensitive to periods of high volatility (outliers), which could be due to institutional changes such as amendments to a central bank charter that can increase or decrease the degree of CBI or some political turmoil. To avoid this problem, our analysis follows De Haan and Klomp (2010) and calculates instead a four-year rolling average of the turnover rate.[10] The use of a four-year rolling average, instead of a decade average, can also mitigate the potential for reverse causality between inflation and central bank independence. That is, our four-year rolling average reduces the potential endogeneity of the turnover rate by helping to separate the effect of a high turnover rate of central bank governors on inflation from the effect of high inflation on the term of central bank governors (Dreher et al. (2008)).

[9] The frequency of central bank governor replacements is simply the inverse of a country's TOR.
[10] We choose a four-year rolling average to be consistent with the average time of an election cycle of four or five years. Later, we use a five-year rolling average as a robustness check.

Vuletin and Zhu (2011) argue that TOR depends on whether the central bank governor is removed prematurely (i.e., before the end of his or her first term) and whether the central bank governor's replacement is an ally or a challenger. A premature removal suggests the firing of a

Table 2: Average TOR over 1980-2009 and frequency of central bank governors

Country/Monetary Zone	Average TOR	Average frequency of CB governor replacement
BCEAO	0.133	7 years and 6 months
BEAC	0.067	15 years
Botswana	0.167	6 years
DRC	0.233	4 years and 3 months
Egypt	0.200	5 years
Ghana	0.133	7 years and 6 months
Kenya	0.200	5 years
Madagascar	0.167	6 years
Malawi	0.267	3 years and 9 months
Mauritania	0.500	2 years
Mauritius	0.167	6 years
Mozambique	0.133	7 years and 6 months
Nigeria	0.167	6 years
Rwanda	0.167	6 years
Sierra Leone	0.267	3 years and 9 months
South Africa	0.133	7 years and 6 months
Sudan	0.267	3 years and 9 months
Tanzania	0.133	7 years and 6 months
Tunisia	0.233	4 years and 3 months
Uganda	0.133	7 years and 6 months

disobedient central bank governor, who is unwilling to abide by the government's economic agenda. As mentioned above, this paper relies on a definition of alliance that is consistent with African politics. That is, a central bank governor is considered an ally if he or she occupies a high position pertaining to the economy in the country's executive branch or in the country's ruling party, or is from the same tribe as the nominating president.

Ivory Coast is an example of such alliance between the nominating president and the central banker. There, the ruling party and the tribe of the president have influenced the choice of a central bank governor. For instance, when Philippe Henri Dacoury-Tabley became head of the BCEAO (Central Bank of West African States), his candidacy was heavily supported by then Ivorian President Laurent Gbagbo of the party, the Ivorian Popular Front (FPI). One of the founders of FPI was Louis Andre Dacoury-Tabley, who is the brother of Governor Tabley, and like President Gbagbo, both brothers are from the *Bete*[11] tribe. After President Gbagbo was ousted, the new president Alassane Ouattara, who was from a different tribe and political party, was given authority over the BCEAO transactions and activities by WAEMU, the regulatory body of the BCEAO. A few weeks later, the new government alleged that Governor Tabley refused to cooperate with them because of his allegiance to the former Gbagbo government. Shortly thereafter, Governor Tabley resigned under pressure by all eight presidents of WAEMU member countries.

Our data set consists of 30 countries for the period 1980-2009, 12 are CFA countries and 18 are non-CFA countries.[12] The first step in constructing the *premature* and *ally* variables is to calculate the annual number of central bank governor changes for each country. In the case of the CFA countries, the number of central bank governor changes is calculated as the number of changes for each monetary zone, i.e. two countries from the same monetary zone will have the same number of governor changes. Each governor change[13] is then classified as either premature or non-premature. Like Vuletin and Zhu (2011), we contend that premature removals of central

[11] See Mirrors of Justice, Law and Power in the Post-cold War Era by Kamari Maxine Clarke and Mark Goodale (72).
[12] Benin is dropped because of missing data for the outcome variable and some of the control variables. We also exclude Guinea-Bissau because this country joined the zone in 1997.
[13] TOR= TOR_premature + TOR_non-premature.

bank governors are often removals of governors who are perceived to be challengers to the government. For every governor change, the new governor is classified as an ally or a non-ally.[14] Thus, each governor change falls into one of the following four categories: 1) premature and ally; 2) premature and non-ally; 3) non-premature and ally; or 4) non-premature and non-ally.

A new central bank governor is considered an ally if he or she either 1) has previously occupied the highest position in a ministry or any top government agency as it pertains to the economy or 2) comes from the same tribal background 3) comes from the same political party as the nominating president. To identify the premature and ally variables, we primarily use two datasets: *Rulers of the world* and the CIA dataset on the *Chiefs of state and cabinet members of foreign government*. We match the databases to the names of the central bank governors in our sample. Other sources then are used to complete any missing variables.[15]

We found 127 changes (6 changes for the CFA central banks and 121 changes for the non-CFA central banks) in central bank governors from 1980 to 2009[16] for an average annual turnover rate of 0.152. That rate implies a central bank governor is replaced on average every 6 years and 5 months. Each central bank governor change is then classified as either premature or non-premature and as either ally or non-ally. Table 1 shows 16.7% of changes in CFA countries are premature compared to 39.8% in non-CFA-countries. One reason why CFA countries have a smaller number of premature changes is because the presidents of all member countries must agree to remove the central bank governor. Out of the 127 changes documented, we count 16

[14] TOR= TOR_ally + TOR_non-ally.
[15] A complete list of the ministries and agencies used is available upon request.
[16] The 127 changes refer to all of the countries in our data. For the CFA zone countries, we do not double count changes. As mentioned earlier; every CFA country has the same number of governor changes.

instances where the premature exit of a central bank governor was followed by an ally replacement; one instance in the CFA zone and 15 instances in the non-CFA countries.

It is important to note that in the CFA countries, Ivory Coast and Gabon have been particularly influential in nominating the central bank governor. Specifically, four of the last six BCEAO governors were from the Ivory Coast, while three of the last five BEAC governors were from Gabon.[17] This indicates that the de facto nomination of a central bank governor in the CFA zones is done by Ivory Coast and Gabon, where both countries likely push for candidates who will benefit their domestic interests.[18]

The data also shows that if the central bank replacement is indeed an ally in both the CFA and non-CFA sub-samples, then an ally is almost always a top official of the executive branch or from the same tribe as the nominating president. There is only one instance over the entire time period when the ally who is selected as a central bank governor is also a high-ranking member of the ruling party.

Using a sample of 42 countries (21 developed countries and 21 developing countries) that includes only one African country, (i.e., South Africa),Vuletin and Zhu (2011) finds that a central bank governor was replaced with an ally 8.5% of the time in developing countries, 0% in developed countries, and 5.4% in the full sample. In contrast, our African sample reveals that a central bank governor is replaced with an ally 33.3% of the time in CFA countries, 16.5% in non-CFA countries, and 17.5% in the full sample. The large number of ally changes in Africa

[17] Both countries are the most important economies in their respective zones.

[18] It is important to note that the bank charters of the BEAC and the BCEAO zones state that legally all heads of state nominate the central bank governor, but in practice, Ivory Coast and Gabon nominate the heads of the central bank in each zone.

can be explained, in part, by the higher level of political instability that Africa experiences, due to the continent's frequent civil or ethnic wars and large number of dictatorships.

Historically, political instability has had a severe impact on the quality of the institutions in many African countries. In the political economy literature, low-quality institutions, such as the lack of respect for property rights, have long been identified as a key reason why Africa's economic performance has been so poor compared to other regions (see Knack and Keefer (1995) or Acemoglu et al. (2001)). Thus, we contend that Africa's lower level of institutional quality is one reason why the percentage of ally changes is much higher in African countries than in the rest of the world.

Table 1: Frequency of central bank governor changes by category

	NON-PREM	**PREM**	**Total**
***CFA* countries**			
NON-ALLY	66.7%	0	66.7%
ALLY	16.6%	16.7%	33.3%
Total	83.3%	16.7%	100%
***NON-CFA* countries**			
NON-ALLY	56.3%	27.20%	83.5%
ALLY	3.9%	12.6%	16.5%
Total	60.2%	39.8%	100%
All countries			
NON-ALLY	55.06%	27.45%	82.5%
ALLY	6.44%	11.05%	17.5%
Total	61.5%	38.5%	100%

1.4 The empirical model

a. The determinants of inflation in Africa:

Understanding the underlying inflationary process, for non-CFA and CFA zone countries is a key component of our analysis. It also provides a clear understanding of the differences between autonomy and membership in a currency union. Inflation rates in poorer countries, in this case Africa have been higher than rates in more developed countries. Studies have shown that the main culprits of higher inflation in the region lie in both non-monetary and monetary determinants of inflation.

On the non-monetary side, one of the main factors that negatively impacts inflation in non-CFA countries are fiscal deficits. Ozurumba (2012) finds that there is a statistically significant relationship between fiscal deficits and inflation in Nigeria. Other factors include cost push factors such as rising oil prices or agricultural commodities shocks have also exacerbated inflationary pressures. Countries like Angola or Egypt have also suffered from high inflation rates due to currency devaluations that have led to higher volatility in their exchange rates. Sowa (1994), on the other hand, find that growth in the money supply is the main determinant of the changes in the price level in Ghana.

Moreover, figures A1 and A2 in the appendix show that the inflation rates for the CFA zone countries have been much lower than their non-CFA counterparts. For CFA countries, inflation is also the result of non-monetary and monetary factors. In the case of WAEMU countries, foreign prices pass through have a significant effect on the price level. This, because, 60% of the trading volume in the region come from manufactured goods imported from Europe. Exchange rate pass through also plays an important role as these countries have no way to dampen the

effect of possible fluctuations in the exchange rate between the U.S. dollar and the euro, given the peg between their currency and the euro.

On the monetary side, although the French treasury limits credits extensions to the CFA zone countries to 20% of a counrty's public revenue in the previous year. This criteria has not always been respected in the past. For instance, between 1994 and 1998, credit advances to Ivory Coast fluctuated between 32.7% and 49.3%. Thus, monetization of fiscal deficits is still a possible determinant of inflation for CFA zone countries. In addition to that, CFA zone countries are mainly commodity exporters countries[19], consequently, foreign inflows also constitute another driver of inflation via the spending of commodity-related revenues.

Finally, recent studies have also investigated the relationship between political instability and inflation volatility. Barugahara (2015) finds that there is a positive and statistically significant relationship betweem instability and inflation for 49 African countries.

b. Model specification:

We divide our analysis into three parts: The first part regresses inflation on the four-year rolling-average TOR, this to examine whether the previous findings of a positive relationship between the TOR and inflation is robust to African economies. The second part tests the impact of our newly-constructed measures of TOR, premature vs non-premature and ally versus non-ally. Finally, the third part analyzes the impact of the interactions of our new CBI measures on inflation.

Our model is captured by the following equation:

$$\pi_{it}=\beta_0 + \beta TOR_{it} + \sum_{c=1}^{C} \beta_c x_{cit} + \alpha_i + \mu_{it},$$

[19] CEMAC countries are oil exporters while WAEMU countries are agricultural commodities exporters.

where π_{it} is inflation in country i, TOR_{it} is the TOR in country i, x_{cit} represents the control variables: trade openness, the measures of political instability, government spending, world inflation, and income per capita for country i in period t, α_i is the country fixed effects, and μ_{it} is the random effect. A researcher can use three techniques when analyzing panel data: 1) pooled OLS, where the data is grouped together and a simple regression is run; 2) country-specific fixed effects, which controls for non-observable differences across countries such as cultural or historical differences and the degree of a country's aversion to inflation; or 3) random effects, where the variation across countries is assumed to be random and not correlated with the control variables in the model. In a panel data setting, fixed effects or random effects models are most commonly used. Researchers often perform the Hausman test to select the appropriate model. Our Hausman test results indicate that the fixed effects model is more suitable than the random effects model. Consequently, the results presented below are produced using a fixed effects specification.

Our panel data set is comprised of 30 years of annual observations from 30 countries. The same unobserved characteristics in each country's error term are present each year, which might lead to autocorrelation of the error term within a country's cluster of observations. To address this issue, we relax the assumption of homoscedasticity and adjust the standards errors for the 30 countries.[20]

Our analysis relies on the inflationary process mentioned above and includes six other plausible determinants[21] of inflation: trade openness, two measures of political instability: civil war and coup d'état, world inflation[22], government spending, and income per capita.

[20] To relax the assumption of no correlation over time for the same country, we assume $\text{cov}(e_{ij}, e_{ik}) = \gamma_{jk}$.

[21] Table A1 in the appendix provides a detailed description of these variables.

1.5 Results

a. The traditional measure of the TOR variable

Our initial analysis regresses inflation on the four-year rolling-average turnover rate. The results of that regression, shown in Table 3 below, reveal a positive relationship between the turnover rate of central bank governors and inflation. That result mirrors the evidence in previous research and holds both for the full sample and the non-CFA countries. For CFA countries, the turnover rate is not related to inflation rates, the coefficient is not statistically significant.

b. The determinants of inflation

Table 4 presents a similar analysis to Table 3, except the "*tranquil times*" determinants of inflation are included in the fixed effects regression to allow for the possibility that our findings are driven by omitted variable bias. Our results show a positive relationship between inflation and the turnover rate continues to hold for the full sample and the non-CFA countries, but not for the CFA countries.[23]Specifically, columns 1-3 show the impact of the world inflation rate which is defined as the inflation rate in G7 countries (Jacome and Vasquez (2005)). We find that across all samples, an increase in the world inflation rate leads to a statistically significant increase in the inflation rate for all of our samples. Columns 4-6 control for trade openness, which is measured as the ratio of exports plus imports to GDP. Romer (1993) finds that, on average, inflation tends to be low for countries with a higher level of trade openness. This inverse

[22] While it might make more sense to use Eurozone inflation for the CFA countries, given that the CFA is pegged to the Euro. For consistency across our samples, we use instead inflation in the G7 countries.

[23] We follow Vuletin and Zhu (2011) and examine the effect of *tranquil times* and *stressful times* determinants of inflation. Although the results are not reported, the effects of inflation target and exchange rate regime were tested for the full sample and the non-CFA countries, but not CFA countries since the data for the CFA countries has no variation. Similar to Vuletin and Zhu (2011), we find that inflation decreases with an explicit inflation target but increases when the exchange rate regime is fixed. The coefficients in each sample are statistically significant.

relationship is statistically significant for the full sample and the non-CFA countries, but has no effect on inflation in the CFA countries.

Table 3: TOR (four-year TOR) regressions without control variables

Countries	**(1) all countries**	**(2) non-CFA countries**	**(3) CFA countries**
Four-year TOR	5.998**	9.528***	-0.825
	(3.298)	(4.720)	(2.894)
Number of observations	780	468	312
$\boldsymbol{R^2}$	0.016	0.012	0.001

Notes: .01 - ***; .05 - **; .1 - *. The dependent variable is the inflation rate. The within $\boldsymbol{R^2}$ is reported. Standard errors are robust and clustered.

Columns 7-9 examine the effect of government spending on inflation. Theoretically, an increase in government spending is expected to push up inflation since countries with higher expenditures relative to revenues are more likely to use the inflation tax to raise revenue. Dupor and Li (2015), however, find empirical evidence that an increase in government spending leads to a fall in the inflation rate. Our results, like Dupor and Li (2015), show that government spending reduces inflation in both the full sample and the non-CFA countries.

Columns 10-12 consider the effects of income per capita. Countries with higher income per capita often have a more efficient tax system and a more sophisticated financial system. Thus, high-income countries are more likely to employ policies that reduce the costs of inflation, which translates into a negative relationship between inflation and income per capita. Our results

indicate that this relationship is negative and statistically significant for both the full sample and the non-CFA countries but positive and statistically significant for the CFA countries.[24]

Columns 13-15 include all variables in the regression. The coefficients on government spending and trade openness become statistically significant for the CFA countries, while the coefficients on income per capita remain the same for all three samples. The sign on the turnover rate does not change, but the coefficient becomes statistically insignificant for the non-CFA countries and statistically significant for the CFA countries.

In summary, our analysis shows that a higher turnover rate of central bank governors increases the level of inflation for the full sample and the non-CFA countries, but it does not affect inflation in the CFA countries.

[24] We speculate that the direct relationship between income per capita and inflation, could be due to the fact that many of the CFA countries are oil exporters. Higher inflation could simply be the result of *Dutch disease.*

Table 4: TOR (4 year RA) regressions with control variables

Countries	(1) all countries	(2) non-cfa countries	(3) cfa countries	(4) all countries	(5) non-cfa countries	(6) cfa countries	(7) all countries	(8) non-cfa countries	(9) cfa countries
Four-year TOR	4.007*	5.713**	-0.716	3.878***	11.082**	-0.417	1.133*	10.130**	-0.741
	(1.935)	(2.937)	(0.529)	(2.003)	(3.003)	(0.546)	(2.008)	(3.118)	(0.537)
world inflation	2.850***	3.62***	0.290***						
	(0.274)	(0.442)	(0.067)						
Trade Openness				-0.043*	-0.056***	0.039			
				(0.014)	(0.037)	(0.002)			
Government Spending							0.405**	0.135	0.010
							(0.095)	(0.161)	(0.022)
Log (Income)									
Number of observations	780	468	312	774	462	312	765	455	310
R^2	0.01	0.21	0.042	0.022	0.19	0.007	0.037	0.051	0.06

Table 4 (cont.): TOR (4 year RA) regressions with control variables

Countries	(10) all countries	(11) non-cfa countries	(12) cfa countries	(13) all countries	(14) non-cfa countries	(15) cfa countries
Four-year TOR	5.140***	4.449	-0.522	4.930**	7.069	-0.203**
	(1.976)	(2.816)	(0.502)	(1.877)	(2.631)	(0.459)
world inflation				2.732***	3.695***	0.305***
				(0.277)	(0.420)	(0.061)
Trade Openness				-0.055*	-0.049***	0.064**
				(0.013)	(0.033)	(0.002)
Government Spending				0.405***	0.533*	0.154*
				(0.091)	(0.137)	(0.022)
Log (Income)	-5.760***	-23.12***	1.10***	-5.730***	-21.675***	1.31***
	(0.973)	(2.259)	(0.163)	(0.975)	(2.503)	(0.169)
Number of observations	776	464	312	765	455	310
R^2	0.051	0.21	0.145	0.143	0.36	0.300

Notes: .01 - ***; .05 - **; .1 - *. The dependent variable is inflation rate. Reported is the within R^2. Standard errors are robust and clustered.

Next, we consider "*stressful times*" determinants of inflation in the analysis. Vuletin and Zhu (2011) study the effects of banking crises and default episodes[25]as a *stressful time* determinant of inflation. This paper uses a political instability indicator as a proxy for times of stress. Although banking crises and default episodes are plausible measures of economic stress in developed countries, we believe political instability is a better proxy for stress given the geo-political climate of Africa. Our two measures of political stability are civil war and coup d'état.

Countries that are politically unstable have a tendency to use the inflation tax to increase revenues, and as a result, have a more difficult time following a time-consistent monetary policy. Thus, we expect a direct relationship between inflation and political instability. Using GMM and fixed effects estimation, Aisen and Veiga (2006) analyze the relationship between political instability and inflation for 100 countries over the period 1960-1999 and show that, on average, a higher level of political instability leads to higher inflation.

Columns 1-3 of Table 5 show the effect of *civil war,* where a dummy variable equals 1 if a civil war occurred and 0 otherwise, for each year in our sample. Not surprisingly, we find that inflation increases when a country goes through a civil war. This finding is positive and statistically significant in the full sample and the non-CFA countries. A civil war increases inflation by a magnitude of 3.640 for non-CFA countries, but has no effect for CFA countries.[26] Columns 4-6 show the effect of *coup d'état*, a dummy variable equal to 1 if there is a coup d'état and 0 otherwise, for each year in our sample. The effect of this variable is the same as the civil war variable except the point estimates are much larger for non-CFA countries. Columns 7-9 reveal that these results still hold for both political stability measures when all of the other

[25] Data on these variables were not available for many countries in our sample.
[26] This result is not surprising since in a monetary union, countries are unable to use seigniorage revenues to finance the cost of a war.

control variables are included. That is, the inclusion of stressful times' indicators does not change our main conclusion that a high turnover rate of central bank governors causes an increase in inflation in the non-CFA and full samples, but leads to a statistically significant decrease in inflation for the CFA countries.

c. Decomposing the TOR variable

This section examines the impact of our new CBI measures on inflation. First, Table 6 presents the effects of premature turnover rates (TOR_PREM), which accounts for the frequency of central bank governors' removal before the end of the first term, and non-premature turnover rates (TOR_NON-PREM),[27] which accounts for central bank governors' removal that occurs after the first term. Like Vuletin and Zhu (2011), we find that the non-premature removal of central bank governors does not result in higher inflation. In contrast, we find that the premature removal of central bank governors leads to a statistically significant fall in the inflation rate for the CFA countries. One possible explanation is that the removal of a central bank governor in the CFA zone may indicate that the central bank governor is a threat to the credibility and the stability of the zone, rather than a challenger to the government.[28]

Second, Table 7 displays the effects of a central bank governor's replacement that is an ally (TOR_ALLY) or a non-ally (TOR_NONALLY)[29] on inflation. The results, in Columns 1-3, show that when a CFA central bank governor is replaced by an ally, inflation decreases more than when the replacement is a non-ally.

[27] TOR= TOR_PREM + TOR_NONPREM
[28] We explain this finding further in the discussion section.
[29] TOR= TOR_ALLY +TOR_NONALLY.

Table 5: TOR (four-year TOR) regressions with control variables and stressful times variables

Countries	(1) all countries	(2) non-cfa countries	(3) cfa countries	(4) all countries	(5) non-cfa countries	(6) cfa countries	(7) all countries	(8) non-cfa countries	(9) cfa countries
Four-year TOR	5.362***	8.053***	-0.596	5.122**	7.927**	-0.589	4.068**	4.061	-1.047**
	(1.932)	(2.974)	(0.541)	(1.999)	(3.089)	(0.543)	(1.821)	(2.572)	(0.461)
Civil war	2.847***	3.640***	-0.087				2.222***	1.683***	-0.185*
	(0.348)	(0.498)	(0.120)				(0.355)	(0.506)	(0.104)
Coup d'état				4.306***	7.714***	-0.010	2.316**	4.681***	0.135
				(1.091)	(1.846)	(0.256)	(1.002)	(1.562)	(0.218)
World inflation							2.129***	2.455***	0.384***
							(0.269)	(0.416)	(0.061)
Trade openness							-0.019	-0.148***	0.004**
							(0.012)	(0.032)	(0.002)
Log (Income)							-3.985***	-17.010***	1.593***
							(0.961)	(2.643)	(0.169)
Government spending							-0.532***	-0.391***	0.085***
							(0.089)	(0.135)	(0.023)
Number of observations	780	468	312	780	468	312	765	455	310
R^2	0.091	0.121	0.006	0.030	0.053	0.004	0.227	0.388	0.308

Notes: .01 - ***; .05 - **; .1 - *. The dependent variable is the inflation rate. Reported is the within R^2. Standard errors are robust and clustered.

Vuletin and Zhu (2011) notes that a less-financially developed country might have more difficulty in finding suitable candidates for a central bank governor's replacement. Thus, a government ALLY might be a proxy for lack of financial development[30].

Table 6: TOR_prem and TOR_non-prem regressions with control variables and political instability

Countries	**(1) all countries**	**(2) non-cfa countries**	**(3) cfa countries**
Premature removals	0.834	-0.239	-1.339**
	(1.305)	(1.634)	(0.598)
Non-premature removals	-0.040	0.212	-0.588**
	(0.958)	(1.380)	(0.252)
World inflation	1.299***	1.512***	0.421***
	(0.124)	(0.192)	(0.031)
Civil war	2.724***	2.433***	-0.071
	(0.354)	(0.498)	(0.113)
Coup d'état	2.145**	4.612***	0.049
	(0.957)	(1.526)	(0.218)
Trade openness	-0.032**	-0.170***	0.004*
	(0.012)	(0.031)	(0.002)
Log (Income)	-4.142***	-13.302***	1.420***
	(0.963)	(2.441)	(0.178)
Government spending	-0.400***	-0.516***	-0.039***
	(0.066)	(0.127)	(0.014)
Number of observations	871	519	352
$\boldsymbol{R^2}$	0.244	0.377	0.466
Ho: β(TOR_nonprem) = β(TOR_prem)	0.582	0.83	0.24

Notes: .01 - ***; .05 - **; .1 - *. The dependent variable is the inflation rate. Reported is the within $\boldsymbol{R^2}$. Standard errors are robust and clustered. The regression is done with no intercept.

To proxy for financial development and intermediation, like Vuletin and Zhu (2011), we examine the effects of *liquid liabilities* and *private credit*.[31] Columns 4-9 in Table 7 show a statistically significant negative relationship between liquid liabilities and inflation; a statistically

[30] See Vuletin and Zhu (2011).
[31] See appendix for a definition of these variables.

significant positive relationship between private credit and inflation in CFA countries. Moreover, even when we control for financial development, replacing a central bank governor with an ally or a non-ally still leads to a decrease in inflation for the CFA countries.

Finally, the four dimensions of the TOR variables are interacted to create four new variables defined as follows: TOR_PREM & ALLY, TOR_PREM & NONALLY, TOR_NONPREM & ALLY, and TOR_NONPREM & NONALLY.[32] Table 8 displays the effects of these variables on inflation. Premature changes followed by a replacement with an ally result in lower inflation for the CFA countries. That result differs from Vuletin and Zhu (2011) who find that when these two events occur, the inflation rate goes up and that is true when the replacement occupies a high position in the executive branch.

[32] CFA countries do not have any observations for TOR_PREM & NONALLY.

Table 7: TOR_ALLY and TOR_NON-ALLY regressions with control variables and political instability

Countries	(1) all countries	(2) non-cfa countries	(3) cfa countries	(4) all countries	(5) non-cfa countries	(6) cfa countries	(7) all countries	(8) non-cfa countries	(9) cfa countries
Ally replacements	1.506	2.328	-1.229***	1.369	2.352	-1.131***	1.451	2.334	-0.772***
	(1.704)	(2.561)	(0.348)	(1.701)	(2.565)	(0.303)	(1.705)	(2.563)	(0.294)
Non-Ally replacements	-0.044	-0.124	-0.659***	-0.107	0.050	-0.749***	-0.053	-0.117	-0.683***
	(0.932)	(1.249)	(0.244)	(0.930)	(1.245)	(0.216)	(0.933)	(1.250)	(0.205)
World inflation	1.325***	1.523***	0.499***	1.331***	1.555***	0.353***	1.322***	1.545***	0.307***
	(0.133)	(0.201)	(0.028)	(0.132)	(0.206)	(0.029)	(0.133)	(0.206)	(0.029)
Civil war	2.806***	3.119***	-0.234**	2.783***	3.236***	-0.155	2.801***	3.114***	-0.130
	(0.442)	(0.635)	(0.108)	(0.441)	(0.630)	(0.096)	(0.442)	(0.636)	(0.091)
Coup d'état	2.171**	3.995**	0.142	2.165**	3.949**	0.112	2.177**	3.963**	0.220
	(1.017)	(1.614)	(0.194)	(1.016)	(1.618)	(0.171)	(1.018)	(1.617)	(0.163)
Trade openness	-0.040***	-0.205***	0.004**	-0.041***	-0.205***	0.008***	-0.041***	-0.205***	0.008***
	(0.014)	(0.034)	(0.002)	(0.014)	(0.034)	(0.002)	(0.014)	(0.034)	(0.002)
Log (Income)	-4.410***	-15.231***	1.494***	-4.505***	-13.775***	1.436***	-4.356***	-15.366***	1.407***
	(1.047)	(2.817)	(0.162)	(1.035)	(2.574)	(0.143)	(1.049)	(2.833)	(0.135)
Government spending	-0.499***	-0.662***	0.073***	-0.500***	-0.662***	0.000	-0.488***	-0.669***	0.008
	(0.094)	(0.143)	(0.020)	(0.094)	(0.144)	(0.019)	(0.095)	(0.144)	(0.018)
Liquid liabilities	-0.071	0.121	0.002				-0.052	0.109	-0.086***
	(0.053)	(0.078)	(0.015)				(0.058)	(0.082)	(0.015)
Private credit				-0.044	0.045	0.102***	-0.031	0.024	0.141***
				(0.035)	(0.048)	(0.011)	(0.038)	(0.050)	(0.012)
Number of observations	821	495	326	822	495	327	821	495	326
R^2	0.224	0.361	0.612	0.224	0.359	0.696	0.225	0.362	0.729

Notes: .01 - ***; .0.5 - **; .1 - *. The dependent variable is the inflation rate. Reported is the within R^2. Standard errors are robust and clustered.

Table 8: TOR interactions regressions with control variables and political instability			
Countries	**(1) all countries**	**(2) non-cfa countries**	**(3) cfa countries**
TOR_PREM & TOR_ALLY	2.760	3.198	-1.324*
	(1.942)	(2.203)	(0.726)
TOR_PREM & TOR_NON-ALLY	-0.701	-1.701	
	(2.838)	(2.447)	
TOR_NON-PREM & TOR_NON-ALLY	-0.162	0.291	-0.411**
	(0.456)	(0.787)	(0.134)
TOR_NON-PREM & TOR_ALLY	-1.289	-3.126	-1.273***
	(1.727)	(3.794)	(0.378)
World inflation	1.303***	1.525**	0.419***
	(0.403)	(0.662)	(0.086)
Civil war	2.730**	2.445	-0.078
	(1.316)	(1.408)	(0.131)
Coup d'état	2.175	4.654*	0.045
	(1.422)	(2.315)	(0.249)
Trade openness	-0.033	-0.171***	0.004**
	(0.037)	(0.050)	(0.001)
Log (Income)	-4.137	-13.414	1.441**
	(3.608)	(8.637)	(0.533)
Government spending	-0.395**	-0.488	-0.039
	(0.182)	(0.353)	(0.048)
Ho: β(TOR_NON-PREM&NON-ALLY) = β(TOR_NON-PREM &ALLY)	0.54	0.34	0.06
Ho: β(TOR_NON-PREM &NON-ALLY) = β(TOR_PREM & NON-ALLY)	0.867	0.475	0.011
Ho: β(TOR_NON-PREM&NON-ALLY) = β(TOR_PREM &ALLY)	0.164	0.331	0.279
Ho: β(TOR_NON-PREM&ALLY) = β(TOR_PREM&NON-ALLY)	0.85	0.541	0.006
Ho: β(TOR_NON-PREM &ALLY) = β(TOR_PREM&ALLY)	0.153	0.16	0.953
Ho: β(TOR_PREM&NON-ALLY) = β(TOR_PREM&ALLY)	0.211	0.137	0.095
Number of observations	871	519	352
R^2	0.246	0.381	0.469

Notes: .01 - ***; .05 - **; .1 - *. The dependent variable is inflation rate. Reported is the within R^2. Standard errors are robust and clustered. The regression is done with no intercept.

d. Discussion of results

The findings in the previous sections indicate that our new CBI measures lead to a decrease in inflation for the CFA countries. Vuletin and Zhu (2011) find the opposite effect in their sample of developed and developing countries. An obvious reason why our results differ is we include countries that are part of a monetary union while Vuletin and Zhu (2011) only examine countries with their own central banks and their own currencies.

Our results can be explained by the fact that the nomination process of both the BEAC and the BCEAO central bank governors, in practice, is done by the two largest economies in the West African and Central African regions, Ivory Coast and Gabon, respectively. Thus, these two countries are effectively selecting the central bank governor.[33]The de facto nomination process of central bank governors both in WAEMU and CAEMC[34] has led Ivory Coast and Gabon to choose central bank governors who will implement monetary policies that favor their national economies rather than the economic well-being of the whole CFA zone. In this context, a premature removal means a central bank governor is perceived as a challenger, not by Ivory Coast or Gabon, but by the other heads of state of the member countries. It is important to note that although the nomination process is done by these two countries, the firing or the premature removal of a central bank governor requires all the heads of state in each of the CFA zones[35].

A CFA central bank governor who is perceived as pushing economic policies favorable to Ivory Coast or Gabon or whose behavior can be viewed as detrimental to the credibility or the stability

[33] See Guillaume and Stasavage (2000). It is worth noting that although the de facto nomination process existed for the entirety of our sample, it is no longer in practice today.

[34] CAEMC stands for Central African Economic and Monetary Community and is the regulatory body of the BEAC.

[35] Though this implies that Ivory Coast or Gabon can thus block a vote to remove the central bank governor of their choice; in practice, what is observed, is that if the majority of the CFA zone countries and France agree, then the decision is implemented.

of the zone can be removed or fired by the unanimous approval of all the member countries' heads of state. Thus, the removal of a CFA governor should lead to a decrease in inflation in the entire zone rather than an increase. For example, inflation fell following the removal of BEAC governor Philibert Andzembe in 2010 when he was discovered that he was implicated in an embezzlement scandal.

For countries that are part of a monetary union, the temptation to put national considerations first is often curtailed by the need to meet specific criteria. In the CFA zone, countries must have an average inflation rate of less than 3%, a debt-to-GDP ratio of 70%, and a fiscal balance-to-GDP ratio that is balanced or in surplus. These criteria, however, often fail to account for the level of heterogeneity that exists between regions and within each region and the presence of asymmetries in the CFA zone gives countries very little incentive to respect these criteria, even if when doing so, their behaviors can be harmful to the well-being of the monetary union.

In the case of the CFA zone, average per capita income in CAEMC is almost twice that of WAEMU. In the West African region, however, there is a higher level of financial development and more intra-regional trade.[36] The WAEMU zone is more prone to fiscal imbalances, while countries of the CAEMC zone have accumulated fiscal surpluses. The differences in fiscal balances are due to WAEMU countries being primarily agricultural commodities exporters, while the CAEMC countries primarily export oil.

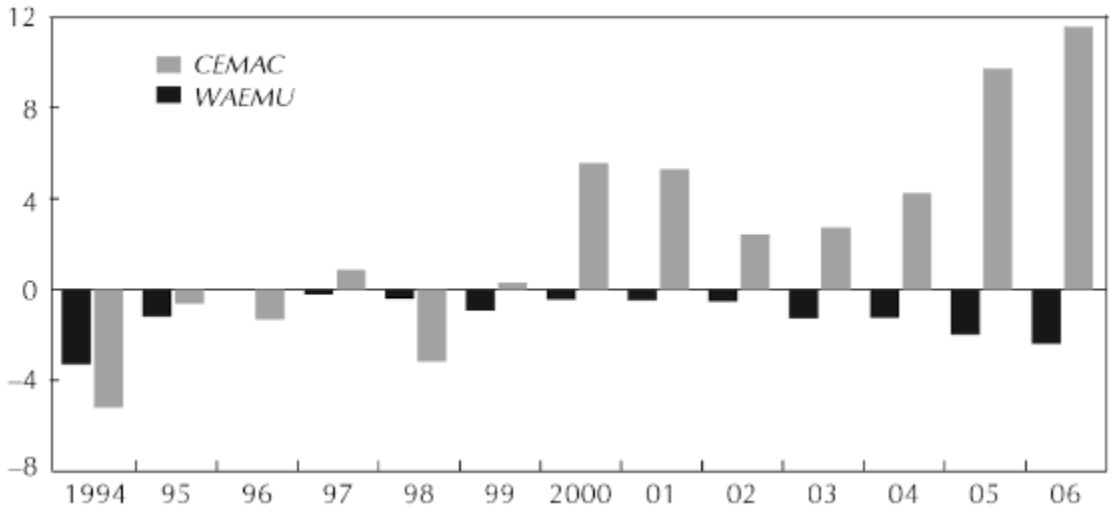
The economic heterogeneity of countries has made it difficult for the members of the CFA zone to respect the convergence criteria mentioned above. Table 9 shows CAEMC countries have had an easier time maintaining fiscal surpluses than WAEMU countries. The same holds true for debt-to-GDP ratio with the biggest violator being Guinea-Bissau. It is not surprising then that

[36] See Gulde and Tsangarides (2008).

when it comes to adjustment policies or fiscal reaction functions; Ivory Coast and Gabon have been more inclined to consider their own national economic circumstances than the Franc zone's overall well-being.[37]

Our results indicate that the replacement of a central bank governor by an ally (TOR_ALLY) is negatively related to inflation, whereas Vuletin and Zhu (2011) find that inflation is five times higher for all samples. We speculate that the differences in our findings are due to the definition of ally in our sample. In their paper, Vuletin and Zhu (2011), define ally as a central bank

Table 9: Comparison of fiscal imbalances between CEMAC and WAEMU



Source: Gulde and Tsangarides (2008).

governor's replacement that comes from a ministry or top executive branch. This paper also considers a governor an ally if he or she comes from the same political party or the same tribe as the nominating president. Our data sample indicates only two instances for CFA countries, in which a central bank governor replacement is an ally. None of these replacements are ministers

[37] See Masson and Pattillo (2005).

or heads of government agencies. This fact implies that the effect of the origin of the central bank governor replacement on inflation might be a function of how “ally” is defined.

Table 10: CEMAC AND WAEMU history							
Fiscal balance criteria: nonnegative	**1994**	**1996**	**1998**	**2000**	**2002**	**2004**	**2006**
CEMAC							
Cameroon	-7.5	-3.8	-2.4	2	0.8	0	3.2
Central African Republic	-5.8	-3.1	-0.7	-1.9	-0.5	-3.9	0.4
Chad	-5.3	-1.4	-0.4	-3.1	-3.2	-0.2	2.5
Congo	-12.4	-6.9	-15.9	7.1	-0.8	9.2	32.6
Equatorial Guinea	-2.7	2.9	-0.5	9.5	11.5	9.9	15.7
Gabon	1.8	11	-1.3	13.9	6.8	11	15.1
Number of countries violating	5	5	6	2	3	2	0
WAEMU							
Benin	-0.9	1.3	3.3	1.9	0.1	-0.4	0.1
Burkina Faso	-2.7	0.6	-0.5	-1.4	-3.7	-3.1	-4.3
Cote d ivoire	-3	-0.4	-0.8	-0.3	-0.4	-1.3	-2
Guinea-Bissau	-7.9	-4.3	-16.4	-16.8	-9	-13.7	-15.9
Mali	-3.1	0.8	0.2	-0.6	-1.3	-0.7	-0.6
Niger	-7	-1.7	-3.3	-3	-1.8	-2.2	-1.8
Senegal	-2.3	1.5	0.9	1.2	1.8	-0.7	-3.5
Togo	-8.3	-3.6	-3	-2.7	0.3	1.4	-2.7
Number of countries violating	8	4	5	6	5	7	7
Total debt/GDP (less or equal 70%)							
CEMAC							
Cameroon	145.6	85.4	81.1	80.4	50.1	44.2	3.1
Central African Republic	94.8	89.9	83.9	80.3	91.4	93.6	82.3
Chad	62.3	54.3	54.2	72.3	57.2	35	23.7
Congo	270.2	212.2	264.4	164.9	200.9	229.6	82.5
Equatorial Guinea	218.1	92.9	59.7	36.3	10.2	6.2	2.7
Gabon	86.4	71.1	84.9	57	65.6	40.1	34.2
Number of countries violating	5	5	4	4	2	2	2
WAEMU							
Benin	82	65.7	65.8	71.8	66.6	49.8	22.1
Burkina Faso	51.6	44.6	46.4	63	51.4	34.8	8.9
Cote d ivoire	176.1	133.2	84.9	108	88.9	88.7	177.4
Guinea-Bissau	378.2	326.1	449	353.8	419.4	379.4	326.2
Mali	116.4	101.3	100.3	99.5	90.2	66.9	27.7
Niger	101.9	76.6	77.9	94.5	81	55.6	14.6
Senegal	84.1	80.4	85.2	76.2	82.2	67.3	44.9
Togo	121.1	85.6	79.7	98.2	93.9	79.6	67.6
Number of countries violating	7	6	6	7	6	3	2

Source: Gulde and Tsangarides, (2008).

1.6 Conclusion

This paper adds to the literature on CBI by examining central bank independence in a monetary union framework and by creating more suitable measures of de facto CBI for developing countries. Since the existing literature shows de jure measures of CBI are inappropriate for developing countries because of the poor quality of their institutions. Novel measures introduced by Vuletin and Zhu (2011) are used and extended to the African context, to better assess the effect of CBI on inflation in developing countries. Specifically, we collect data on central bank governor changes and classify these changes as premature (before the end of the official term) and non-premature and determine whether a central bank governor's replacement can be classified as ally or non-ally depending on their connections to the nominating president.

Our findings show that the traditional de facto measure of CBI explains some of the variation in inflation rate both in the full sample and the non-CFA countries. When that measure is deconstructed, however, the evidence indicates that both premature and non-premature changes of central bank governors lead to a decrease in inflation rates for CFA countries. The results also show that inflation in CFA countries under a central bank governor who is an ally is lower than when the central bank governor is a non-ally. Those results are in contrast to Vuletin and Zhu (2011) who find that both premature removals of central bank governors and ally replacements lead to an increase in inflation. We argue that this difference is due to the presence of mechanisms in a monetary union to prevent countries from engaging in behaviors that can be harmful to the union. Therefore, the premature exit of a CFA central bank governor who is perceived to be a challenger is beneficial to the whole zone's economic well-being and should lead to lower inflation.

Our paper also suggests the Cukierman index is not appropriate to study the relationship between CBI and inflation in Africa. Instead, it is essential to account for the frequency of central bank governors 'changes and the nature of the replacement of central bank governors, given the authoritarian regimes that often govern African countries. African central bank governors often encounter harsher political pressures compared to peers in their developed countries when implementing monetary policy and fighting against inflation. Consequently, African countries should not be grouped with other developing countries when studying de facto CBI.

Finally, our paper also shows that the relationship between CBI and inflation is different when a country belongs to a monetary union. In an African context, in which countries often suffer credibility and thus time-inconsistency problems, a monetary union provides monetary discipline which in turn ensures that the common central bank remains independent. Thus future studies on CBI should recognize and take into account how CBI affects countries in a monetary union.

1.7 Appendix

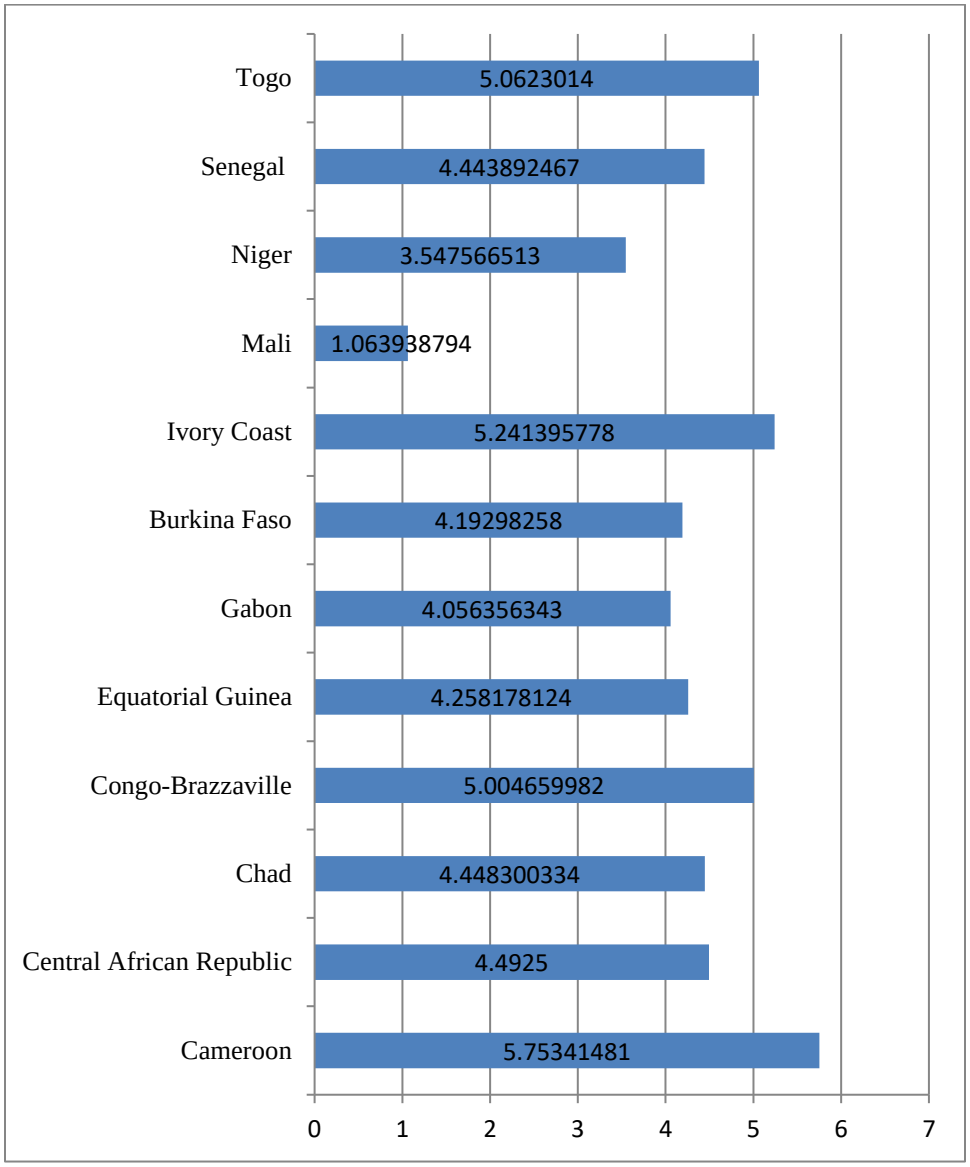


Figure A1: Average inflation rates for CFA countries

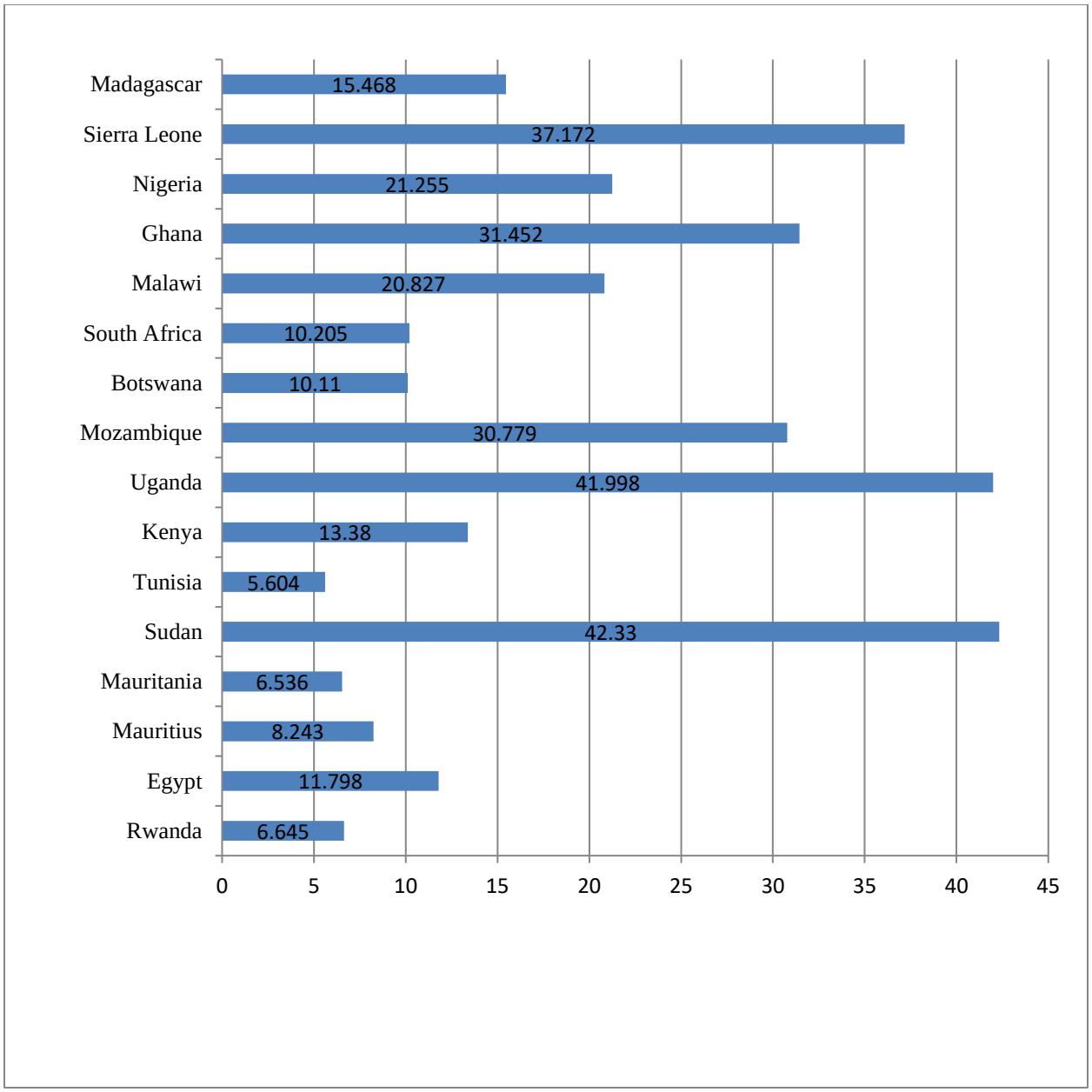


Figure A2: Average inflation rates for non-CFA countries

UEMOA: stands for West African monetary union (also known as WAEMU) and include west African countries that have the west African CFA as a currency: Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo.

CEMAC: stands for Central African Economic and Monetary Union and include central African countries that have the central African CFA as their currency: Cameroon, Central African Republic, Chad, Congo-Brazzaville, Equatorial Guinea, and Gabon.

Figure A3: Map of CFA countries

Source: afrolegends.com

Table A1: Description of variables with sources

Variable name	Description	Source
Inflation	inflation rate calculation is based on CPI	WB world development indicators
World Inflation	inflation rates in G7 countries measured by the consumer price index	OECD data
Explicit inflation target	does a central bank has an explicit inflation target?	various central bank websites
Exchange rate regimes	takes a value of 1 if fixed exchange rate regime 1 and 0 otherwise	IMF regime classifications
Measures of political instability	proxied by civil war and coup d'état	Center for systemic peace
Liquid Liabilities	currency + demand + interest liabilities of banks and nonbank financial intermediaries	Loayza and Ranciere (2006) and Levine et al. (2000)
Private Credit	value of credits by financial intermediaries to the private sector divided by GDP	Loayza and Ranciere (2006) and Levine et al. (2000)
Government spending	government expenditures on goods and services and national defense and security	WB world development indicators
Income per capita	GDP divided by midyear population (GDP per capita in constant dollars 2010)	WB world development indicators
CFA dummy	takes a value of 1 if I the CFA zone and 0 if not	BEAC, BCEAO websites
Premature	takes a value of 1 if CB governor changes before the expiration of his/her first term; 0 otherwise.	various CB websites and based on author's calculations
Ally	1 if member of executive branch (see ministries table A1), high ranking member of ruling party or same tribe, 0 otherwise	various CB websites and based on author's calculations

CHAPTER 2: Did Mali benefit from joining the CFA zone? An analysis using the synthetic control method

2.1 Introduction

Development economists have long debated the causes for Africa's growth puzzle. While some pundits have pointed to the legacy of colonialism and its long-lasting effect on the quality of institutions (Acemoglu et al. 2005; Nunn, 2008), others have blamed geography for the high level of pauperization faced by the continent today (Bloom et al. 1998). Monetary independence, or lack thereof, has not received much attention in the economics literature as an explanatory factor behind Africa's economic stagnation. Indeed, after independence, many African countries abandoned colonial currencies such as the British West African Pound or the Portuguese Escudo for their own national currency and for their own central banks. Most former French colonies, however, chose to remain in the CFA zone and maintain their peg to the French franc or the euro today. At the time, monetary independence was seen as a symbol of nationalism or even patriotism but many of these new national currencies substantially declined in value and became inconvertible. It became clearer to some African countries that regional monetary integration might be a solution to their joint goals of nationalism or independence and economic stability. In recent decades, several initiatives have been proposed to increase the level of regional monetary integration. For example, in 2000, the East African Community comprised of Burundi, Kenya, Rwanda, South Sudan, Uganda, and Tanzania was revived with the goal of establishing a common currency and building a political federation. Existing monetary blocks such as the CFA zone[38] also extended their scope by putting in place economic unions such as the West African Economic and Monetary Union (WAEMU) for their West African Members in 1994 or the

[38] Although this monetary union is often referred to as the "CFA zone", this term is somewhat misleading because the CFA zone in reality consists of two different monetary zones and the country of Comoros, each with their own central bank and regulating agency.

Central African Economic and Monetary Community (CAEMC) for the Central African members in 1995. Recently, there has been a renewed debate about the CFA zone across the continent. Several African pundits have called for the dismantling of the CFA zone by arguing it is an insidious form of neo-colonialism that curtails the sovereignty of these countries vis-à-vis France. Critics of the zone also argue that the economic shocks faced by CFA members are different from the shocks faced by France and the European Union.[39] Thus, the CFA zone's central banks cannot easily respond to their economies' shocks. The level of political instability in many African countries means exchange rate targeting is not necessarily the appropriate monetary policy tool, as countries might not be able to resist the temptation to monetize their debts. Also, African countries often have fiscal imbalances which make them more likely to use the seigniorage tax. This fact is especially true for African central banks because they have a lower degree of de facto central bank independence relative to more developed countries. In that case, however, a monetary union might be a second-best solution to enhance the monetary credibility and stability of these countries.

Empirical studies have shown that membership in the CFA zone is correlated with a higher level of price stability (see Yehoue, 2007; Coulibaly and Davis, 2013). For example, the impact of the CFA is particularly noticeable when comparing the growth performance of CFA countries to non-CFA countries. Devarajan and Melo (1987) find that CFA countries grew faster than non-CFA countries from 1960-1982. Furthermore, Coulibaly and Davis (2013) find that CFA zone countries grow 1 or 2 percentage points faster than non-CFA countries. Other researchers have investigated the effect of monetary integration on FDI and trade. Cham (2016) found that monetary integration in the West African Monetary zone led to an increase in FDI and trade.

[39] Both CFA francs were pegged to the French Franc and since 1999 to the euro.

Carrere (2004), Masson and Patillo (2004), and Bangake and Eggoh (2017) find that membership in a currency union has also increased the level of trade between country members; while Nitsch (2002) finds that monetary integration has no effect on interregional trade.

This paper analyzes the effect of the CFA zone on short run business cycles indicators such as income per capita and inflation as well as long-term economic indicators such as trade relations with France and foreign direct investment (FDI). This paper contributes to the literature on CFA monetary integration and monetary integration in several ways. One, to our knowledge, this paper is the first to use the synthetic control method (SCM) to assess the gains of joining a monetary union on macroeconomic fundamentals as well as long-term economic prospects. This paper differs from the literature on the effect of trade on currency unions in several ways: 1)The seminal paper by Andrew Rose and Jeffrey Frankel uses gravity models to estimate the effect of currency union on output and trade, whereas our paper uses the synthetic control method. This technique, first introduced by Abadie, Diamond and Hainmueller (2003), is a comparative studies approach that assesses the trend that the affected unit, Mali, would have followed in the absence of the treatment, CFA zone's membership. The synthetic control method controls for the effect of time-varying unobservables unlike traditional methods such as fixed effects or difference-in-differences.; 2) This paper differs from other papers in the literature because of its narrow focus on the CFA zone. The distinction between the CFA zone and other currency unions such as the European Monetary Union is essential. Indeed, the former is a legacy of colonialism and any assessment of the effect of currency unions on macroeconomic fundamentals cannot be separated from also taking into account the effect of colonial legacy as highlighted by Acemoglu et al. (2001) on development; 3) to our knowledge, we are the first to test the effect of joining the CFA zone on trade relations with France. We recognize that this choice might be

unconventional, given that most of the literature has focused on gauging whether or not monetary integration increases trade between member countries. We argue, however, that the CFA is a former French colonial currency and till this day, the zone maintains strong political and economic ties with France. Two, while previous studies have concentrated on countries that are already members of the CFA zone, our paper examines whether or not Mali would have achieved better economic outcomes by retaining its own currency instead of joining the CFA zone.

Our analysis consists of comparing Mali,[40] a former French colony that left the CFA zone after independence but rejoined the union in 1984, to a counterfactual constructed from a set of appropriate donor countries that were not exposed to the treatment, countries that did not join the CFA zone. Using the SCM, we can identify the direct effects of joining the CFA zone on GDP per capita, the inflation rate, FDI, and our total trade measure.[41] Our results indicate that joining a monetary union, such as the CFA zone, has a statistically significant impact on GDP per capita, inflation, and FDI. Specifically, Mali's GDP per capita and FDI rose and its inflation rate immediately fell after joining the CFA zone. We, however, find that joining the CFA zone had no effect on Mali's total trade with France.

The remainder of the paper is structured as follows. Section 2 describes the CFA zone. Section 3 outlines the theoretical framework. Section 4 discusses the SCM method. Section 5 presents the

[40] There are two other countries that were late joiners of the CFA zone: Equatorial Guinea who joined in 1985 and Guinea-Bissau who joined in 1997. Although our analysis would have ideally studied these two cases, we are unable to include Equatorial Guinea because of data limitations, specifically, for the pre-treatment period. Guinea-Bissau, in contrast, went through a civil war approximately one year after joining the CFA zone, which would confound any observed effects because joining the CFA and the war are contemporaneous events.

[41] Our total trade measure is simply the ratio of trade with France to total trade.

data and the variables. Section 6 examines the results. Section 7 tests the robustness of our results and section 8 concludes.

2.2 Historical background of the CFA zone

At to the end of WWII, several colonial powers formed monetary arrangements (e.g., CFA zones) whose sole purpose was to strengthen the ties between the colonies and the metropole. These arrangements included the creation of monetary institutions that served as the foundations for today's African monetary institutions. The CFA[42] Franc was introduced in 1945 and was pegged to the French Franc at 1 CFA franc for 1.7 French Francs.[43] As mentioned earlier, there are two zones, each with its own regulating agency. The Central African Economic and Monetary Community (CAEMC) consists of Cameroon, Central African Republic, Chad, Equatorial Guinea, Gabon, and Congo and uses a currency denoted XAF issued by their region's central bank (BEAC). The West African Economic and Monetary Union (WAEMU) includes Benin, Burkina-Faso, Guinea-Bissau, Ivory Coast, Mali, Niger, Senegal, and Togo and uses a currency denoted XOF issued by their region's central bank (BCEAO).[44]

While many former British and Portuguese colonies opted to leave the colonial currency system behind in favor of a national currency, most French colonies opted to preserve the monetary relationship with France.[45] Even though their central bank's charters have changed over time, the CFA remained pegged to the French Franc and the most noteworthy feature of the franc

[42] CFA in French means Colonies Francaises d 'Afrique.
[43] Masson and Pattillo (2005, p. 15).
[44] BEAC stands for *Banque des Etats de l'Afrique* Centrale and BCEAO stands for *Banque Centrale des Etats de l'Afrique de l'Ouest* in French.
[45] Former French colonies such as Madagascar or Mauritania left the zone and created their own currencies in 1973. Following independence, Mali initially left in 1962 and replaced the CFA with the Malian Franc but rejoined the zone in 1984. Portuguese colonies, Equatorial Guinea and Guinea-Bissau, joined the zone respectively in 1985 and 1997.

monetary union, the *operations account system*, was upheld.[46] The operations account guarantees unlimited access of the two central banks to the French Franc prior to 1999 and to the Euro thereafter, via the Bank of France. For most countries with fixed exchanges rates, the national central banks are required to maintain the announced fixed rate. This is done by ensuring that the central bank maintains a sufficient reserve of foreign currencies. For CFA zone countries, in contrast, the parity of the CFA with the Euro is maintained by the French Treasury, which essentially eliminates the potential problem of having too few foreign reserves. In exchange, the CFA zone countries were required to deposit all their external assets and earnings in their operations account at the French Treasury. Since 2005, the Central African countries and West African countries are only required to deposit 50% and 60%, respectively, of their earnings. Other notable features of the CFA zone include: 1) The board of directors for each central bank must include French representatives (i.e., 2 for the BEAC, 3 for BCEAO, and 4 for the Central bank of Comoros); 2) The CFA currencies are legal tenders only in their respective zones; 3) Free capital mobility exists between the two zones and France; and 4) The CFA is pegged to the euro at a fixed rate of 1 euro=655,957 CFA Franc.

The devaluation of the CFA Franc in 1994 was a major event that impacted the zone. The member countries were losing their competitive edge because their currency was overvalued. Prices of key exports such as cocoa (Ivory Coast) or petroleum (Gabon) were falling which led to the deterioration of these countries' current accounts. To restore competitiveness, the CFA franc peg with the French Franc was changed from 50CFA to 100CFA for 1 French Franc. The devaluation of the CFA was one of the conditions attached to the structural adjustments packages provided by the World Bank and the IMF to these African countries. It was also accompanied by

[46] It is important to note that both BEAC and BCEAO maintain separate operations account with the French treasury.

the creation of the UEMOA and CEMAC to facilitate banking supervision, regional integration, and coordination of both fiscal and monetary policies within the CFA zone.

2.3 Conceptual framework

The *Theory of Optimum Currency Areas* in Mundell (1961) outlines many of the benefits of joining a currency union. Mundell defines a currency area as a geographic region in which member countries share the same currency and have a fixed exchange rate. According to Mundell, an optimal currency area should abide by the following four principles:

1. The mobility of the factors of production: Mobility across countries lessens the need for exchange rate adjustment and also keeps markets at equilibrium. In the case of the Eurozone, a decrease in the demand for French goods and an increase in the demand for German goods will lead to unemployment in France and inflation in Germany. Mundell argues that if labor is mobile, then these two problems can be averted.
2. Political integration: Countries must be willing to follow similar monetary and fiscal policies in order for the currency union to be successful. For example, Eurozone countries were required to sign the Stability and Growth Pact (SGP) which provides fiscal surveillance of the members by the European Commission and the Council of Ministers as well as guidelines for each government's deficit (3% of GDP) and debt (60% of GDP). Countries that do not follow those restrictions can have economic sanctions imposed on them.
3. Fiscal integration: Countries must be willing to engage in a certain level of risk sharing. Suppose one member country is affected by an adverse demand shock. To avoid a

spillover effect, other member countries must provide fiscal transfers to help the country experiencing the shock.

4. Trade openness and regional integration: Sharing a common currency can improve trade, particularly for small economies. Rose and Van Wincoop (2001) have shown that countries, which join a currency union, can increase trade by about 400 percent. Using a gravity model, Glick and Rose (2001) find that trade is higher for countries in currency unions than for countries with their own currency.

The four principles listed above are central to the theoretical argument in favor of a monetary union. Another benefit from joining a currency union is that monetary discipline is imposed on member countries. For example, a country with its own currency and monetary independence might be more willing to use expansionary monetary policy in response to domestic or external shocks. Countries that abuse this policy tool can gain credibility from joining a currency union via lower money supply growth, and thus, experience a decrease in their inflation rate (Edwards, 1992 and Ghosh, 1996). Thus, a monetary union promotes discipline and enhances credibility, which leads to a lower level of inflation.

In terms of income and growth, a flexible exchange rate gives a country the ability to use monetary policy to respond to economic disturbances. Countries that are exporters of primary commodities tend to use monetary policy in response to negative shocks. Membership in a currency union or fixed exchange rate, however, makes it more difficult for member countries to respond to economic distortions. Nevertheless, income can increase because trade among member countries tends to rise. Using data on 200 countries, Frankel and Rose (2001) show that for every one percent increase in trade, income per capita goes up by one-third of a percent over a 20-year period. This finding is contrary to other studies that show floating exchange rate

regimes are better equipped to respond to economic disturbances (Broda, 2002 and Edwards and Levy-Yeyati, 2005).

There are some potential costs of membership in a currency union. Countries who face different asymmetric shocks from other members might not find it beneficial to join a currency union. Since countries in a currency union do not have the ability to respond to adverse economic shocks using monetary policy, countries that are more concerned about inflation might find it hard to reconcile their monetary policy objectives with countries that are more concerned by unemployment. In addition, a common monetary policy is optimal when there is mobility of labor and diversification of the economy as well as similar production or exports patterns (Masson and Pattillo, 2005). Fiscal and political integration also depend on the quality of institutions (Guillaume and Stasavage, 2000). For example, for a pact such as the SGP to be sustainable, countries need to have a certain level of fiscal discipline and avoid beggar-thy-neighbor policies. Consequently, for a currency area to be optimal, the composition of the currency union is fundamental. For example, the European Monetary Union is credible because its foundation as a monetary institution stems from the German Bundesbank, which is well-known for its stellar discipline.

2.4 The empirical method: the synthetic control approach

a. The method

Our identification strategy consists of comparing the trends in outcome variables of the country exposed to our treatment with that of a counterfactual constructed using a donor pool of countries. That procedure is the core of the SCM developed by Abadie and Gardeazabal (2003) and extended by Abadie, Diamond, and Hainmueller (2010). Our research benefits from using

this method because it uses several donor countries rather than one country to build a more precise counterfactual. This difference allows for a better representation of the treated unit and removes the difficulty of finding just one donor country. Thus, the counterfactual consists of a weighted average of possible donor countries that best reproduces the initial trends or characteristics of the treated country before the intervention occurs. Another advantage of this method is that the contribution of each potential control to the construction of the counterfactual is made explicit to the researcher. Finally, the SCM is flexible because it allows the researcher to appropriately choose donor countries that are closely matched to the treated country.

The trend followed by the counterfactual in the absence of the treatment represents the outcome that the variables of the treated country would have followed without the intervention. In our case, our outcome variables consists of GDP per capita, the inflation rate, a trade measure that consists of the ratio of trade to France to trade with the rest of the world, and FDI. The treated unit, Mali, is exposed to the intervention at different periods, while the treatment consists of joining the CFA zone which it did in 1984.

The SCM uses a sample of i + *1* countries indexed by i where country i = *1* is the country that is receiving the treatment. Our sample is a balanced panel consisting of 14 countries including Mali observed over a period *t = 1,…., T;* where T_0 represents the number of years Mali was not a CFA zone country (pre-treatment) and *T*- T_0 represents the number of years Mali was a CFA zone member (post-treatment). Let Y_{it} be the outcome of Mali at time t and $Y_{it}(0)$ and $Y_{it}(1)$ be the potential outcome of country *i* pre- and post-treatment, respectively. Thus, the observed effect can be captured by $\beta_{it} = Y_{it}(1) - Y_{it}(0)$ and $Y_{it} = Y_{it}(0)$ in pre-treatment or $Y_{it}\ (1) = Y_{it}(0) + \beta_{it}$ in post-treatment. This relationship can be estimated using the following factor model:

$$Y_{it}\ (0) = \ \delta_t + \ Z_{it} \qquad (1)$$

$$Y_{it}\,(1) = \beta_{it} + \delta_t + Z_{it} \qquad (2)$$

where $Z_{it} = \theta_t X_i + \gamma_t \mu_i + \varepsilon_{it}$. X_i is a vector of observed explanatory variables, θ_t is a vector of unknown parameters, γ_t consists of unobserved common factors, μ_i is a vector of country-specific unobservables and ε_{it} is a zero-mean error term. Suppose X_1 is a vector of pre-treatment characteristics of Mali while X_0 is a vector of the same characteristics for the donor countries.[47] The SCM then minimizes the difference between X_1 and X_0 which is given by $X_1 - X_0 W$, where W is a vector of weights on the donor countries such that $w_i \geq 0$ and $\sum w_i = 1$:

$$\min_w \sqrt{(X_1 - X_0 W)' \mathrm{V} (X_1 - X_0 W)} \qquad (3)$$

where V is some symmetric positive semidefinite matrix. The SCM selects w^* such that the estimator of β_{it} is given by the comparison between the outcome for Mali and the outcome for the synthetic control for the donor countries during the pre-treatment period:[48]

$$\widehat{\beta_{it}} = Y_{it}\,(1) - \sum_{j=2}^{j+1} w^*_j Y_{jt} \qquad (4)$$

The weights on the donor countries are chosen so that the weighted averages match Mali as closely as possible.

b. Statistical significance

Traditional statistical inferential techniques are not practical with the SCM because the sample size is usually small. Furthermore, there is no random sampling since researchers can choose the sample units themselves. Thus, the SCM relies on weaker assumptions than traditional methods such as differences-in-differences, which often require the common trend assumption to hold, or

[47] Note that these characteristics may include the pre-intervention values of the outcome variable as well.
[48] See Abadie, Diamond and Hainmueller (2010).

panel data methods such as fixed effects which control only for time-invariant factors (fixed effects).

Abadie et al. (2010) show placebo studies provide an alternative way to assess the statistical significance of the results. Placebo studies are based on the assumption that control units that did not experience the treatment should not have similar or larger trends, like Mali, in outcomes variables in the post-treatment period. If that were the case, then the validity of the SCM will be severely undermined and it could imply the effect was observed by chance. There are two types of placebo studies. One, in-time placebos are conducted by re-assigning the time of the intervention. In our case, we could assume Mali joins the CFA zone in 1975 instead of 1984. This "false treatment" should not result in large effects, otherwise, it will be difficult to pin the "joining of the Franc zone" as a reason for the observed trends in our outcome variables. Two, in-place placebos assign the treatment sequentially to all the control units and compare the results with those obtained for our treated unit. If we observe a smaller effect of the treatment on our control units, our baseline results generated by the SCM are valid.

In this paper, we conduct in-place placebo tests, and despite the absence of randomization, the distribution of in-place placebos can be captured by p-values, which have the interpretation of being the probability of obtaining an estimated effect at least as large as that of the treated country.[49] We calculate these p-values in the following way:

$$\text{p-value} = \Pr.\ (|\hat{\alpha}_{1t}{}^{PL}| \geq |\hat{\alpha}_{1t}|) = \sum_{i \neq 1} \frac{1(|\hat{\alpha}1tPL| \geq |\hat{\alpha}1t|)}{I},$$

where $\hat{\alpha}_{1t}{}^{PL} = \hat{\alpha}_{it} : (i \neq 1)$ is the distribution of in-place placebos effects.

[49] See Galiani and Quistorff (2016).

c. Data and variables

Our sample consists of 14 countries (including Mali) of annual data for 1970-1995.[50] The data on GDP per capita (constant 2010 US$), inflation rate (CPI), trade openness (imports and exports as a % of GDP), and industry value added (% of GDP) are from the World Bank World Development Indicators. Other predictors that we include in our X_i vector include indicators of political instability such as political regimes, civil wars, or democracy; from the Cheibub data set (see Cheibub et al. 2010). The data on FDI, net inflows, in current $) is from the United Nations databank. Finally, we create a total trade measure (exports plus imports) using the ratio of total trade with France to total trade with the rest of the world. That data is from the MIT media lab observatory of economic complexity. We conduct a separate analysis for Mali, for each of our outcome variables, where the pre-treatment period consists of 14 years (1970-1984) and the post-treatment period is 11 years (1984-1995.

Our sample of donor countries in our sample includes: Algeria, Bangladesh, Burundi, Democratic Republic of Congo (DRC), Egypt, Honduras, Malawi, Mauritania, Nepal, Rwanda, Sierra Leone, Sudan, and Tunisia. Ideally, we would prefer to limit our sample to African countries with similar socio-economic conditions but to increase our chances of finding the best match for Mali's counterfactual, we also include non-African countries such as Bangladesh, Honduras, and Nepal.

[50] Except for FDI, we cover the period 1976-1994 because of data availability issues.

2.5 Results

This section explains how we construct a synthetic version for Mali as well as the results of our natural experiment for each outcome variable.

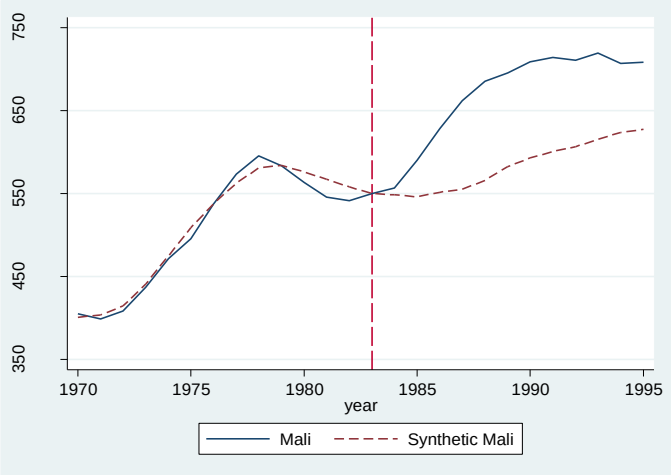
a. GDP per capita

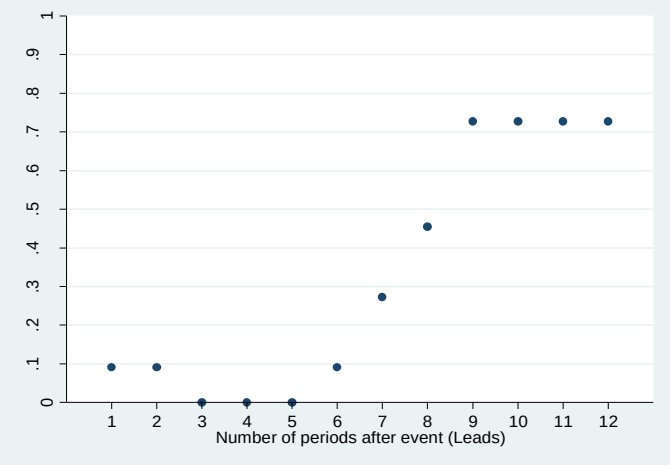
Our results show that the synthetic Mali consists of four countries with the following weights: Malawi (.927), Egypt (.038), Sudan (.027), and Burundi (.008). Table 2 shows the pre-treatment characteristics of Mali and synthetic Mali. Overall, synthetic Mali is similar to Mali in the pre-treatment period, particularly in terms of GDP per capita.[51] The left panel of Figure 1 shows the trajectory of GPD per capita for Mali and the counterfactual over a 25-year period. Synthetic Mali matches Mali really well before Mali joins the CFA zone, then both units immediately start to diverge. This finding indicates joining the CFA zone had a positive effect on Mali's GDP per capita. Next, we run in-place placebo tests where we assign the treatment to all countries in the donor pool. The right

panel of Figure 1 shows the computed p-values to assess the statistical significance of our results. These p-values show that joining the CFA zone leads to a statistically significant (p-value less than 0.1) increase in GDP per capita in the first 6 periods after treatment but then the results become statistically insignificant. Overall, our analysis shows that Mali experienced an increase in its GDP per capita, immediately after joining the CFA zone.

[51] The tables showing balancing properties can be found in the appendix.

Figure 1: GDP PER CAPITA and significance levels for GDP

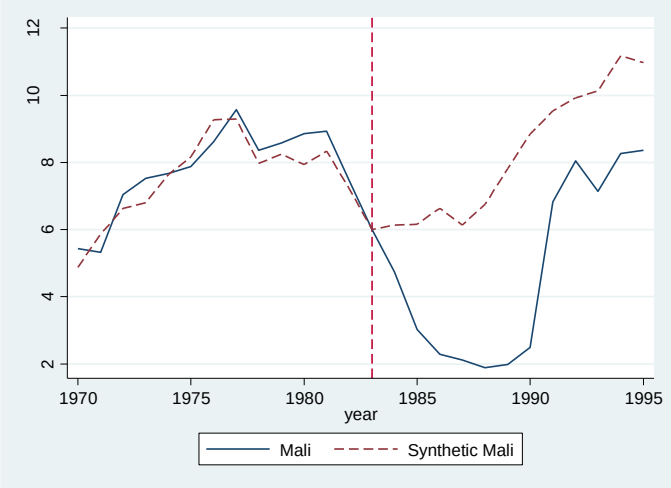


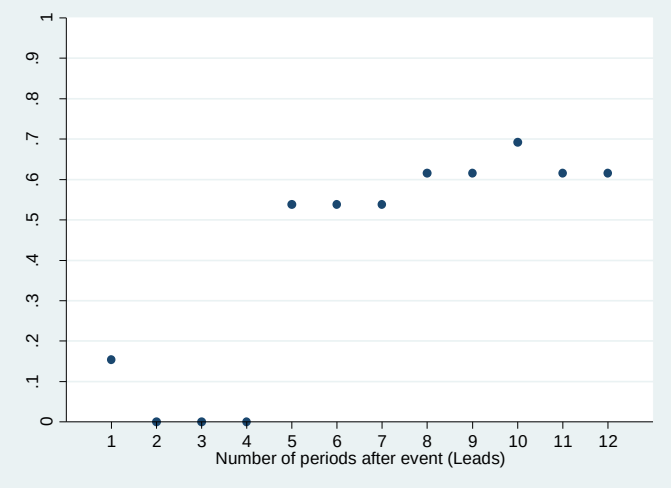


b. Inflation

Our inflation results show that synthetic Mali consists of Burundi (.54), Malawi (.22), Nepal (.22), and Sudan (.02). Table 3 illustrates that synthetic Mali's pretreatment characteristics are very similar to that of Mali, especially for the inflation rate and political instability. The left panel of Figure 3 shows that synthetic Mali does a good job matching Mali's inflation rate in the pre-treatment period. Figure 2 displays the trends in inflation in the pre-treatment and the post-treatment periods. As predicted by the theory, Mali experiences a huge drop in its inflation rate, once it joins the CFA zone. 7 years after joining the CFA zone, inflation was 10% lower in Mali than in synthetic Mali. The results from the placebo tests in the right panel of Figure 2 show, joining the CFA zone initially produces a statistically significant reduction in Mali's inflation rate but those effects become statistically insignificant after 4 periods.

Figure 2: Inflation and significance levels for GDP

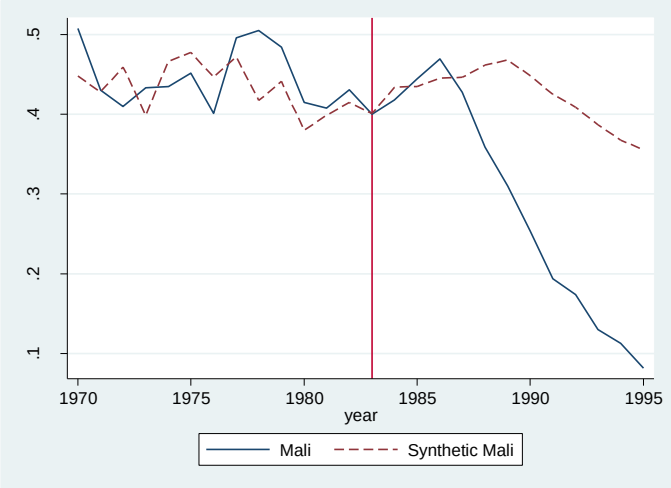


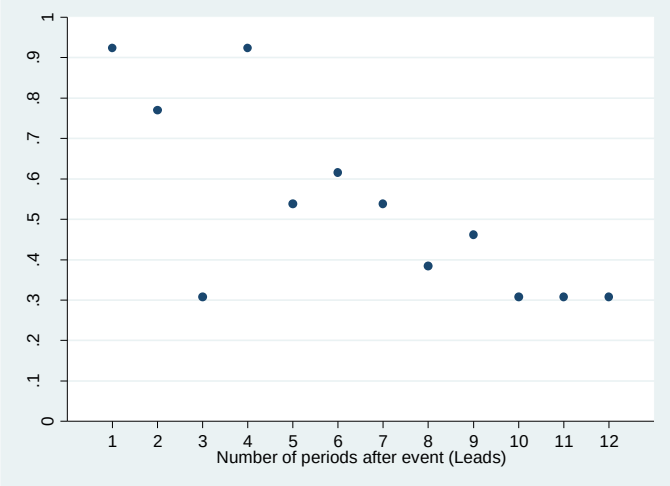


c. Trade with France

In terms of trade with France, synthetic Mali consists of Mauritania (.845) and Algeria (.155). Table 4 shows the pre-treatment predictors for Mali and synthetic Mali. Except for the predictors of the variable trade with France, the synthetic Mali does not match the trajectory of total trade for Mali very well. This result is also evident in Figure 3. The left panel shows a downward trend in trade with France in the post-treatment period for both Mali and synthetic Mali. The results of our placebo tests in the right panel of Figure 3 indicate that any difference between Mali and synthetic Mali is statistically insignificant.

Figure 3: Trade relations with France and significance levels





d. Foreign Direct Investment (FDI)

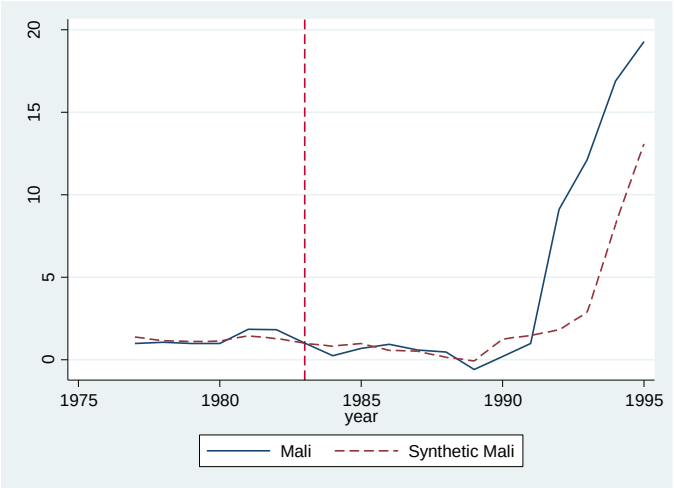
Due to the lack of data, the SCM for FDI is run from 1976-1994 and only includes 8 countries: Algeria, Bangladesh, Democratic Republic of Congo (DRC), Honduras, Malawi, Mauritania, Sierra Leone, and Sudan. Synthetic Mali for FDI, however, only consists of Bangladesh (1). Table 5 shows the predictors of FDI before joining the CFA zone for Bangladesh and Mali. Except for GDP per capita and industry value added, synthetic Mali follows the same trend as Mali. Our results from the left panel of Figure 4 shows that both Mali and synthetic Mali follow the same trend even after Mali joins the CFA zone but then around 1994, Mali experiences one-time jump in FDI. The in-place placebo results reveal some of these differences are statistically significant only one year in our post-treatment period.

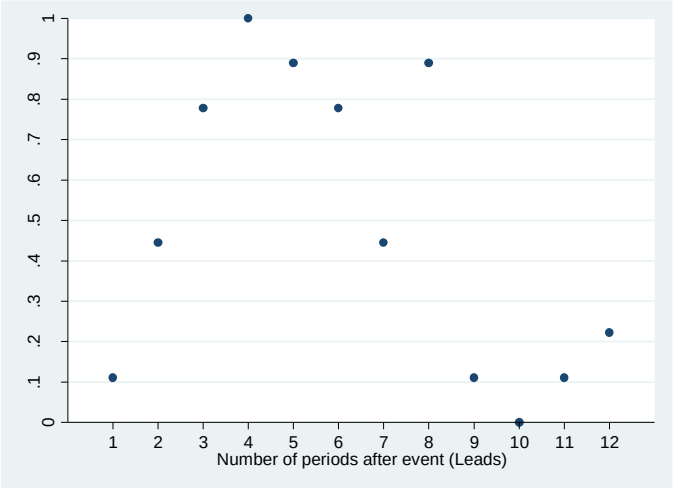
2.6 Robustness tests

a. Removing neighboring countries:

This section examines the robustness of our results. We began by excluding from our donor pool countries that are direct neighbors to Mali. This change controls for any external spillover effects that Mali joining the CFA zone might have on neighboring countries that are not part of the CFA zone via economic ties such as trade linkages or through output (that is, changes in the terms of trade). To conduct this, we remove Mauritania and Algeria from our sample and re-run the SCM. Results are reported in Figure 3 panel A. The findings from our baseline analysis are confirmed by these robustness tests. The only difference comes from FDI where the differences between Mali and synthetic Mali become statistically significant in the last three years of our post-treatment period.

Figure 4: FDI and significance levels





b. Leave-out robustness check

A second robustness check consists of removing the countries with the highest weight in the construction of our synthetic Mali. This exercise examines whether our results are driven by a specific country. We rerun our SCM for GDP per capita, Inflation, total trade and FDI and for Mali; we remove Malawi, Burundi, Mauritania, and Bangladesh respectively. The results for Mali are shown in Figure 3 panel B in the appendix and are consistent with our earlier findings, except that GDP per capita becomes statistically insignificant while FDI becomes statistically significant.

2.7 Conclusion

This article uses the SCM to examine the effect of Mali joining the CFA zone on GDP per capita, inflation, total trade and FDI. The SCM procedure consists of comparing the trend that Mali followed after joining the CFA zone, versus its trend in the absence of treatment. Overall, we find that Mali joining the CFA zone leads to statistically significant effects on GDP per capita, inflation, and FDI. Mali experienced an increase in GDP per capita and a decrease in inflation but contrary to previous papers, we find no evidence of any effect on trade relations with France after joining the CFA zone. The SCM gives researchers the ability to directly assess the immediate economic effects from a country joining the CFA zone. These findings are especially relevant for countries that are considering joining the CFA zone or other proposed monetary unions such as the East African Community.

2.8 Appendix

TABLES

Table 2: Balancing properties:

Table 2A: Balancing properties for GDP per capita		
	Mali	**Synthetic Mali**
Industry value added	15.87098	22.22112
Trade openness	4.844904	5.332605
Inflation	0.5417	1.549011
Political regime	4	3.037
Civil war	0	0
GDP per capita (1980)	435.8286	437.492
GDP per capita (1977)	440.1837	433.7181
GDP per capita (1972)	368.9902	374.026

Table 2B: Balancing properties for inflation		
	Mali	**Synthetic Mali**
Industry value added	12.69474	14.36146
Trade openness	40.66842	36.28375
GDP per capita	415.1651	314.486
Political regime	4	4
Civil war	0	0
Inflation (1979)	11.0852	10.33433
Inflation (1975)	9.889476	11.02517
Inflation (1970)	5.788683	5.009566

Table 2C: Balancing properties for total trade		
	Mali	**Synthetic Mali**
GDP per capita	411.7612	1495.903
Industry value added	12.62204	33.9415
regime	4	3.517143
Civil war	0	0.3017857
Inflation	9.52982	9.378332
Total trade (1980)	0.347748	0.3259796
Total trade (1975)	0.360232	0.376407
Total trade (1970)	0.379408	0.3351395

Table 2D: Balancing properties for FDI		
	Mali	**Synthetic Mali**
GDP per capita	436.3355	359.7806
Industry value added	13.02318	18.51078
regime	4	3.857143
Civil war	0	0
Inflation	10.52334	12.32801
FDI (1982)	3946759	2336785
FDI (1979)	2132444	4583334
FDI (1976)	1710535	2638889

Table 3: Definition of variables

Variable name	Description	Source
Inflation	inflation rate calculation is based on CPI	WB world development indicators
Measures of political instability	proxy by civil war and political regime	Center for systemic peace
Industry value added	government expenditures on goods and services and national defense and security	WB world development indicators
GDP per capita	GDP divided by midyear population (GDP per capita in constant dollars 2010)	WB world development indicators
Foreign Direct Investment (FDI)	net inflows	United Nations Database
Trade with France	ratio of trade with France and trade with the rest of the world	MIT media lab (Observatory of Economic Complexity)

Figures:

Figure 1: the CFA zone

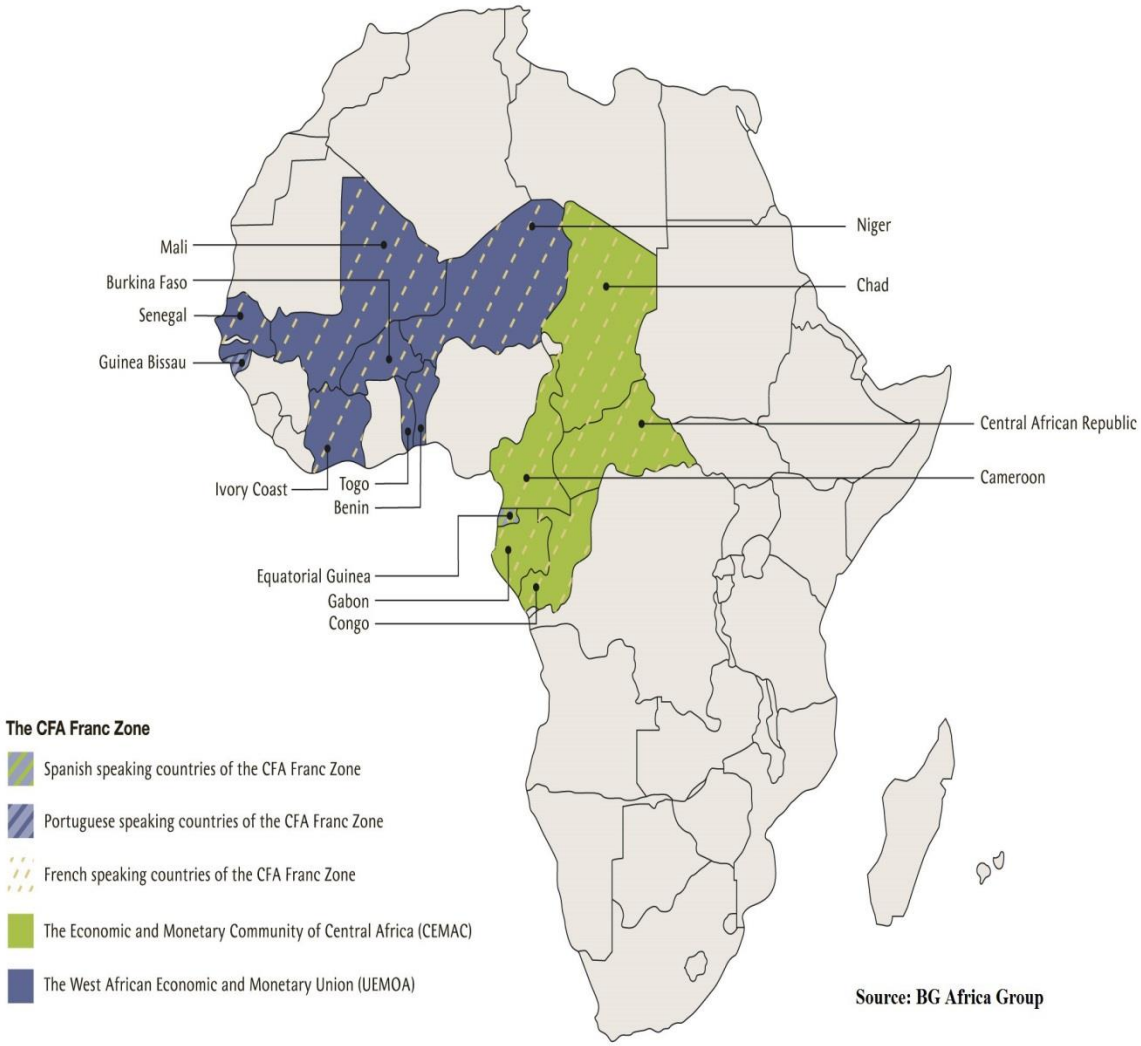
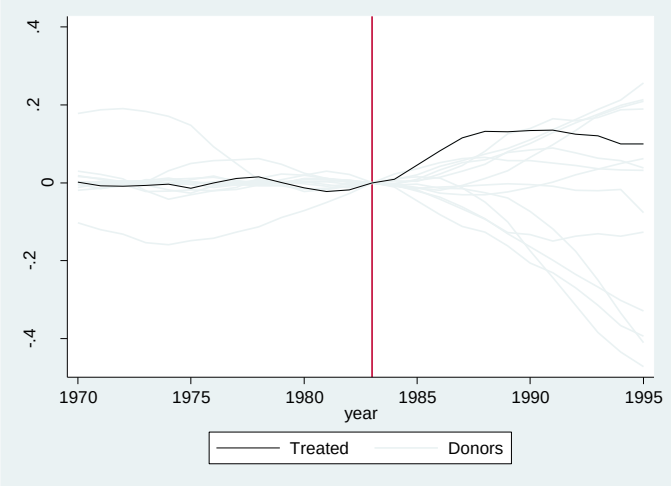
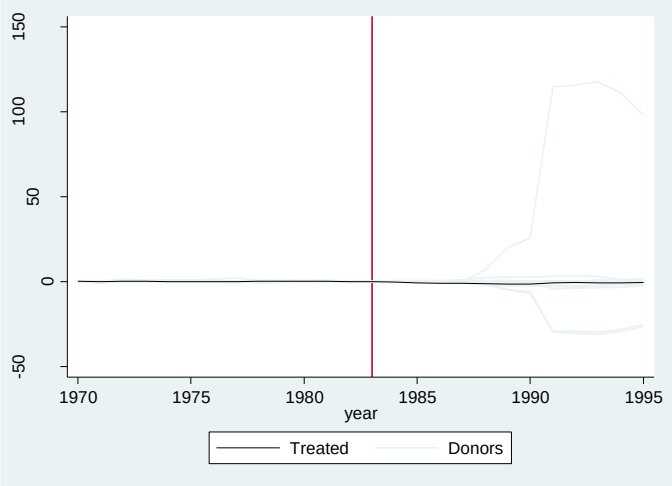


Figure 2: Placebo tests

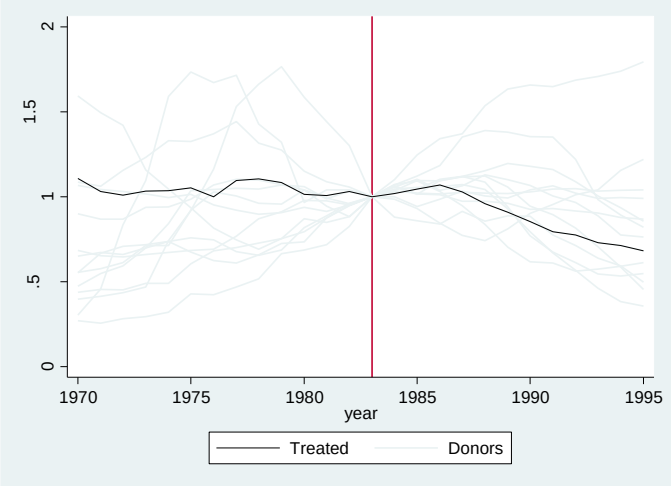
Panel A: GDP per capita



Panel B: Inflation



Panel C: Trade with France



Panel D: FDI (net inflows)

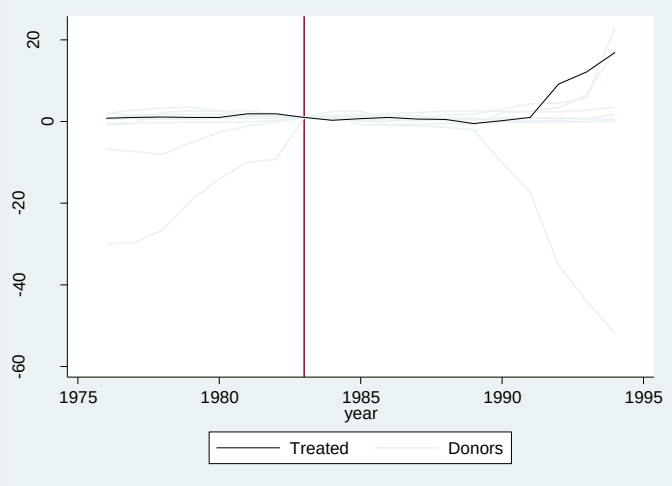
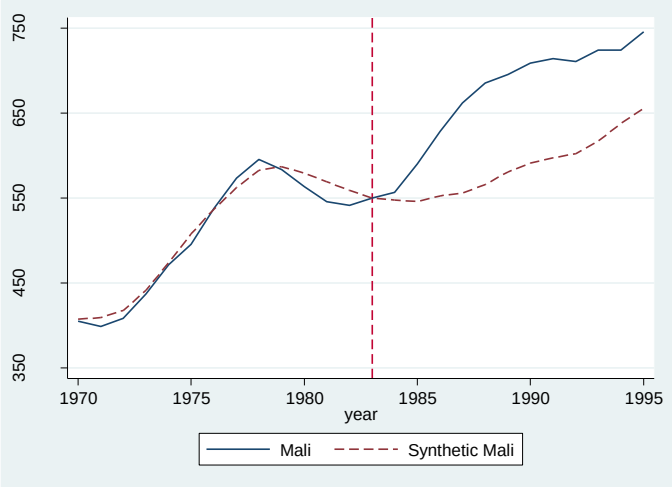
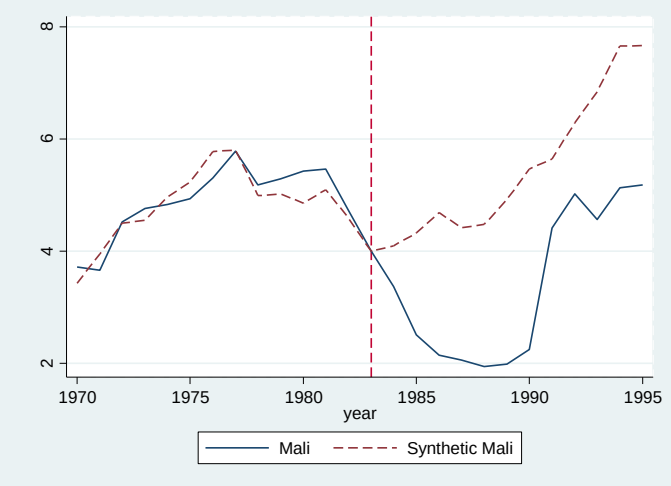
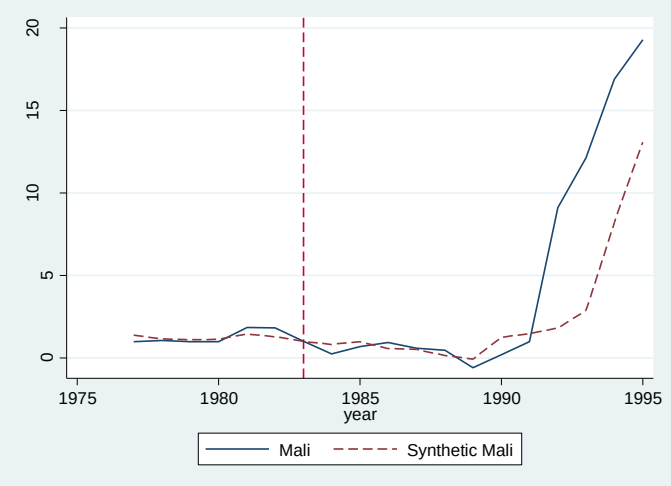


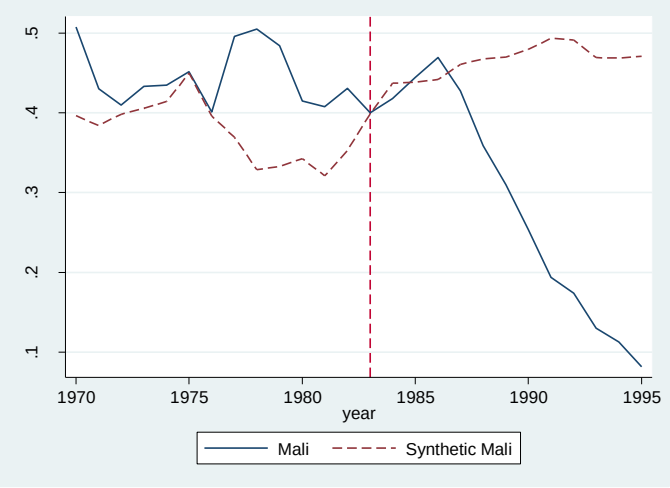
Figure 3: Robustness tests:

Panel A: removing neighboring countries

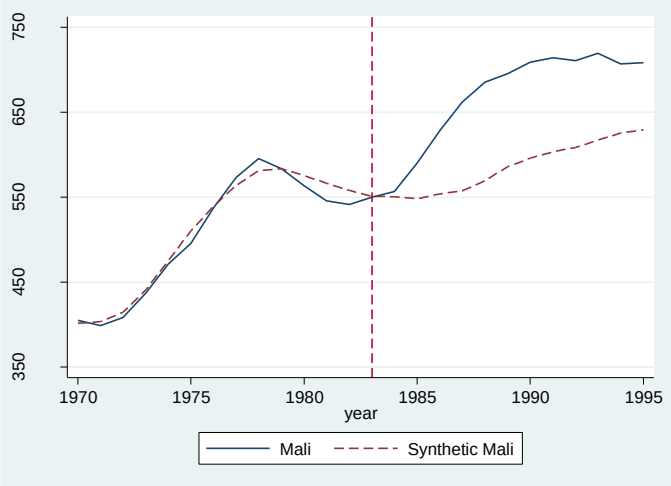


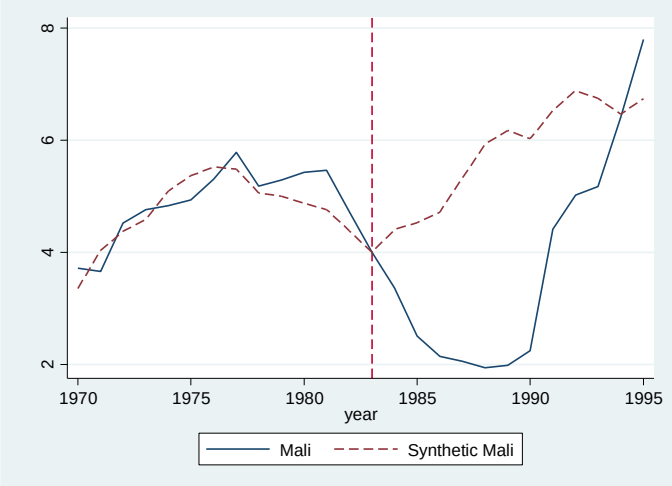


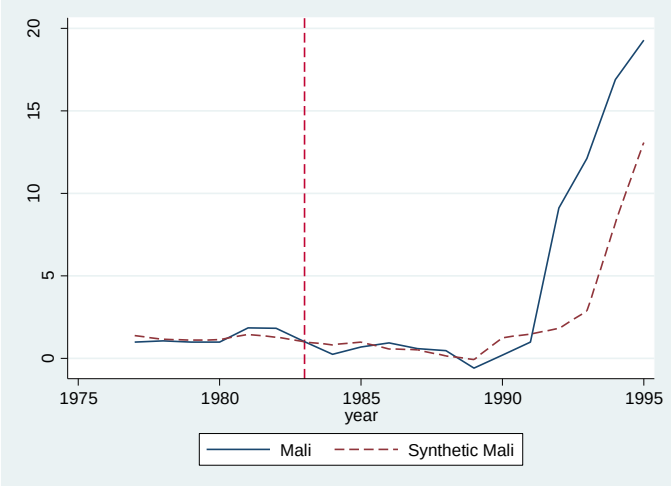


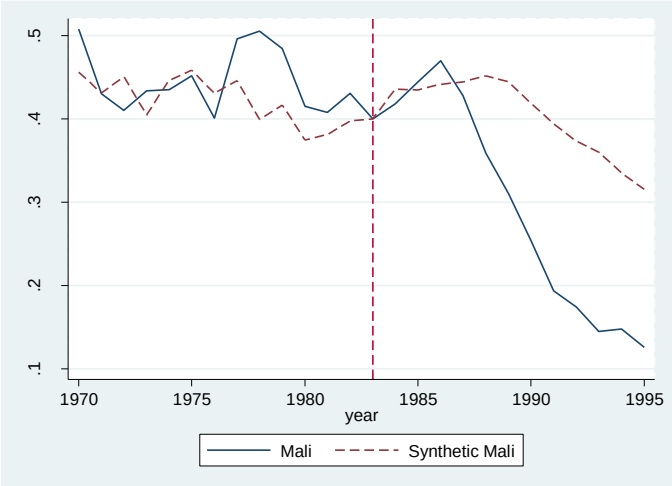


Panel B: removing countries with the highest weights









Chapter 3: Do Commodity Price Shocks Impact Central Bank Governors' Removals? Evidence from Africa

3.1 Introduction

In macroeconomics, the twin-deficit hypothesis posits that there is a strong correlation between a nation's current account deficit and its budget deficit. This economic phenomenon is more likely in African countries because they are heavily dependent on primary commodities such as crude oil or cocoa. In Africa, the ratio of primary commodities to exports has grown from 57% in 1990-1999 to 76% in 2010-2014 (Christensen, 2014).African countries with a lower degree of export diversification and a strong dependence on exports revenues; tend to run high fiscal deficits. When faced with low commodities prices, African countries have primarily financed these deficits using debt monetization. Other adverse effects of a commodity price shock can range from higher unemployment, decrease in government revenue to lower net exports.

In a climate of low commodity prices, the monetary authority's response to a current account deficit and a fiscal deficit should be centered on containing a rise in inflation and preventing an appreciation of the exchange rate. This is only possible however if the central bank is independent, that is the monetary authority is free to choose both the goals and the instruments of monetary policy. In most developing countries, specifically in Africa, the dominance of the fiscal authority can become a threat to the independence of central banks. For example, in 2014, the governor of the central bank of Nigeria was fired by the then Nigerian president when he uncovered the disappearance of billions of petrodollars from the government coffers. This scandal was exarcebated by the fact that Nigeria, the biggest producer of Brent crude petroleum in Africa, was trying to cope with the sudden decline in oil prices.

Thus, this paper aims to examine the relationship between the probability of a central bank governor's removal and commodity price shocks in an African context. To our knowledge, there is no paper in the literature on central bank independence (CBI) that has examined this particular relationship. Papers such as Dreher et al. (2010) have analyzed the determinants of central bank governor removals and have found that the probability of a central bank governor

being removed increased with political instability, the occurrence of elections or the share of legal term in office. Other papers such as Artha and De Haan (2015) find that financial crises are also an important determinant of central bank governors' removal. Using conditional fixed effects logit models that are similar to the models used in the papers aforementioned as well as Vuletin and Zhu (2011), we decompose central bank governors' removals into premature removals, i.e. removals that occur before the end of the governor's legal term in office and ally replacements, i.e. that is the central bank governor is replaced by an ally to the president. We then test the relationship between premature removals and commodity prices shocks as well as ally replacements and commodity price shocks. Our results could be summarized as follows:

- Commodity price shocks do not have a statistically significant effect on premature removals.
- Commodity price shocks lead to a statistically significant increase in the probability of an ally replacement.
- This result holds when our full-sample is divided into two: CFA[52] countries and non-CFA countries.
- Oil/mineral shocks significantly increase the likelihood of an ally replacement.

The remainder of the paper is divided into the following sections: Section 2 describes the data, section 3 explains the methodology, section 4 is the results, section 5 presents some robustness tests and section 6 concludes.

3.2 Data

Our sample period is 1980-2009. We include 23 African countries, 9 CFA countries and 14 non-CFA countries. We only include African countries whose economies have low level of export diversification[53]. The data on central bank governor changes is from various central bank websites as well as the KOF Swiss Economic Institute website. Among non-CFA countries, Mauritania experienced 14 central bank governor changes during our sample period; this is the highest number of changes. Whereas Tanzania, Uganda and Ghana had only 4 central bank

[52] CFA countries are countries that are part of the CFA zone, a monetary union with France, in which the currency is pegged to the Euro at a fixed rate.
[53] We only include countries whose exports consists of three commodities or less.

governor changes which is the lowest. Among CFA countries, CEMAC[54] countries only experience 2 central bank governor changes compared to 4 for the WAEMU[55] countries over the entire period. In our sample, a central bank governor is replaced on average every 6 years and 1 month. We classify our central bank governor changes as premature and ally according to Vuletin and Zhu (2011) and Strong (2019). Premature changes and ally changes are our dependent variables.

Sample statistics are summarized in table 1.

As mentioned above, our variable of interest is commodity price shocks[56]. Commodities include agricultural commodities such as cotton or cocoa beans and oil or minerals such as copper or gold. There are countries in our data set such as Nigeria where crude oil represents more than 70% of its exports or Burkina Faso where raw cotton represents more than 60% of its exports. The data on commodities prices is from Global Economic Monitor Commodities database (World Bank). Later on, we devise a robustness test that consists of classifying our data on commodities into two groups: agricultural and oil/minerals.

Next, we include other determinants of the probability of a central bank governor changes. As previously done in the literature, we classify them as economic determinants and political determinants[57]. As shown in Table 1, our economic control variables consists of inflation, trade openness, income per capita and measures of financial development such as liquid liabilities or private credit. To control for the effect of outliers, we transform the inflation rate as follows: $(\pi / (1+\pi)) * 100$.

Our political control variables include a democracy score, which is an eleven point scale (0-10) which is based on essential characteristics of a democracy such as the presence of institutions, the presence of constraints on the executive power or the guarantee of civil liberties. Regime score uses a (-10, 10) scale where -10 is autocratic and 10 is democracy. Coup d'état and civil war are dummy variables which takes a value of 1 if there is a civil war or coup d'état or 0 otherwise. The data is from the Polity index from the Systemic Peace website. Finally presidential elections is a dummy variable that takes a value of 1 if there is an election that year and 0 otherwise. The data is from the African Elections Database. Finally monetary policy

[54] CEMAC stands for the Central African Economic and Monetary Community.
[55] WAEMU stands for the West African Economic and Monetary Union.
[56] We simply take the natural log of commodity prices.
[57] See Appendix for complete definition of our variables.

arrangements include inflation targeting, a dummy variable that takes a value of 1 if a country in our sample has an explicit inflation target or 0, otherwise.

Table 1: Summary statistics

Variables	ALL COUNTRIES			NON-CFA COUNTRIES			CFA COUNTRIES		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Variable of interest									
Commodity price	19.30	0.15	151.69	16.31	0.15	151.69	23.96	1.14	94.95
Financial Factors									
Banking crisis	0.03	0.00	1.00	0.03	0.00	1.00	0.04	0.00	1.00
Currency crisis	0.06	0.00	1.00	0.06	0.00	1.00	0.04	0.00	1.00
Debt crisis	0.02	0.00	1.00	0.01	0.00	1.00	0.02	0.00	1.00
Economic Factors									
Inflation	13.32	-17.75	200.03	17.69	-17.64	200.03	6.54	-17.75	80.79
Trade openness	70.74	6.32	531.74	59.00	6.32	140.70	88.57	20.06	531.74
Liquid Liabilities	25.28	0.00	98.47	29.54	0.00	98.47	17.79	0.42	31.40
Private credit	15.82	0.00	82.86	17.58	0.00	82.86	12.67	0.89	41.19
Government spending	14.55	2.06	84.51	14.29	2.06	45.30	14.95	2.65	84.51
Income per capita	1777.71	202.43	20172.31	1226.90	202.43	7483.76	2618.21	289.12	20172.31
Political Factors									
Presidential Elections	0.13	0.00	1.00	0.12	0.00	1.00	0.14	0.00	1.00
Civil War	0.28	0.00	5.00	0.25	0.00	5.00	0.32	0.00	4.00
Coup d'état	0.15	0.00	1.00	0.13	0.00	1.00	0.17	0.00	1.00
Regime score	-7.21	-10.00	10.00	-5.57	-10.00	10.00	-9.75	-10.00	7.00
Democracy score	1.76	0.00	10.00	2.10	0.00	10.00	1.19	0.00	7.00
Monetary policy arrangements									
Inflation Targeting	0.01	0.00	1.00	0.02	0.00	1.00	0.00	0.00	0.00
Other Factors									
Time spent in office	4.72	0.00	16.00	3.35	0.00	15.00	6.86	6.00	10.00
Nature of central bank changes									
ally changes	0.04	0.00	1.00	0.05	0.00	1.00	0.03	0.00	1.00
premature changes	0.06	0.00	1.00	0.10	0.00	1.00	0.01	0.00	1.00
Number of countries		23			14			9	

3.3 Methodology

We estimate the effect of commodity price shocks on the probability of a central bank governor replacement, where we define a replacement in two folds: 1) premature replacement that is a central bank governor is removed before the end of its term and 2) ally replacement that is a central bank governor's replacement is an ally to the president that is nominating him. An ally has the following characteristics: 1. He or she occupies a high-ranking position (pertaining to the economy) in the executive branch such as minister of finance or minister of trade; 2. He or she occupies a high-ranking position in the political party in power. He or she shares tribal affiliation with the nominating president.

Our dependent variable is governor changes that equal one if at least one change occurs or 0 otherwise; this change is then classified as ally or premature[58]. Thus, we use the following conditional fixed effects logit model:

$$changes_{it} = \beta_0 + \beta_1 shocks_{it-1} + \beta_2 time\text{-}elapsed_{it-1} + \beta_3 X_{it-1} + \gamma_i + \mu_{it}$$

where *changes* are central bank governor changes; *shocks* are commodity price shocks; *time-elapsed* is the number of years the central bank governor has already spent in office (Dreher *et al*., 2010, Klomp and De Haan, 2010 and De Haan and Artha, 2015). X_i is a vector of economic financial and political control variables; γ_i is each country's fixed effect and μ_{it} is an i.i.d error term. Our model is estimated with clustered standard errors and control variables are lagged to avoid any possible endogeneity issues.

Our financial variables include banking crisis, currency crisis and debt crisis. De Haan and Artha (2015) found that financial crises increase the probability of a central bank governor change; specifically banking and debt crises.

Next, our economic control variables include the following: inflation, if a country suffers a period of high inflation; the central banker is often held responsible, which then will increase the probability of a central bank governor change. Trade openness, which is expected to lower the probability of a central governor since more open economies on average have a lower inflationary bias (Romer, 1993). Measures of financial development such as liquid liabilities,

[58] In our data set, a change is either premature or non-premature such that total number of changes= PREMATURE+NON-PREMATURE. We repeat the same process for all changes, i.e. total number of changes= ALLY + NON-ALLY.

private credit and income per capita are expected to lower the probability of central bank governor exchange. The fiscal authority in countries with a high level of financial sector is less likely to rely on unanticipated monetary expansion in case of a deficit. (Sargent and Wallace, 1981).

Our political factors include presidential elections, which is likely to be positively related to a central bank governor change (De Haan and Artha, 2015). Similarly, measures of political instability such as coup d'état or civil war are expected to increase the probability of central bank governor change (Dreher et al., 2010). Finally, Political regimes, particularly democratic ones are likely to decrease the probability of a central bank governor change (Farvaque, 2002). Finally, monetary arrangements such as an explicit inflation target are a signal of a higher level of central bank independence; thus should be negatively related to the probability of a central bank governor change.

3.4 Results

We divide this section into two sections. The first section consists of looking at the effect of our variable of interest on the probability that a central bank governor gets removed prematurely. The second part looks at the effect of commodity shocks on the probability that a central bank governor gets replaced by an ally.

a. <u>Premature changes:</u>

We start by running a conditional fixed effects logit model where we include commodity price shocks as well as all of our other determinants of a central bank governor change[59]. Then, we rerun a model that includes only statistically significant variables that we add one by one to the model as shown in Table 2.

Our variable of interest, commodity price shock, is statistically insignificant but becomes statistically significant when we include all the other determinants. As expected, there is a positive relationship between commodity price shock and premature removals. Other statistically significant variables include time in office, trade openness, civil war and democracy. Trade openness and democracy have the expected sign as shown in the previous papers aforementioned. But our results show that the probability of a premature removal decreases when

[59] The results of this model are available upon request.

Table 2: Effect of commodity price shocks on premature removals of central bank governors (full sample).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Commodity price shock	0.331	0.474	0.310	0.373	0.488	0.271	0.380	0.338	1.393**
	(0.564)	(0.568)	(0.569)	(0.566)	(0.549)	(0.591)	(0.573)	(0.569)	(0.670)
Time in office		-0.179***							-0.138**
		(0.066)							(0.068)
Debt			1.251						2.028
			(1.141)						(1.414)
Inflation				0.007					0.003
				(0.007)					(0.009)
Trade openness					-0.021*				-0.034**
					(0.012)				(0.015)
Government spending						0.020			0.042
						(0.035)			(0.043)
Civil war							-0.352		-0.646**
							(0.225)		(0.322)
Coup d'état								-0.037	0.204
								(0.482)	(0.544)
Banking crisis									-0.461
									(1.313)
Currency crisis									-0.784
									(0.964)
Democracy									0.465*
									(0.261)
Number of observations	449	449	449	449	449	433	449	449	396
Prob. > Chi2	0.563	0.087	0.529	0.581	0.155	0.715	0.182	0.843	0.005

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor premature removal occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the full sample (CFA and non-CFA countries). Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table 3: The effect of commodity price shocks on premature removals of central bank governors (non-CFA countries).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Commodity price shock	0.344	0.475	0.310	0.397	0.531	0.268	0.405	0.309	0.570
	(0.599)	(0.615)	(0.606)	(0.601)	(0.580)	(0.630)	(0.611)	(0.612)	(0.639)
Time in office		-0.108							-0.095
		(0.067)							(0.071)
Debt			1.554						1.735
			(1.191)						(1.308)
Inflation				0.008					0.004
				(0.008)					(0.009)
Trade openness					-0.025**				-0.026*
					(0.012)				(0.014)
Government spending						0.019			0.022
						(0.036)			(0.043)
Civil war							-0.342		-0.439
							(0.224)		(0.268)
Coup d'état								0.211	0.287
								(0.508)	(0.573)
Banking crisis									-0.933
									(1.269)
Currency crisis									-0.129
									(0.863)
Number of observations	329	329	329	329	329	318	329	329	318
Prob. > Chi2	0.570	0.193	0.443	0.467	0.089	0.753	0.202	0.782	0.178

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor premature removal occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the non-CFA countries. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

there is a civil war and the longer a central bank governor stays in office. This is contrary to the findings in the literature. One possible reason is that in African countries, where the degree of central bank independence is lower than in developed countries, fiscal authorities prefer to keep central bankers that have shown a certain degree of cooperation.

Next, we check for the heterogeneity in our data, by dividing our full sample into two regions: CFA countries and non-CFA countries; then, we rerun our analysis, but only for non-CFA countries. Results are shown in Table 3. None of the coefficients on commodity shocks are statistically significant. The only variable that is statistically significant is trade openness and as expected, the sign is negative.

b. Ally changes:

In this section, the dependent variable is now the probability that a central bank governor change is an ally change. We start first with an analysis of the full sample and our results are shown in Table 4 below. Our results reveal that commodity price shocks lead to a statistically significant increase of the probability of an ally replacement by 161.4 percentage points when our variable of interest is included by itself. When we include all other explanatory variables, this probability increases by 203.3 percentage points. Other statistically significant variables include time in office, which increases the probability of an ally change occurring by 8.6 percentage points or civil war which leads to a statistically significant decrease in the probability of a central bank governor ally change. These results are consistent with our findings above.

Next, to control for heterogeneity, we split our full sample into two: non-CFA countries and CFA countries. In this section, we are able to include the latter group because our data on ally changes has enough variation. Results are shown in Table 5 below. A commodity price shock leads to a statistically significant increase of the probability of a central bank governor ally replacement. Civil war and political regime have a statistically significant effect on the probability of an ally replacement.

Table 4: The effect of commodity price shocks on central bank governors' ally replacement (full sample).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Commodity price shock	1.614**	1.619**	1.699***	1.721***	1.647**	1.631**	2.033***
	(0.641)	(0.659)	(0.657)	(0.658)	(0.667)	(0.657)	(0.748)
Time in office		0.046					0.086*
		(0.047)					(0.050)
Inflation			0.007				0.011
			(0.011)				(0.011)
Trade openness				-0.006			-0.005
				(0.009)			(0.009)
Civil war					-0.638*		-0.731**
					(0.354)		(0.348)
Regime						-0.001	-0.009
						(0.010)	(0.011)
Number of observations	480	480	480	480	480	480	480
Prob. > Chi2	0.014	0.032	0.041	0.038	0.003	0.050	0.013

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the full sample. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table 5: The effect of commodity price shocks on central bank governors' ally replacement (non-CFA countries).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Commodity price shock	1.419***	1.419***	1.462***	1.512***	1.494***	1.423***	1.590***
	(0.511)	(0.507)	(0.552)	(0.531)	(0.513)	(0.491)	(0.575)
Time in office		-0.010					0.040
		(0.119)					(0.099)
Inflation			0.004				0.005
			(0.007)				(0.008)
Trade openness				-0.009			-0.006
				(0.011)			(0.013)
Civil war					-0.573***		-0.634***
					(0.100)		(0.126)
Regime						-0.010*	-0.014**
						(0.006)	(0.006)
Number of observations	210	210	210	210	210	210	210
Prob. > Chi2	0.006	0.014	0.027	0.014	0.000	0.014	0.000

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the non-CFA countries. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Next, we look at the effect of commodity price shocks in the CFA zone; results are shown below in Table 6. Commodity price shocks lead to a statistically significant increase in the probability of a central bank governor ally replacement in CFA countries. When this variable is included by itself, this probability increases by 196.5 percentage points and 237.8 percentage points when all other explanatory variables. None of the other determinants of our dependent variable are statistically significant.

Table 6: The effect of commodity price shocks on central bank governors' ally replacement (CFA countries)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Commodity price shock	1.956**	2.213***	1.878**	1.980**	1.885**	2.128**	2.378**
	(0.776)	(0.854)	(0.769)	(0.776)	(0.803)	(0.830)	(0.954)
Time in office		0.096					0.099
		(0.067)					(0.068)
Inflation			-0.036				-0.023
			(0.046)				(0.050)
Trade openness				-0.004			-0.005
				(0.010)			(0.011)
Civil war					-0.315		-0.495
					(0.914)		(0.985)
Regime						-0.011	-0.018
						(0.016)	(0.017)
Number of observations	270	270	270	270	270	270	270
Prob. > Chi2	0.016	0.019	0.039	0.051	0.052	0.045	0.049

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the CFA countries. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

3.5 Robustness Test

We have been analyzing the effect of commodity price shocks on the probability that a central bank governor is removed prematurely or that the central bank governor is replaced by an ally. As a robustness test, we divide our group of commodities into two: agricultural commodities and oil/mineral commodities and re-run our analysis. For agricultural commodities, our data set now consists of 12 countries: 8 non-CFA countries and 4 CFA countries and the main agricultural commodities are cocoa beans, coffee and cotton. For oil/mineral commodities, our data consists of 6 non-CFA countries and 5 CFA countries. Most countries' primary exports

are crude petroleum (oil), except for the Democratic Republic of Congo which exports copper and Mauritania which exports iron ore.

a. Premature removals:

In Table A1 and A2, shown in the appendix, we examine the effect of agricultural commodities shocks to the probability of a premature removal. In the full sample, the coefficients on our dependent variable are all statistically insignificant. Also, time in office and democracy both remain statistically significant and the coefficients have the same sign. Next, we split the full sample into non-CFA and CFA countries, but as before we have no variation in the data for CFA countries, so we only perform an analysis for non-CFA countries. The coefficients on shocks remain statistically insignificant. Trade openness now becomes statistically insignificant whereas Time in office and debt are now statistically significant. The level of a country's debt leads to an increase in the probability of a premature removal by 240 percentage points.

Next, we look at the effects of oil/mineral commodities shocks on premature removals. The results are shown in Tables A3 and A4. In the full sample, the coefficient on shock is positive and statistically significant. An oil/mineral shock leads to an increase of 320 percentage points in the probability of a central bank governor being prematurely removed. For non-CFA countries, the coefficient on shocks is only significant when trade openness, the only statistically significant explanatory variable, is included.

b. Ally replacements:

Tables A5, A6 and A7 present the results for agricultural commodities. For the full sample, the coefficients on shocks are now statistically insignificant. But, for non-CFA countries and CFA countries, the relationship between shocks and the probability of an ally replacement remain positive and statistically significant. Finally, for oil/mineral commodities, that relationship is positive and statistically significant for the full sample and CFA countries only. For non-CFA countries, the coefficients on shocks are statistically insignificant.

3.6 Conclusion

This paper analyzes the effect of commodity price shocks on the probability of a central bank governor's removal. Using a conditional fixed effects logit model with robust standard errors model similar to Dreher et al. (2010) or Artha and De Haan (2015), we examine the effect of these shocks on premature removals and ally replacements. Our results show that commodity price shocks lead to a substantial statistically significant increase of the probability of an ally replacement both in non-CFA countries as well as CFA countries. When commodity price shocks are decomposed into agricultural commodities shocks and oil/mineral shocks show that agricultural commodities shock do not have an effect both on premature removals and ally replacements. Whereas, oil/mineral shocks significantly increase the likelihood that a central banker is prematurely removed or gets replaced by an ally. Our analysis shows that African countries with a high degree of export concentration and oil/minerals as their primary commodities have a higher likelihood of central bank governor premature removals as well as a higher likelihood of ally replacements. This is true for African countries with national central banks and their own currencies as well as countries that are part of a monetary union. This is especially relevant for CFA countries, because of the de facto nomination process of a central banker, which essentially is in the hands of one country that is the country whose economy is the most important.

3.7 Appendix

A. Premature removals of central bank governors

Table A1: The effect of agricultural commodity price shocks on premature removals of central bank governors (full sample).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Agricultural price shocks	-0.682	-0.242	-0.964	-1.024	-0.494	-0.479	-1.468	-0.427	-3.284
	(1.771)	(1.972)	(1.798)	(1.838)	(1.837)	(1.804)	(1.929)	(1.798)	(3.630)
Time in office		-0.965***							-0.970**
		(0.331)							(0.377)
Debt			1.851						6.940
			(1.215)						(9.503)
Inflation				0.011					-0.048
				(0.011)					(0.053)
Trade openness					0.032				0.044
					(0.026)				(0.032)
Government spending						-0.046			-0.058
						(0.089)			(0.138)
Civil war							0.740		4.582
							(0.509)		(2.883)
Coup d'état								-15.572	-13.702
								(2.117)	(2.870)
Banking crisis									-15.154
									(2.740)
Currency crisis									1.977
									(1.910)
Regime									-0.921**
									(0.419)
Democracy									2.000**
									(0.910)
Number of observations	270	270	270	270	270	265	270	270	232
Prob. > chi	0.698	0.000	0.391	0.625	0.450	0.825	0.294	0.285	0.000

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor premature removal occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the non-CFA countries. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table A2: The effect of agricultural commodity price shocks on premature removals of central bank governors (non-CFA countries).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Agricultural price shocks	-0.466	-0.322	-0.958	-0.759	-0.307	-0.256	-2.111	-0.215	-2.589
	(1.897)	(2.074)	(2.011)	(1.967)	(1.944)	(1.961)	(2.302)	(1.911)	(3.045)
Time in office		-1.241***							-1.261***
		(0.462)							(0.459)
Debt			2.401*						9.891
			(1.340)						(8.594)
Inflation				0.009					-0.092
				(0.012)					(0.059)
Trade openness					0.017				0.018
					(0.029)				(0.028)
Government spending						-0.060			-0.033
						(0.105)			(0.130)
Civil war							4.204		5.096
							(1.521)		(1.295)
Coup d'état								-14.760	-14.591
								(1.902)	(3.318)
Banking crisis									-14.540
									(5.345)
Currency crisis									2.304
									(1.782)
Number of observations	180	180	180	180	180	180	180	180	180
Prob. > chi	0.805	0.000	0.286	0.773	0.811	0.815	0.126	0.504	0.011

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the full sample. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table A3: Effect of oil/mineral commodity price shocks on premature removals of central bank governors (full sample).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Oil/Mineral price shocks	0.905	1.198	0.806	1.212	2.470**	0.773	1.003	0.921	3.209**
	(0.892)	(0.983)	(0.892)	(0.988)	(1.229)	(0.923)	(0.940)	(0.907)	(1.507)
Time in office		-0.122							-0.066
		(0.081)							(0.087)
Debt			17.825						16.348
			(2.306)						(1.081)
Inflation				0.012					0.011
				(0.010)					(0.013)
Trade openness					-0.044***				-0.050**
					(0.017)				(0.020)
Government spending						0.017			0.041
						(0.039)			(0.050)
Civil war							-0.333		-0.547
							(0.227)		(0.344)
Coup d'état								-0.056	0.024
								(0.552)	(0.671)
Banking crisis									0.400
									(1.368)
Currency crisis									-1.659
									(1.367)
Regime									-0.065
									(0.055)
Democracy									0.277
									(0.180)
Number of observations	180	180	180	180	180	169	180	180	166
Prob. > chi	0.278	0.155	0.063	0.277	0.008	0.522	0.153	0.552	0.014

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor premature removal occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the full sample. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table A4: Effect of oil/mineral commodity price shocks on premature removals of central bank governors (non-CFA countries).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Oil/Mineral price shocks	0.643	0.817	0.540	0.948	2.127*	0.491	0.717	0.613	2.231
	(0.869)	(0.948)	(0.864)	(0.972)	(1.257)	(0.899)	(0.915)	(0.881)	(1.474)
Time in office		-0.085							-0.038
		(0.082)							(0.090)
Debt			15.565						15.193
			(8.370)						(6.794)
Inflation				0.014					0.012
				(0.010)					(0.012)
Trade openness					-0.042**				-0.044**
					(0.017)				(0.019)
Government spending						0.021			0.038
						(0.040)			(0.051)
Civil war							-0.329		-0.366
							(0.227)		(0.292)
Coup d'état								0.109	0.039
								(0.564)	(0.683)
Banking crisis									-0.207
									(1.349)
Currency crisis									-0.895
									(1.204)
Number of observations	150	150	150	150	150	139	150	150	139
Prob. > chi	0.436	0.416	0.081	0.309	0.014	0.602	0.210	0.725	0.058

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor premature removal occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the non-CFA countries. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

B. Ally replacements of central bank governors:

Table A5: The effect of agricultural commodity price shocks on central bank governors' ally replacement (full sample).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Agricultural price shocks	2.078	1.821	2.071	1.665	1.863	2.422	-1.540
	(1.686)	(2.340)	(1.685)	(1.827)	(1.705)	(1.755)	(3.292)
Time in office		-0.906*					-0.940*
		(0.496)					(0.508)
Inflation			-0.019				-0.039
			(0.050)				(0.051)
Trade openness				0.031			0.070
				(0.040)			(0.053)
Civil war					-0.454		-1.310
					(1.118)		(2.872)
Regime						-0.017	-0.003
						(0.019)	(0.026)
Number of observations	150	150	150	150	150	150	150
Prob. > chi	0.131	0.001	0.295	0.243	0.288	0.217	0.008

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the full sample. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table A6: The effect of agricultural commodity price shocks on central bank governors' ally replacement (non-CFA countries).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Agricultural price shock	3.246***	3.987***	3.399***	4.479***	3.498***	3.645***	3.229***
	(0.734)	(0.800)	(0.873)	(1.472)	(0.714)	(0.797)	(1.214)
Inflation			-0.035***				-0.060***
			(0.012)				(0.022)
Trade openness				0.015			-0.003
				(0.020)			(0.018)
Regime						0.025**	0.017
						(0.013)	(0.011)
Number of observations	240	43	240	230	234	240	40
Prob. > chi	0.000	0.000	0.000	0.000	0.002	0.000	0.000

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the non-CFA countries. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table A7: The effect of agricultural commodity price shocks on central bank governors' ally replacement (CFA countries)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Agricultural price shock	1.228***	0.954***	1.225***	0.809*	1.468***	1.324***	0.287
	(0.320)	(0.199)	(0.356)	(0.441)	(0.256)	(0.468)	(1.611)
Time in office		-0.773***					-1.078***
		(0.259)					(0.350)
Inflation			0.006				0.095
			(0.086)				(0.161)
Trade openness				0.022			0.066
				(0.014)			(0.081)
Civil war					-0.647***		-0.817**
					(0.188)		(0.346)
Regime						-0.011	0.014
						(0.016)	(0.033)
Number of observations	120	120	120	120	120	120	120
Prob. > chi	0.000	0.000	0.000	0.002	0.000	0.093	0.000

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the CFA countries. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table A8: Effect of oil/mineral commodity price shocks on ally replacements of central bank governors (full sample).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Oil/Mineral price shocks	2.311**	2.022**	2.666**	2.622**	2.665**	2.255**	3.217***
	(0.998)	(1.028)	(1.061)	(1.064)	(1.070)	(1.014)	(1.238)
Time in office		0.093					0.153**
		(0.057)					(0.064)
Inflation			0.013				0.020*
			(0.011)				(0.012)
Trade openness				-0.011			-0.008
				(0.011)			(0.011)
Civil war					-0.717*		-0.854**
					(0.401)		(0.383)
Regime						0.003	-0.005
						(0.012)	(0.014)
Number of observations	330	330	330	330	330	330	330
Prob. > chi	0.017	0.015	0.031	0.030	0.002	0.055	0.002

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the full sample. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table A9: Effect of oil/mineral commodity price shocks on ally replacements of central bank governors (non-CFA countries).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Oil/Mineral price shocks	0.887	0.843	1.233	1.081	1.130	0.836	1.512
	(1.083)	(1.101)	(1.182)	(1.256)	(1.178)	(1.081)	(1.427)
Time in office		0.015					0.098
		(0.079)					(0.088)
Inflation			0.011				0.015
			(0.011)				(0.012)
Trade openness				-0.005			-0.000
				(0.016)			(0.018)
Civil war					-0.672*		-0.753*
					(0.402)		(0.387)
Regime						0.004	-0.005
						(0.012)	(0.014)
Number of observations	180	180	180	180	180	180	180
Prob. > chi	0.392	0.682	0.423	0.654	0.042	0.661	0.184

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the non-CFA countries. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero.

Table A10: Effect of oil/mineral commodity price shocks on ally replacements of central bank governors (CFA countries).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Oil/Mineral price shocks	10.030***	18.685**	11.879**	9.867***	9.959***	8.789***	18.241*
	(3.705)	(9.178)	(4.748)	(3.789)	(3.676)	(3.392)	(10.577)
Time in office		0.237**					0.222**
		(0.096)					(0.108)
Inflation			-0.214				-0.038
			(0.160)				(0.260)
Trade openness				-0.002			0.009
				(0.013)			(0.021)
Civil war					-13.905		-12.344
					(4.498)		(8.236)
Regime						0.302	0.644
						(0.292)	(1.604)
Number of observations	150	150	150	150	150	150	150
Prob. > chi	0.000	0.000	0.000	0.001	0.001	0.001	0.009

Notes: Dependent variable is a binary variable that takes the value of 1 if at least one central bank governor ally replacement occurs and 0, otherwise; .01 - ***; .05 - **; .1 - *; the number in parentheses are standard errors. Results are for the CFA countries. Prob. > chi2 represents the null hypothesis of all coefficients are equal to zero

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