The Political Economy of African Currency Unions: Evidence from a Time-Inconsistent Model*

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February 2, 2023

Abstract

This paper develops a model to assess the benefits and costs of a currency union between the monetary autonomous countries of the West African Monetary Zone (WAMZ) and the monetary union countries of either the West African Economic and Monetary Union (WAEMU) or the Central African Economic and Monetary Community (CAEMC). We utilize a tractable model with three key features to account for the existence of fiscal dominance and political business cycles that are common in Africa but are not emphasized in the currency union literature. One, our model allows central banks to set their own inflation rate target with the idea that, in Africa, a currency union's inflation rate target is usually lower than an individual country's desired target. Two, this paper assumes each African government/central bank maximizes its own utility rather than the households' utility. Three, our model captures the lack of monetary policy credibility when policymakers pursue time-inconsistent policies. Specifically, we show that an African country without monetary policy credibility benefits from joining a monetary union when the country has similar supply shocks to the other currency union countries, but it suffers when the country must accept the currency union's lower inflation rate target.

Keywords: Monetary union; Africa; Inflation rate target; Supply shocks.

JEL Classifications: E52, E58, E61, 055.

*We would like to thank Atsuyoshi Morozumi for helpful discussions and comments.

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1 Introduction

In 1945, the West African CFA franc and the Central African CFA franc were introduced as the official currencies of French colonial West Africa and French colonial Equatorial Africa, respectively.[1] When the French colonial areas of Sub-Saharan Africa gained their independence in the early 1960s, most of those newly independent countries maintained their existing currency unions with other former French colonies.[2] The resulting currency unions are now known as the West African Economic and Monetary Union (WAEMU) and the Central African Economic and Monetary Community (CAEMC). In 2000, five non-CFA countries formed the West African Monetary Zone (WAMZ) with the intention of creating their own currency union and then establishing a larger currency union with the WAEMU countries.[3] The attempts to establish a currency union among just the WAMZ countries or a larger union between the WAEMU and WAMZ countries have been unsuccessful to date. In the Great Lakes region of East Africa, seven countries belong to the East African Community (EAC). Those countries plan to form a currency union but have not reached an agreement on the specific details to implement the union. The Common Monetary Area (CMA) is a four-country monetary arrangement in which the dominant country South Africa maintains fixed exchange rates with three of its smaller neighboring countries. In that system, the South African rand is the area's de facto common currency, but the smaller countries still maintain their own currencies.[4] The existence of five different zones with varying degrees of monetary unification suggests that the topic of currency unions needs to be analyzed from an African perspective. This paper focuses on assessing the economic benefits and costs of forming a currency union between the WAMZ countries and either the WAEMU or CAEMC monetary unions, but our results extend to any potential currency union in Africa. Table 1 lists the member countries in the WAEMU, CAEMC, and WAMZ zones.

Any analysis of currency unions in Africa must account for two socioeconomic and political characteristics unique to the continent. One, many African governments depend on seigniorage as a nontrivial source of revenue. Cukierman, Edwards, and Tabellini (1992) assert that tax collection is more inefficient in countries that are not technologically sophisticated.[5] They also argue that countries where agriculture is a sizable portion of GDP have less efficient tax systems due to the difficulties in taxing that sector.[6] Furthermore, Click (1998) finds that governments with low credit worthiness rely more on seigniorage because they cannot easily borrow funds in capital markets. The lack of technological sophistication, the sizeable fraction of GDP attributed to agriculture, and low government credit ratings in much of Africa forces most of the continent's countries to exploit seigniorage to help fund

[1] CFA denotes Coopération financière en Afrique centrale in French, which means Financial Cooperation in Central Africa in English.

[2] Mali left the West CFA franc zone in 1961, but it rejoined that currency union in 1984. Guinea and Mauritania permanently separated from the West CFA franc zone in 1960 and 1973, respectively.

[3] Liberia joined WAMZ in 2010.

[4] The CMA lacks a shared central bank and a communal set of reserves, so it is not considered a full monetary union.

[5] Cukierman, Edwards, and Tabellini (1992) use GAP per capita as their measure of technological sophistication.

[6] Agriculture comprises about 6 to 7% of world GDP, but that percentage is much higher in all our sample of African countries aside from Equatorial Guinea and Gabon.

government operations. As a result, many African economies exhibit the characteristics of fiscal dominance, where the central bank is compelled to support the country's fiscal authorities. A fiscally-dominant country that is not part of a currency union has an incentive to run a higher inflation rate than the inflation rate a currency union would target.[7] Two, Block, Ferree, and Singh (2003) and Iddrisu and Bokpin (2018) find that political business cycles exist in Africa, particularly in multiparty, politically-competitive democracies. The concept of a "political business cycle" was introduced by Nordhaus (1975) and Tufte (1980), which found that politicians in some countries manipulate monetary or fiscal policy to improve the probability of being reelected. Many governments in Africa try to form an alliance with their central banks, so the monetary authority will pursue an expansionary policy prior to national elections. In fact, one drawback to African governments joining a currency union is that the union's central bank will be unlikely to use its policy tools to influence election outcomes in the member countries. Our model accounts for fiscal dominance and political business cycles in Africa by assuming: 1) Each central bank sets its own inflation rate target, but the inflation target set by a monetary union is usually lower than the inflation target set by an individual country; 2) Policymakers pursue time-inconsistent policies; and 3) Each government maximizes its own utility rather than the households' utility.

The literature on currency unions is extensive, but studies focusing specifically on African currency unions are much more limited. Mundell (1961) argues in his theory of optimum currency areas (OCA) that countries should form a currency union when faced with similar economic shocks and business cycles. Mundell's OCA theory implicitly assumes that a country's central bank has credibility to commit to monetary policy. We do not believe, however, that such a criterion holds in an African context. Using a New Keynesian model, Chari, Dovis, and Kehoe (2020) revisits Mundell's OCA theory and concludes that countries unable to commit to monetary policy should form a currency union with other countries that have similar demand or productivity shocks and dissimilar markup or supply shocks. Chari et al. reaches those conclusions using a model where governments maximize the households' utility, which runs contrary to our assertion that most African governments maximize their own utility.

In terms of studies focused on Africa, Debrun, Masson, and Pattillo (2005) examines the impact of government spending's share of output on the benefits and costs of joining a currency union in West Sub-Saharan Africa. The model, however, fails to account for the utility costs an African country would incur by adopting the currency union's lower inflation target rather than its preferred higher inflation target under monetary independence. Debrun et al. also does not explain how Mundell's OCA theory differs from their conclusion that African countries lacking a commitment to monetary policy should form a currency union with countries with similar markup or aggregate supply shocks.

This paper analyzes the benefits received and costs incurred by African countries when they join a currency union with neighboring countries. Expanding on the work of Debrun et al. (2005), we build a tractable time-inconsistent model of African government preferences, where central banks for individual countries and currency unions set their own inflation rate

[7] Strong (2021) finds that African countries are 2.4 times more likely to remove their central bank governor if they are not in a currency union compared to if they are in a currency union. The paper shows the inflation rate is higher in African countries in which the central bank governor is replaced with more regularity.

targets. Our results show African countries that cannot commit to monetary policy gain utility by joining a currency union with other countries that have had similar supply shocks, but lose utility if the monetary union has a lower inflation rate target. That finding reveals a new criterion for joining a currency union in which a country's decision depends, in part, on the difference between the inflation rate targets set by the country's independent central bank and the currency union's central bank. If the inflation rate target differential is zero, our results indicate Mundell's (1961) OCA theory holds in an African context. This paper differs from most other research on currency unions because it introduces an additional factor to consider, along with Mundell's OCA theory, to determine whether a country should join a currency union.[8]

The paper is organized as follows. Section 2 describes the theoretical model and generates our theoretical results. Section 3 calibrates the parameters of the model to African data. Section 4 calculates the utility gains or losses that WAEMU, CAEMC, and WAMZ countries experience from joining a current or proposed monetary union. Section 5 concludes.

2 African Countries Prefer a Higher Inflation Rate

Inflation tends to be much higher in many African countries than is considered socially optimal in most developed economies. We contend that African governments willingly accept a higher inflation rate because many of those governments prefer to allocate resources to political business cycles and ethnic favoritism and choose to partially finance that spending with seigniorage revenue.

2.1 Political Business Cycles

Nordhaus (1975) first introduced the concept of the political business cycle where incumbent politicians manipulate fiscal or monetary policy during an election year to increase their chances of being reelected. Since politicians want to remain in office, they seek to stimulate the economy by exploiting the short-run tradeoff between lower unemployment and higher inflation. Specifically, these elected officials push expansionary fiscal and monetary policies prior to elections to raise employment and income, which increases government popularity, and thus, improves their likelihood of being reelected (Schuknecht, 1996). The Nordhaus model assumes voters rate incumbent politicians based on the recent performance of the economy, and this concept is known as opportunistic cycles.

The empirical literature reveals many African politicians are opportunistic and rely on the political business cycle to improve their chances of reelection. For example, Block (2002) examines economic data for 44 African countries from 1980-1995 and finds the real money supply and public expenditures rise in an election year by 4.5 and 2 percentage points, respectively, while inflation increases between 6 to 8 percentage points in the post-election year. Mosley and Chiripanhura (2016) shows African countries that have competitive federal elections have a greater likelihood of experiencing political business cycles. That is, they find that African countries with a multi-party political system exhibit statistically significant

[8] *See* Devarajan and de Melo (1990), Bayoumi and Ostry (1997), and Ogunkola (2005).

increases in their budget deficits and money supply during an election year. Strong (forthcoming) illustrates that the magnitude of the political business cycle depends on whether an African country has a fiscal rule to restrain elected officials from overstimulating the economy prior to elections. Using data from 32 African countries, Strong shows the money supply rises prior to national elections but that increase is about 50% smaller in countries with fiscal rules compared to countries with no fiscal rules.

2.2 Ethnic Favoritism

Many economists regard ethnic favoritism as one of the culprits for Africa's underdevelopment and poor economic growth. Ethnic favoritism involves the policy authorities favoring one ethnic group at the expense of others who do not identify with that group. This behavior can lead to the misallocation of resources, the under-provision of public resources, and rent-seeking activities by party loyalists (Baldwin and Huber 2010). Easterly and Levine (1997) show that cross-country differences in public policies can be explained by ethnic diversity. Frank and Rainer (2012) find that ethnic favoritism is an important determinant of education and infant mortality outcomes for 18 African countries. Specifically, that paper shows that education, measured by primary school attendance or literacy, improves by 2 percentage points for members of the head of state's ethnic group. De Luca, Hodler, Raschky, and Valsecchi (2018) note that nighttime light intensity is 7 to 10 percent brighter in the regions populated by the ethnic group affiliated with a country's political leaders.

If a country's leaders support policies that favor a particular ethnic group, those leaders will have a strong preference for appointing officials from the same ethnic group to strategic government positions to ensure that its policies favoring that group are implemented. Such strategic positions include the finance minister and, in our case, the head of the central bank. Indeed, we contend that a developing country with an independent central bank that supports ethnic favoritism prefers a higher inflation rate than in more developed countries because the resulting seigniorage revenue is used to help fund those economic policies. In a related study, Strong (2021) examines the impact of central bank governors changes on inflation in 31 African countries and finds that when the central bank governor and the head of the executive branch shares the same ethnicity, inflation goes up by 6 percentage points for African countries that are not part of the CFA zone but does not have a statistically significant impact on African countries that are members of the CFA zone.

3 Theoretical Model

Our theoretical model, like that in Debrun et al. (2005), assumes that governments for WAEMU, CAEMC, and WAMZ countries prefer to maximize their own utility and not the households' utility. Those governments cannot commit to monetary policy, but instead follow a discretionary policy, where they solve a myopic (one-period) optimization of their utility function. Specifically, the government in country i seeks to maximize the log of its output, $y_{i,t}$, while minimizing the following: 1) the deviation of government spending's share of output, $g_{i,t}$, from its socially optimal level, $\overline{g}_i$, 2) taxes' share of output, $\tau_{i,t}$, and 3) the deviation of the inflation rate, $\pi_{i,t}$, from its target, $\pi^*_{i,t}$. Country i's utility function, $U_{i,t}$, is a

modified version of the one used by Barro and Gordon (1983), but it is still tractable enough to obtain an analytical solution:

$$U_{i,t} = \left(-\frac{1}{2}\right)\left[\phi_\tau \tau_{i,t}^2 + \phi_g \left(g_{i,t} - \overline{g}_i\right)^2 + \phi_\pi \left(\pi_{i,t} - \pi_{i,t}^*\right)^2\right] + y_{i,t}, \tag{1}$$

where the utility parameters ϕ_τ, ϕ_g, and ϕ_π are restricted to positive values. The inflation rate target for country i comprises both a constant, country-specific inflation rate target, π_i^*, and a negative response to a country-specific aggregate supply shock, $\varepsilon_{i,t}$,

$$\pi_{i,t}^* = \pi_i^* - \delta \varepsilon_{i,t}, \tag{2}$$

where $\delta > 0$ is the response of the inflation rate target to an aggregate supply shock. Our identification of a country-specific inflation rate target is a key departure from Debrun et al., where the inflation target is set to zero for all countries. The inflation rate target is also assumed to depend negatively on the aggregate supply shock so a tradeoff exists between output and inflation in the model.[9] To generate a closed form solution for our model, we specify that government spending can only be financed with tax and seigniorage revenue (i.e., the government cannot issue additional debt), and seigniorage is linearly related to the inflation rate. Thus, the government budget constraint for country i can be expressed as follows:

$$g_{i,t} = \tau_{i,t} + \mu \pi_{i,t}, \tag{3}$$

where $1/\mu > 0$ measures the inflation rate's response to changes in money balances.[10]

A modified Lucas (1973) aggregate supply curve characterizes the level of output produced in country i:

$$y_{i,t} = c\left(\pi_{i,t} - E_{i,t-1}(\pi_{i,t}) - \tau_{i,t} - \sum_{k \neq i, k=1}^{n} \theta_{i,k}(\pi_{k,t} - E_{t-1}(\pi_{k,t}))\right) + \varepsilon_{i,t}. \tag{4}$$

The supply function assumes that an unanticipated jump in inflation, $\pi_{k,t} - E_{t-1}(\pi_{k,t})$, pushes up economic activity, while a rise in the taxes' share of output pushes down economic activity. The parameter $c > 0$ measures the impact of taxes and unexpected inflation on output. Country i's output is also impacted by economic decisions made by its trading partners. As in Debrun et al. (2005), an unexpected rise in a trading partner's inflation rate boosts that country's output. Higher demand pushes up prices of intermediate goods used by both countries, which causes country i's production costs to rise and output to fall.[11] The parameter $\theta_{i,k}$ represents the impact that an unexpected rise in country k's inflation rate has on output in country i. Lastly, output is impacted by a white noise aggregate supply shock, $\varepsilon_{i,t}$, with a variance of σ_i^2. Ahmed and Park (1994) finds that aggregate supply shocks are the main source of output movements in small open economies.

[9] Muscatelli (1998) and Debrun et al. (2005) make the same assumption in their models.

[10] Inflation is related to changes in money balances as a fraction of output, $\Delta m_{i,t}$, as follows: $\pi_{i,t} = \mu \Delta m_{i,t}$, where the value of μ is influenced by factors such as the velocity of money.

[11] This argument assumes the regional supply of intermediate goods is inelastic due to production bottlenecks. Some of those bottlenecks include local production capacity limitations and the lack of transportation infrastructure, which are common in African countries.

Country i maximizes (1) subject to (2), (3), and (4) every period to obtain its optimal levels of inflation, taxes, and government spending:

$$\pi_{i,t} = \frac{\phi_g\phi_\tau\mu\overline{g}_i + (\phi_\tau + \phi_g + \mu\phi_g)c + \phi_\pi(\phi_\tau + \phi_g)(\pi_i^* - \delta\varepsilon_{i,t})}{\phi_\tau\phi_g\mu^2 + \phi_\pi(\phi_\tau + \phi_g)}, \tag{5}$$

$$\tau_{i,t} = \frac{\phi_g\phi_\pi\overline{g}_i - (\phi_g\mu(1+\mu) + \phi_\pi)c - \mu\phi_g\phi_\pi(\pi_i^* - \delta\varepsilon_{i,t})}{\phi_\tau\phi_g\mu^2 + \phi_\pi(\phi_\tau + \phi_g)}, \tag{6}$$

$$g_{i,t} = \frac{\phi_g(\phi_\pi + \mu^2\phi_\tau)\overline{g}_i + (\phi_\tau\mu - \phi_\pi)c + \mu\phi_\tau\phi_\pi(\pi_i^* - \delta\varepsilon_{i,t})}{\phi_\tau\phi_g\mu^2 + \phi_\pi(\phi_\tau + \phi_g)}. \tag{7}$$

Those values show that as the socially optimal level of government spending's share of output rises, the inflation rate, taxes' share of output, and actual government spending's share of output all rise. A higher inflation rate target pushes up the inflation rate, which provides the government with more seigniorage revenue. Therefore, the governments can raise their spending and lower their taxes. Output's response, c, is related positively to inflation, negatively to taxes, and indeterminately to government spending. Finally, a positive aggregate supply shock lifts up output, and puts downward pressure on inflation. Lower inflation then reduces government revenue causing government spending to fall and taxes to rise.

Some countries belong to a monetary union where a common central bank conducts monetary policy for all of the member countries. Like the member countries in the union, the common central bank cannot commit to monetary policy, but instead, maximizes a utility function, $U_{MU,t}$, that is an output-weighted average of the myopic utility functions for the n member countries:

$$U_{MU,t} = \sum_{i=1}^{n}\omega_i\left[\left(-\frac{1}{2}\right)\left(\phi_\tau\tau_{i,t}^2 + \phi_g\left(g_{i,t} - \overline{g}_i\right)^2 + \phi_\pi\left(\pi_{MU,t} - \pi_{MU,t}^*\right)^2\right) + y_{i,t}\right], \tag{8}$$

where ω_i is country i's share of output in the monetary union, $\pi_{MU,t}$ is the inflation rate in the monetary union, and $\pi_{MU,t}^*$ is the inflation rate target set by the monetary union's central bank.[12] Since individual countries and the monetary union both solve a myopic utility maximization problem, any utility gains from joining the monetary union are due to cooperation among the member countries and not from enhanced commitment to a credible monetary policy. A monetary union's central bank can select its $\pi_{MU,t}^*$ in one of two ways. One, $\pi_{MU,t}^*$ could be fixed to the output-weighted average of the inflation rate targets for its n member countries, $\pi_{MU,t}^* = \sum_{i=1}^{n}\omega_i\pi_{i,t}$. Two, $\pi_{MU,t}^*$ could be set in line with a trading partner's inflation rate target so a fixed exchange rate can be maintained with that trading partner's currency. Our model assumes $\pi_{MU,t}^*$ is selected based on the second approach because both the WAEMU and CEMAC monetary unions set their inflation rate targets to levels necessary to maintain a fixed exchange rate with the Euro.

The utility maximization problem is more complicated for a country in a monetary union than for an individual country. In a monetary union, the common central bank sets the inflation rate for the member countries, but the individual countries select their own levels of government spending, taxes, and output. The central bank of the monetary union maximizes

[12] By definition, $\sum_{i=1}^{n}\omega_i = 1$.

(8) with respect to the inflation rate, $\pi_{MU,t}$, subject to the following inflation rate target, budget constraint, and Lucas supply curve equations:

$$\sum_{i=1}^{n} \omega_i \pi^*_{MU,t} = \sum_{i=1}^{n} \omega_i \pi^*_{MU} - \delta \sum_{i=1}^{n} \omega_i \varepsilon_{i,t}, \tag{9}$$

$$\sum_{i=1}^{n} \omega_i g_{i,t} = \sum_{i=1}^{n} \omega_i \tau_{i,t} + \mu \sum_{i=1}^{n} \omega_i \pi_{MU,t}, \tag{10}$$

$$\sum_{i=1}^{n} \omega_i y_{i,t} = \sum_{i=1}^{n} \omega_i \left(c \left(\pi_{MU,t} - E_{t-1}(\pi_{MU,t}) - \tau_{i,t} - \sum_{k \neq i, k=1}^{n} \theta_{ik} (\pi_{MU,t} - E_{t-1}(\pi_{MU,t})) \right) + \varepsilon_{i,t} \right). \tag{11}$$

Each country i then maximizes its utility, (1), with respect to its government spending, $g_{i,t}$, taxes, $\tau_{i,t}$, and log of output, $y_{i,t}$, subject to (2), (3), and (4).

The resulting first-order conditions from the monetary union's problem, country i's problem, and the constraint equations, (2), (3), and (4), are combined to solve for the monetary union's inflation rate, $\pi_{MU,t}$, country i's taxes' share of output, $\tau_{MUi,t}$, and country i's government spending's share of output, $g_{MUi,t}$:

$$\pi_{MU,t} = \frac{\phi_g \phi_\tau \mu \overline{g}_A + ((\phi_\tau + \phi_g)(1 - \theta_A) + \mu \phi_g) c + \phi_\pi (\phi_\tau + \phi_g)(\pi^*_{MU} - \delta \varepsilon_{A,t})}{\phi_\tau \phi_g \mu^2 + \phi_\pi (\phi_\tau + \phi_g)}, \tag{12}$$

$$\begin{aligned} \tau_{MUi,t} &= \frac{\phi_g (\phi_\tau \phi_g \mu^2 (1 - \Psi_i) + \phi_\pi (\phi_\tau + \phi_g)) \overline{g}_i}{(\phi_\tau \phi_g \mu^2 + \phi_\pi (\phi_\tau + \phi_g))(\phi_\tau + \phi_g)} \\ &\quad - \frac{\left(\phi_g \mu (1 - \theta_A + \mu) + \phi_\pi\right) c + \mu \phi_g \phi_\pi (\pi^*_{MU} - \delta \varepsilon_{A,t})}{\phi_\tau \phi_g \mu^2 + \phi_\pi (\phi_\tau + \phi_g)}, \end{aligned} \tag{13}$$

$$\begin{aligned} g_{MUi,t} &= \frac{(\phi_\tau \phi_g \mu^2 (\phi_g + \phi_\tau \Psi_i) + \phi_g \phi_\pi (\phi_\tau + \phi_g)) \overline{g}_i}{(\phi_\tau + \phi_g)(\phi_\tau \phi_g \mu^2 + \phi_\pi (\phi_\tau + \phi_g))} \\ &\quad + \frac{(\mu \phi_\tau (1 - \theta_A) - \phi_\pi) c + \mu \phi_\tau \phi_\pi (\pi^*_{MU} - \delta \varepsilon_{A,t})}{(\phi_\tau \phi_g \mu^2 + \phi_\pi (\phi_\tau + \phi_g))}, \end{aligned} \tag{14}$$

where $\overline{g}_A = \sum_{i=1}^{n} \omega_i \overline{g}_i$ is the weighted-average of the socially optimal government spending's share of output for the union, $\varepsilon_{A,t} = \sum_{i=1}^{n} \omega_i \varepsilon_{i,t}$ is the weighted-average aggregate supply shock for the union, $\Psi_i = \overline{g}_A / \overline{g}_i$ is the ratio of the union's weighted-average of the socially optimal government spending to country i's socially optimal government spending, and $\theta_A = \sum_{i=1}^{n} \omega_i \sum_{k \neq i, k=1}^{n} \theta_{i,k}$ accounts for the spillover effects on output from a surprise inflation in country j $(i \neq j)$ that are external to the decisions of country i's central bank but are internal to the decisions of the monetary union's central bank.

The monetary union sets an inflation rate target, $\pi^*_{MU,t}$, independent of the inflation rate targets of the member countries.[13] An increase in the inflation rate target pushes up the

[13] We do not know the optimal inflation rate targets for each individual WAEMU and CAEMC countries. Their common central banks have been setting an inflation target for such a long period of time that there is no reliable data on each member country's desired inflation rate target.

actual inflation rate, which leads country i to raise its government spending and reduce its taxation. The optimal inflation rate in the monetary union, (12), increases when the union's average share of socially optimal government spending rises, the union's aggregate supply shock is negative, and the degree of spillover effects from surprise inflation is small. Country i has a higher share of taxation, (13), when its relative share of socially optimal government spending is large (i.e., $\Psi_i < 1$), the union's aggregate supply shock is positive, and the size of the spillover effects from a surprise inflation is large. Finally, government spending's share of output, (14), rises in country i when its relative share of socially optimal government spending is low, the union's aggregate supply shock is negative, and the amount of spillover effects from a surprise inflation is small.

Our exact solutions for inflation, government spending, and taxation for both country i and a monetary union enable us to calculate the precise net benefit or loss that country i incurs from joining a monetary union, as opposed to retaining monetary independence.[14] That net utility effect from entering into a monetary union is calculated as follows:

$$\begin{aligned} E_{t-1}\left[U_{MUi,t}\right] - E_{t-1}\left[U_{i,t}\right] \;=\; & -\frac{\phi_g^2\phi_\tau^2\mu^2(1-\Psi_i)^2\overline{g}_i^2}{2(\mu^2\phi_\tau\phi_g+\phi_\pi(\phi_\tau+\phi_g))(\phi_\tau+\phi_g)} \\ & +\frac{\theta_A(2-\theta_A)(\phi_\tau+\phi_g)c^2}{2(\mu^2\phi_\tau\phi_g+\phi_\pi(\phi_\tau+\phi_g))}+\frac{\mu\phi_g\phi_\tau(1-\theta_A)(1-\Psi_i)\overline{g}_i c}{\mu^2\phi_\tau\phi_g+\phi_\pi(\phi_\tau+\phi_g)} \\ & -\frac{\mu^2\phi_g\phi_\tau\phi_\pi\left((\pi^*_{MU})^2-(\pi^*_i)^2\right)}{2(\mu^2\phi_\tau\phi_g+\phi_\pi(\phi_\tau+\phi_g))} \\ & +\frac{\mu\phi_g\phi_\tau\phi_\pi\overline{g}_i\left(\pi^*_{MU}-\pi^*_i\right)}{\mu^2\phi_\tau\phi_g+\phi_\pi(\phi_\tau+\phi_g)}+\frac{\mu\phi_g\phi_\pi c\left(\pi^*_{MU}-\pi^*_i\right)}{\mu^2\phi_\tau\phi_g+\phi_\pi(\phi_\tau+\phi_g)} \\ & -\frac{\phi_\pi^2\delta^2(\phi_\tau+\phi_g)\left(\sigma_A^2-2cov(\varepsilon_{A,t},\varepsilon_{i,t})+\sigma_i^2\right)}{2\left(\mu^2\phi_g\phi_\tau+\phi_\pi(\phi_\tau+\phi_g)\right)}, \end{aligned} \tag{15}$$

where E_{t-1} is the expectation at period $t-1$, σ_A^2 is the variance of $\varepsilon_{A,t}$, and σ_i^2 is the variance of $\varepsilon_{i,t}$. The difference between the expected utility from joining a monetary union, $E_{t-1}\left[U_{MUi,t}\right]$, and the expected utility from retaining monetary independence, $E_{t-1}\left[U_{i,t}\right]$, reveals the tradeoffs faced by country i in determining whether to join a monetary union. The coefficient on $(1-\Psi_i)^2\overline{g}_i^2$ demonstrates that country i suffers a welfare loss by joining a monetary union whenever its optimal government spending's share of output differs from the average in the monetary union, $\Psi_i \neq 1$. Members of the monetary union benefit whenever there are spillover effects, $\theta_A > 0$, from an unexpected rise in inflation according to the coefficient on c^2. The positive value multiplied by $(1-\Psi_i)\overline{g}_i c$ shows that countries with a high level of government spending's share of output, $\Psi_i < 1$, benefit from joining a monetary union.

Country i suffers a net welfare loss by joining a monetary union when its inflation rate target, π^*_i, under monetary independence is larger than the inflation rate target, π^*_{MU}, in a monetary union. That adverse effect is apparent in the positive response of $E_{t-1}\left[U_{MU,t}\right] - E_{t-1}\left[U_{i,t}\right]$ to increases in both $\overline{g}_i\left(\pi^*_{MU}-\pi^*_i\right)$ and $c\left(\pi^*_{MU}-\pi^*_i\right)$. Specifically, a lower inflation

[14] To determine the values of both utility functions, $y_{MUi,t}$ and $y_{i,t}$ are calculated as $y_{MUi,t} = -c\tau_{MUi,t}$ and $y_{i,t} = -c\tau_{i,t}$, respectively.

rate target reduces seigniorage revenue which forces the government to reduce its spending and raise taxes. Those higher taxes also generate an additional deadweight loss which leads to lower output. The negative coefficient on $(\pi^*_{MU})^2-(\pi^*_i)^2$ represents the second-order effects of changes in π^*_{MU} and π^*_i on net welfare. Specifically, a higher value of π^*_{MU} and a lower value of π^*_i increase net welfare but at a decreasing rate. The coefficient on the variance and covariance terms illustrates that country i will minimize its welfare loss from joining a monetary union when its country-specific aggregate supply shocks are highly correlated with the monetary union's aggregate supply shocks. That result is consistent with Mundell's (1961) conclusion that countries with similar economic shocks should form a monetary union.

4 Calibrating the Model

The data series used to calibrate the parameters of the model are displayed in Table 2.[15] To begin, the inflation rate targets, π^*_A, for the countries in WAEMU and CAEMC monetary zones are set by their respective common central banks, while targets, π^*_i, for the WAMZ countries are set individually by each country's central bank. Table 3 displays our calibrated values for π^*_i. Statute in the WAEMU zone specifies that the primary objective of monetary policy is price stability, which is defined as an average inflation rate between 1% and 3% over a two-year period. The monetary policy objective in the CAEMC zone, on the other hand, is to keep the community inflation rate at 3% or lower.[16] Thus, we calibrate the inflation rate target to 2% for the WAEMU zone countries and 3% for the CAEMC zone countries.

The specific monetary policies pursued by the individual WAMZ countries provide a framework for our calibration of each country's inflation rate target. In 2002, the Bank of Ghana was granted operational independence and started announcing inflation targets. Those inflation targets became official policy of the Bank of Ghana in 2007. Using data from Bleaney, Morozumi, and Mumuni (2020), we set Ghana's inflation rate target to 10%, which is Ghana's average inflation rate target from 2005 to 2016. The Central Bank of The Gambia sets an annual inflation rate target to meet its legal mandate for price stability. We set The Gambia's inflation rate target to 5% based on the inflation rate targets reported in the Bank's 2005 to 2016 annual reports. During that same period, the Central Bank of Nigeria reported its inflation rate target on Table 2.1 of its annual report, but its monetary policy was not strictly guided by that target. This paper sets Nigeria's inflation rate target to 10% based on that data. Inflation targeting is not a goal of either the Central Bank of Liberia or the Bank of Sierra Leone, but their Banks' annual reports mention single-digit inflation as an objective of their monetary policies. The fact that there is no specific numerical inflation objective for either country means we must calibrate their inflation rate targets based on actual inflation. From 2005 to 2016, the lower bound on actual inflation was around 7% in Liberia and 6% in Sierra Leone, so we set the inflation rate targets for Liberia and Sierra Leone to those values. The Central Bank of the Republic of Guinea establishes specific monetary targets, but it also has a non-specific, single-digit inflation target. Applying the same methodology

[15] We do not consider Benin, Central African Republic, Chad, and Equatorial Guinea in our analysis due to a lack of data.

[16] Another policy objective of the central banks in the WAEMU and CAEMC monetary zones is to maintain a fixed exchange rate between their respective currencies and the Euro.

as we did for Liberia and Sierra Leone, we set the inflation rate target for Guinea to 8%. Finally, the inflation rate target for a hypothetical monetary union among just the WAMZ countries is set to 2%.

Socially optimal government spending, $\overline{g}_i$, is not directly observable so that value must be estimated. According to our utility function, governments prefer to keep inflation at its target and taxes low. The result is actual government's spending share of output, $g_{i,t}$, is below $\overline{g}_i$. To estimate $\overline{g}_i$, we use underspending by the government on health and education as a proxy for the difference between $\overline{g}_i$ and $g_{i,t}$. Mauro (1998) shows that countries with poor institutional quality allocate less government resources to education and health than countries with good institutional quality. Specifically, Mauro argues that corrupt politicians distort government spending by shifting resources from areas with little economic rents, like education and health, to sectors with large economic rents which incentives the firms in those high-rent sectors to bribe the aforementioned politicians. Our model assumes that a country with perfect institutions spends the socially optimal shares of output on education and health. The percentage rate difference between the socially optimal and actual shares of government spending on health and education will be used to calculate the difference between the observed level of $g_{i,t}$ and the unobserved level of $\overline{g}_i$.

Our estimation of the optimal amount of education and health spending is similar to that of Debrun et al. (2005), except: 1) We estimate both values across countries and time while Debrun et al. only considers the differences across countries and averages the data for each country over time; and 2) Our regressions include both time and country fixed effects. The education regression is estimated using a panel of annual data from 2005 to 2016 for 25 African countries.[17] Specifically, we estimate the following regression:

$$Educ_{i,t} = \alpha_0 + \alpha_1 ln(GDP_{i,t}) + \alpha_3 ICRG^E_{i,t} + \sum_{j=2006}^{2016} \beta_j + \gamma_i + \varepsilon^E_{i,t}, \tag{16}$$

where $Educ_{i,t}$ is government education spending as a fraction of GDP, $ln(GDP_{i,t})$ is the log of real GDP per capita at PPP, $ICRG^E_{i,t}$ is an International Country Risk Guide (ICRG) index of institutional quality measure, β_j is time j's fixed-effects parameter, γ_i is country i's fixed-effects parameter, and $\varepsilon^E_{i,t}$ is an independently and identically-distributed error.[18] The difference between socially optimal education expenditures, $\overline{Educ}_{i,t}$, and the actual education expenditures is calculated by multiplying α_3 by the difference between the highest possible ICRG score, $\overline{ICRG}^E$, and the actual ICRG score (i.e., $\overline{Educ}_{i,t} - Educ_{i,t} = \alpha_3(\overline{ICRG}^E - ICRG^E_{i,t})$).

[17] Our sample is limited to 25 African countries due to data availability. Furthermore, some of the annual observations for those 25 countries are missing. The countries and years of data utilized in this analysis include: Angola (2005, 2006, 2010-2016), Burkina Faso (2005-2007, 2010-2015), Cameroon, Cote d'Ivoire, Egypt (2005-2008, 2010-2015), Ethiopia (2006-2016), Gabon (2010-2016), The Gambia, Ghana, Guinea (2005, 2008-2016), Guinea-Bissau (2010-2016), Kenya (2005, 2006, 2010-2016), Liberia (2008, 2012-2016), Madagascar, Mali (2005, 2008-2016), Mozambique (2005, 2006, 2010-2016), Namibia (2006, 2008, 2010-2016), Niger (2006-2016), Senegal (2005, 2006, 2008-2016), Sierra Leone (2005, 2007-2016), South Africa, Togo, Tanzania, Uganda (2010-2016), and Zambia (2005, 2007, 2008, 2010-2016). Countries without any years listed have data over the entire 2005-2016 period.

[18] $ICRG^E_{i,t}$ is the sum of the ICRG indices for government stability (12 max), democratic accountability (6 max), corruption (6 max), law and order (6 max), and bureaucracy quality (4 max), where a score of 34 indicates the best institutions.

A panel of annual data from 2005 to 2016 for 33 African countries is used to estimate our health spending regression.[19] That estimated regression is as follows:

$$\begin{aligned} Health_{i,t} &= \theta_0 + \theta_1 ln(GDP_{i,t}) + \theta_3 ICRG^H_{i,t} + \theta_4 HIV_{i,t} \\ &\quad + \theta_5 LifeExp_{i,t} + \theta_6 InfantMort_{i,t} + \sum_{j=2006}^{2016} \rho_j + \phi_i + \varepsilon^H_{i,t}, \end{aligned} \tag{17}$$

where $Health_{i,t}$ is government health expenditures as a fraction of GDP, $ln(GDP_{i,t})$ is the log of GDP per capita at PPP, $ICRG^H_{i,t}$ is an ICRG index of institutional quality measure, $HIV_{i,t}$ is a dummy variable that is 1 if the HIV/AIDS prevalence rate is above 10%, $LifeExp_{i,t}$ is the life expectancy at birth in total years, $InfantMort_{i,t}$ is the infant mortality rate per 1,000 live births, ρ_j is time j's fixed-effects parameter, ϕ_i is country i's fixed-effects parameter, and $\varepsilon^H_{i,t}$ is an independently and identically-distributed error.[20] Just as in the education specification, the difference between socially optimal health spending, $\overline{Health}_{i,t}$, and the actual health spending is equal to the difference between the highest possible ICRG score, $\overline{ICRG}^H$, and the actual ICRG score multiplied by θ_3 (i.e., $\overline{Health}_{i,t} - Health_{i,t} = \theta_3(\overline{ICRG}^H - ICRG^H_{i,t})$).

Socially optimal government spending is equal to actual government spending multiplied by the gross rate that socially optimal education and health expenditures exceed actual education and health spending (i.e., $\overline{g}_{i,t} = g_{i,t}\left(\overline{Educ}_{i,t} + \overline{Health}_{i,t}\right) / \left(Educ_{i,t} + Health_{i,t}\right)$).[21,22] The parameter $\overline{g}_i$ then is calibrated to the average value of $\overline{g}_{i,t}$ from 2005 to 2016. Table 3 reports the calibrated $\overline{g}_i$ values for the WAEMU, CAEMC, and WAMZ countries. Finally, the optimal government spending's share of output, $\overline{g}_A$, for each monetary union is calibrated to the GDP-weighted average of $\overline{g}_i$ for the union's member countries.[23] Table 4 reports the calibrated values for $\overline{g}_A$.

We follow Debrun et al.'s (2005) approach to calibrating the standard deviation of the aggregate supply shock, σ_i. The values for σ_i are presented in Table 3. Specifically, country i's aggregate supply shock, $\varepsilon_{i,t}$, is calculated by multiplying its annual percentage change in the terms of trade for goods by the degree of openness in its economy, which is defined as exports' share of output plus imports' share of output.[24] We multiply the change in the terms of trade by the degree of openness because shifts in the terms of trade have larger

[19] Our sample comprises annual data from the following countries: Algeria, Angola, Botswana, Burkina Faso, Cameroon, Republic of Congo, Democratic Republic of Congo, Cote d'Ivoire, Egypt, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Morocco, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, and Zambia.

[20] $ICRG^H_{i,t}$ is the sum of the ICRG indices for government stability (12 max), democratic accountability (6 max), and corruption (6 max), where a score of 24 indicates the best institutions.

[21] If there is no education spending data for a particular country, $\overline{g}_{i,t}$ is calculated for that country using just the health spending data.

[22] For example, let us consider the case of Cote d'Ivoire. Actual education and health are 0.0427 and 0.0092, respectively, while optimal education and health are 0.0479 and 0.0119, respectively. Since actual government spending's share of GDP is 0.2028, optimal government spending's share of GDP is $0.2398 = (0.2080)(0.0479 + 0.0119)/(0.0427 + 0.0092)$.

[23] $\overline{g}_A = \sum_{i=1}^{n} \omega_i \overline{g}_i$, where ω_i is GDP in country i divided by GDP in the entire monetary union.

[24] $\sigma_i = \left(\frac{exports_i - imports_i}{GDP_i}\right)\sigma_i^{TOT}$, where σ_i^{TOT} is the standard deviation of country i's percentage change in the terms of trade for goods.

effects on aggregate output when foreign trade makes up a greater share of the economy. Finally, the standard deviation of the aggregate supply shock, σ_A, for each monetary union is set to the standard deviation of the output-weighted average of $\varepsilon_{i,t}$ for the union's member countries.[25] The values for σ_A are displayed in Table 4.[26]

The parameter $\theta_{i,k}$ is calibrated to country i's exports to country k as a share of country i's GDP. We follow Debrun et al. (2005) and increase that value by 25% percent to reflect the informal trade that occurs between Sub-Saharan African countries. The country-specific exports data comes from the IMF's Direction of Trade Statistics and is the average of annual observations from 2005 to 2016. In a monetary union, the sum of country i's exports to each country in the monetary union is divided by country i's GDP. The GDP-weighted average of that number for the member countries is calculated to generate the value for θ_A in the monetary union.[27] Table 4 reports the values for θ_A.

The remaining parameters are assumed to be the same for all countries and monetary unions. The response of the inflation rate target to an aggregate supply shock, δ, and the response of output to taxes and unexpected inflation, c, are both normalized to 1. The inverse of inflation's response to changes in money balances, μ, is set to its average value in the six WAMZ countries because they are the only countries in our sample with monetary independence. Using (2), we calibrate μ to 0.281, which is equal to the average difference between government spending's share of GDP and taxes' share of GDP divided by the inflation rate.[28] Finally, the utility parameters ϕ_g, ϕ_τ, and ϕ_π are calibrated by first taking the difference between the optimal levels of government spending, taxes, and inflation for two countries with monetary independence, (5)-(7), and then solving for the utility parameter ratios ϕ_π/ϕ_τ and ϕ_g/ϕ_τ. Those ratios are substituted into the difference between the inflation rate for a monetary union, (12), and the inflation rate for a country with monetary independence, (5). The resulting equation is solved for ϕ_τ, and that value is substituted into the utility parameter ratios to generate values for ϕ_τ and ϕ_g.[29] To obtain those values, we use inflation data from the WAEMU monetary zone and government spending, tax, and inflation data from the six WAMZ countries, which are the only countries in our sample with an independent monetary policy. For each country in WAMZ, we calculate its utility ratios with the other five WAMZ countries and substitute those values into the equation for the difference in WAEMU's optimal inflation rate and the initial WAMZ country's inflation rate for a total of five sets of values for ϕ_g, ϕ_τ, and ϕ_π. That exercise is repeated for the six WAMZ countries for a total of 30 sets of values. After discarding any utility parameter set with a negative value for one or more of the utility parameters, we average the remaining sets of parameter values to get $\phi_g = 0.5630$, $\phi_\tau = 0.2491$, and $\phi_\pi = 1.5585$.

[25] $\sigma_A = std(\varepsilon_{A,t})$, where $\varepsilon_{A,t} = \sum_{i=1}^{n} \omega_i \varepsilon_{i,t}$.

[26] The values for $cov(\varepsilon_{A,t}, \varepsilon_{i,t})$ are published in an online appendix available on the authors' personal websites.

[27] $\theta_A = \sum_{i=1}^{n} \omega_i \sum_{k \neq i, k=1}^{n} \theta_{i,k}$.

[28] $\mu = \sum_{i=1}^{6} \sum_{t=2005}^{2016} [(g_{i,t} - \tau_{i,t})/\pi_{i,t}]$.

[29] These equations are derived in an online appendix available on the authors' personal websites.

5 Empirical Results

The WAEMU and CAEMC monetary unions have had a fixed exchange rate with the French franc/euro since December 1945.[30] The French Treasury guarantees the convertibility of both currencies at a fixed exchange rate, but it requires that 50% of the reserves from each monetary union be deposited at the Bank of France. That guarantee confers credibility from the Bank of France to the WAEMU and CAEMC monetary unions.[31] Efforts by the WAEMU and WAMZ countries to form a single monetary union have gained momentum in recent years. To help facilitate the expanded monetary union, the WAEMU monetary union and the French government agreed in December 2019 to eliminate the requirement that 50% of reserves must be deposited at the Bank of France. The agreement also stipulated that the French Treasury would continue to maintain its fixed exchange rate guarantee. Such a move was welcomed by those African countries because it eliminates some of the old vestiges of colonial France, but also it has the potential to reduce the credibility transfer from the Bank of France to the new monetary union.

In our model, the monetary union's utility function, (8), assumes the union does not have credibility to commit to any particular policy. Thus, our model cannot capture the credibility benefits that the Bank of France confers on the WAEMU and CAEMC monetary unions. If any new African monetary union, such as the proposed WAEMU and WAMZ union, has a weaker link or no link to a foreign central bank with credibility, then our utility specification could be considered a close approximation of reality.

Country i's net utility gain or loss from joining a monetary union is calculated by calibrating (15) to values specific to country i and the proposed monetary union. Since the utility functions $U_{i,t}$ and $U_{MU,t}$ have a one-for-one linear relationship with the log of output, the expected utility gain from joining a monetary union, $E_{t-1}[U_{MU,t}] - E_{t-1}[U_{i,t}]$, is equivalent to the same-sized increase in output. For example, a utility increase of 0.0200 from joining a monetary union provides country i with the same gain in utility as a 2% increase in output.

Table 5 presents each member country's utility gain or loss from joining the following current or proposed monetary unions: WAEMU, CAEMC, WAMZ, WAEMU + WAMZ, and CAEMC + WAMZ. The first column shows that each member country of the WAEMU monetary union benefits from being part of that monetary union, as opposed to having monetary independence. In fact, all of the WAEMU countries experience a utility gain equivalent to a 1.2% to 2.1% increase in output. The utility changes for the CAEMC countries, which are reported in the second column, are not as compelling. Cameroon receives a utility increase comparable to a 0.3% rise in output, while the Republic of Congo and Gabon suffer a utility decrease consistent with a reduction in output of 1.4% and 0.7%, respectively. In both cases, the utility results do not account for the possibility that each WAEMU and CAEMC country might prefer a different inflation rate target than that set by its monetary union.

The three remaining columns of Table 5 present the utility changes associated with the WAMZ countries forming their own monetary union or entering into a monetary union

[30] The exchange rate target switched from the French franc to the euro on January 1, 1999.

[31] Since the formation of these monetary unions, both the West African CFA franc and the Central African CFA franc were devalued on October 17, 1948, and January 12, 1994.

with either the WAEMU or CAEMC countries. The utility results from the third column reveal none of the WAMZ countries benefit from forming their own monetary union. Liberia endures an especially large utility decline, which is attributed to its enormous aggregate supply shocks that are moderately correlated with the same shocks in other WAMZ countries. If the WAEMU and WAMZ countries form a monetary union, the fourth column shows all of the WAEMU countries endure a modest decline in utility relative to remaining in their current monetary union. The WAMZ country of Ghana realizes a small utility increase, while Guinea, Sierra Leone, and especially Liberia, experience non-trival utility decreases compared to maintaining their own monetary independence. The fifth column shows that a monetary union between the CAEMC and WAMZ countries results in a utility decline for all of the countries, except Cameroon, relative to each country's current monetary system.

Tables 6 and 7 present the utility gains or loses when a single WAMZ country joins either the WAEMU or CAEMC monetary union. The columns of both tables display the changes in utility when the specified WAMZ country joins the WAEMU union in Table 6 and the CAEMC union in Table 7. For example, the last column of Table 6 shows the utility gains associated with adding only Sierra Leone to the WAEMU monetary union. The utility change in these tables for the WAEMU and CAEMC countries is measured relative to the current configuration of their monetary union, while the utility gain or loss for the WAMZ country is compared to its utility with an independent monetary policy. The results in Table 6 show the addition of The Gambia, Ghana, or Sierra Leone to the WAEMU monetary union would benefit most every country involved. Adding Guinea to the WAEMU union raises Guinea's utility equivalent to a 0.1% increase in output, whereas all of the WAEMU countries do not experience any meaningful change in utility. A union between Nigeria and the WAEMU countries would result in a small drop in Nigeria's utility, but it would generate a larger fall in the WAEMU countries' utility comparable to a 1.0% to 2.7% decrease in output. Our results from Liberia joining the WAEMU union, however, indicate Liberia would suffer a utility decline similar to that of a 10.6% drop in output, where the utility for the WAEMU countries would slightly fall. As for the CAEMC monetary union, Table 7 reveals no country obtains any meaningful utility increases when any single WAMZ country joins the CAEMC countries in a monetary union.

A key difference between our model and the model in Debrun et al. (2005) is that we assume the inflation rate target of a country or monetary union is unique to the economic and political environment of that entity. Debrun et al. implicitly assumes the inflation rate target is zero for all countries and monetary unions. Our theoretical results in (15) show that country i suffers a utility loss when it joins a monetary union with a lower inflation rate target than country i would select with an independent monetary policy. Since most of the WAEMU and CAEMC countries have been part of a currency union since the 1940s, no reliable data exists on the preferred inflation rate target for those countries under monetary independence. Every WAMZ country, however, has an independent central bank, so we can ascertain with a reasonable degree of certainty those countries' optimal inflation rate targets under monetary independence.

Table 8 examines how our utility results for the WAMZ countries from Tables 5 to 7 would be impacted if the change in the inflation rate target were not considered as in Debrun et al. (2005). The utility gain or loss is represented by w/ $\Delta\pi^*$ when the change in the inflation rate target is taken into account (our model) and by w/o $\Delta\pi^*$ when the

change in the inflation rate target is not taken into account (i.e., Debrun et al.'s model). Since the WAMZ countries all have inflation targets that exceed the 2% to 3% targets of the current or proposed monetary unions, the failure to consider the reduction in the inflation rate target biases the utility results upward. The first row of Table 8 shows that we would wrongly conclude Ghana and Nigeria would benefit from a monetary union among the six WAMZ countries if the decline in the inflation rate target were disregarded. In a union between the WAEMU and WAMZ countries, the second row of Table 8 shows The Gambia and Nigeria would not suffer a utility loss in the absence of any change in the inflation rate target. An analysis of a single monetary union among the CAEMC and WAMZ countries, which is displayed in the third row of Table 8, would also lead us to infer mistakenly that Ghana and Nigeria would benefit from being part of that expanded monetary union when the decrease in the inflation rate target is ignored. The fourth and fifth rows illustrate the effects of the inflation rate target in models where a single WAMZ country joins into a monetary union with the WAEMU or CAEMC countries. When the decrease in the inflation rate target is not considered, our findings incorrectly suggest that Nigeria would benefit from a monetary union with either the WAEMU or CAEMC countries and that Ghana would find it advantageous to join the CAEMC monetary union. These empirical results show that the shift to a lower inflation rate target when country i joins a monetary union has a negative impact on country i's utility, and if that change is ignored, one would erroneously conclude that country i benefits from joining the monetary union.

6 Conclusion

This paper develops a time-inconsistent model to evaluate the possible gains from joining a monetary union for African countries. Previous research on currency unions often relies on Mundell's (1961) OCA theory to evaluate the benefits of joining or forming a monetary union. We take a slightly different approach. Our model employs three features to account for the issues of fiscal dominance and political business cycles that affect the conduct of monetary policy in many African countries. Specifically, we assume that in Africa: 1) Central banks set their own inflation rate targets, but an inflation rate target set by a currency union is usually lower than an individual country's desired inflation rate; 2) Policymakers pursue time-inconsistent policies; and 3) Each government maximizes its own utility rather than the households' utility. Our theoretical results show African countries that cannot commit to monetary policy gain utility by joining a monetary union with other countries that have had similar supply shocks, but lose utility if that currency union targets a lower inflation rate. Thus, we conclude that a country's decision to join a currency union depends, in part, on how much lower a currency union's inflation target is compared to that country's desired inflation rate. If the differential is inconsequential, our results verify that Mundell's (1961) OCA theory holds in an African context.

Our empirical results indicate that when most West Sub-Saharan African countries join a monetary union, they experience utility changes equivalent to somewhere between a 2% rise in output and a 2% fall in output. Specifically, we find that many WAMZ countries derive higher utility from forming a union with the WAEMU countries than with the CAEMC countries or among themselves. The empirical results also show that the failure to account

for the differences in inflation targets can cause one to conclude erroneously that an African country would benefit from joining a monetary union. When the differences in the inflation rate targets are factored into the analysis, our findings reveal that every WAMZ country experiences a utility loss when joining either the CAEMC zone or forming a union among themselves. In contrast, the WAMZ countries of The Gambia, Ghana, Guinea, and Sierra Leone benefit when they individually join the WAEMU zone, while Ghana is the only WAMZ country that benefits from joining the union between WAMZ and the WAEMU zones.

Much of the existing literature finds that countries with similar economic shocks or business cycles, considerable intercountry labor mobility, or a high level of trade integration should form a monetary union. This paper contributes to that literature by theoretically modeling the differences in inflation rate targets of individual countries and the monetary unions they could possibly join. In Africa, many countries tend to prefer a higher inflation rate than is acceptable in other parts of the world. The reason why African countries permit higher inflation is a topic that is not examined in this paper. Our results show that if the cost of foregoing monetary independence is accepting a much lower inflation rate, then some African countries may not find it beneficial to join a currency union.

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Table 1: African Monetary Unions and Zones

WAEMU	CAEMC	WAMZ
Benin	Cameroon	The Gambia
Burkina Faso	Central African Rep.	Ghana
Cote D'Ivorire	Chad	Guinea
Guinea-Bissau	Republic of Congo	Liberia
Mali	Equatorial Guinea	Nigeria
Niger	Gabon	Sierra Leone
Senegal		
Togo		

Table 2: The Data (source)
2005-2016 (annual)

Total government expenditure on education as a % of GDP (World Bank)
Domestic general government health expenditure as a % of GDP (World Health Organization)
GDP per capita, constant prices, purchasing power parity (International Monetary Fund)
International country risk guide (The PRS Group)
Incidence of HIV per 1,000 uninfected population (World Bank)
Life expectancy at birth in years (World Bank)
Infant mortality rate is per 1,000 live births (World Bank)
Terms of trade for goods (International Monetary Fund)
GDP, nominal, domestic currency (International Monetary Fund)
Exports of goods and services, nominal, domestic currency (International Monetary Fund)
Imports of goods and services, nominal, domestic currency (International Monetary Fund)
Inflation rate, percentage change (International Monetary Fund)
General government total expenditure as a % of GDP (International Monetary Fund)
General government revenue as a % of GDP (International Monetary Fund)
Exports, U.S. dollar, Direction of trade statistics (International Monetary Fund)
GDP, U.S. dollar, Direction of trade statistics (International Monetary Fund)

Table 3: Parameter Values for Specific Countries

Country	π_i^*	$\overline{g}_i$	σ_i
WAEMU			
Burkina Faso	0.020	0.2750	0.0577
Cote D'Ivoire	0.020	0.2398	0.1315
Guinea-Bissau	0.020	0.2620	0.1272
Mali	0.020	0.2402	0.0856
Niger	0.020	0.2753	0.0558
Senegal	0.020	0.2417	0.0650
Togo	0.020	0.2717	0.0307
CAEMC			
Cameroon	0.030	0.2091	0.0616
Republic of Congo	0.030	0.4613	0.2444
Gabon	0.030	0.2682	0.2140
WAMZ			
The Gambia	0.050	0.1982	0.0837
Ghana	0.100	0.2040	0.0686
Guinea	0.080	0.2225	0.1167
Liberia	0.070	0.3140	0.4315
Nigeria	0.100	0.2084	0.0493
Sierra Leone	0.060	0.2110	0.1302

Table 4: Parameter Values for Monetary Unions

Union	$\overline{g}_A$	σ_A	θ_A
WAEMU	0.2494	0.0679	0.0366
CAEMC	0.2761	0.1105	0.0126
WAMZ	0.2087	0.0474	0.0056
WAEMU + WAMZ	0.2146	0.0681	0.0230
CAEMC + WAMZ	0.2160	0.0528	0.0095
WAEMU + The Gambia	0.2485	0.0665	0.0384
WAEMU + Ghana	0.2324	0.0568	0.0400
WAEMU + Guinea	0.2471	0.0623	0.0363
WAEMU + Liberia	0.2709	0.0763	0.0372
WAEMU + Nigeria	0.2151	0.0385	0.0125
WAEMU + Sierra Leone	0.2583	0.0622	0.0489
CAEMC + The Gambia	0.2742	0.1067	0.0127
CAEMC + Ghana	0.2430	0.0801	0.0080
CAEMC + Guinea	0.3764	0.1143	0.0118
CAEMC + Liberia	0.2777	0.1175	0.0026
CAEMC + Nigeria	0.2167	0.0550	0.0046
CAEMC + Sierra Leone	0.2724	0.1072	0.0120

Table 5: Utility Gains from Joining a Monetary Union

	WAEMU*	CAEMC*	WAMZ*	WAEMU + WAMZ**	CAEMC + WAMZ**
Burkina Faso	0.0212	n.a.	n.a.	−0.0085	n.a.
Cote D'Ivorire	0.0188	n.a.	n.a.	−0.0108	n.a.
Guinea-Bissau	0.0122	n.a.	n.a.	−0.0087	n.a.
Mali	0.0189	n.a.	n.a.	−0.0071	n.a.
Niger	0.0179	n.a.	n.a.	−0.0056	n.a.
Senegal	0.0200	n.a.	n.a.	−0.0074	n.a.
Togo	0.0208	n.a.	n.a.	−0.0082	n.a.
Cameroon	n.a.	0.0027	n.a.	n.a.	0.0021
Rep. of Congo	n.a.	−0.0139	n.a.	n.a.	−0.0142
Gabon	n.a.	−0.0066	n.a.	n.a.	−0.0129
The Gambia	n.a.	n.a.	−0.0094	−0.0012	−0.0058
Ghana	n.a.	n.a.	−0.0095	0.0015	−0.0056
Guinea	n.a.	n.a.	−0.0189	−0.0104	−0.0154
Liberia	n.a.	n.a.	−0.1302	−0.1245	−0.1235
Nigeria	n.a.	n.a.	−0.0070	−0.0005	−0.0030
Sierra Leone	n.a.	n.a.	−0.0119	−0.0084	−0.0081

*Utility gains relative to independence.

**Utility gains relative to existing monetary union for WAEMU and CAEMC countries and utility gains relative to independence for WAMZ countries.

Note: The expected utility gain is equivalent to the same-sized increase in income.

Table 6: Utility Gains from a Single WAMZ Country Joining WAEMU*

	WAEMU +					
	The Gambia	Ghana	Guinea	Liberia	Nigeria	Sierra Leone
Burkina Faso	0.0013	0.0033	0.0005	−0.0011	−0.0162	0.0076
Cote D'Ivorire	0.0010	−0.0001	−0.0007	−0.0015	−0.0265	0.0064
Guinea-Bissau	0.0011	0.0020	−0.0005	−0.0017	−0.0171	0.0067
Mali	0.0012	0.0032	0.0000	−0.0008	−0.0163	0.0073
Niger	0.0012	0.0049	0.0002	−0.0007	−0.0101	0.0083
Senegal	0.0012	0.0024	0.0000	−0.0023	−0.0150	0.0074
Togo	0.0012	0.0032	0.0002	−0.0014	−0.0136	0.0074
The Gambia	0.0082	n.a.	n.a.	n.a.	n.a.	n.a.
Ghana	n.a.	0.0118	n.a.	n.a.	n.a.	n.a.
Guinea	n.a.	n.a.	0.0010	n.a.	n.a.	n.a.
Liberia	n.a.	n.a.	n.a.	−0.1059	n.a.	n.a.
Nigeria	n.a.	n.a.	n.a.	n.a.	−0.0030	n.a.
Sierra Leone	n.a.	n.a.	n.a.	n.a.	n.a.	0.0047

*Utility gains relative to existing monetary union for WAEMU countries and utility gains relative to independence for WAMZ countries.

Note: The expected utility gain is equivalent to the same-sized increase in income.

Table 7: Utility Gains from a Single WAMZ Country Joining CAEMC*

	CAEMC +					
	The Gambia	Ghana	Guinea	Liberia	Nigeria	Sierra Leone
Cameroon	0.0003	−0.0011	−0.0062	−0.0074	−0.0010	0.0001
Rep. of Congo	0.0000	−0.0064	−0.0068	−0.0050	−0.0180	−0.0014
Gabon	−0.0003	−0.0056	−0.0277	−0.0062	−0.0089	−0.0003
The Gambia	−0.0125	n.a.	n.a.	n.a.	n.a.	n.a.
Ghana	n.a.	−0.0070	n.a.	n.a.	n.a.	n.a.
Guinea	n.a.	n.a.	−0.0094	n.a.	n.a.	n.a.
Liberia	n.a.	n.a.	n.a.	−0.1033	n.a.	n.a.
Nigeria	n.a.	n.a.	n.a.	n.a.	−0.0062	n.a.
Sierra Leone	n.a.	n.a.	n.a.	n.a.	n.a.	−0.0116

*Utility gains relative to existing monetary union for CAEMC countries and utility gains relative to independence for WAMZ countries.

Note: The expected utility gain is equivalent to the same-sized increase in income.

Table 8: The Impact of the Inflation Rate Target on Utility Gains*

	The Gambia	Ghana	Guinea	Liberia	Nigeria	Sierra Leone
WAMZ						
w/ $\Delta\pi^*$	−0.0094	−0.0095	−0.0189	−0.1301	−0.0070	−0.0119
w/o $\Delta\pi^*$	−0.0045	0.0010	−0.0103	−0.1225	0.0035	−0.0057
WAEMU+WAMZ						
w/ $\Delta\pi^*$	−0.0012	0.0015	−0.0104	−0.1245	−0.0005	−0.0084
w/o $\Delta\pi^*$	0.0036	0.0120	−0.0018	−0.1167	0.0099	−0.0022
CAEMC+WAMZ						
w/ $\Delta\pi^*$	−0.0058	−0.0056	−0.0154	−0.1235	−0.0030	−0.0081
w/o $\Delta\pi^*$	−0.0027	0.0031	−0.0085	−0.1176	0.0057	−0.0036
WAEMU +						
w/ $\Delta\pi^*$	0.0082	0.0118	0.0010	−0.1059	−0.0030	0.0047
w/o $\Delta\pi^*$	0.0130	0.0223	0.0096	−0.0982	0.0075	0.0109
CAEMC +						
w/ $\Delta\pi^*$	−0.0125	−0.0070	−0.0094	−0.1033	−0.0062	−0.0116
w/o $\Delta\pi^*$	−0.0094	0.0017	−0.0026	−0.0974	0.0026	−0.0071

*Utility gains relative to independence.

Note: The expected utility gain is equivalent to the same-sized increase in income.