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Why Join a Monetary Union? Theoretical Answers for Policy Makers in the West African Monetary Zone (WAMZ)

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In light of the increase in regional monetary unions, this paper examines the importance of currency union using a modified Barro-Gordon model. The model assumes that monetary unions follow a rule-base while individual central banks follow discretionary monetary policy rule. We find that monetary union serves as a disciplinary mechanism and enhances commitment for member countries. Our results also strengthen other findings that monetary unions can lower inflation and government spending.

1. Introduction and Framework

The adoption of the euro by the European Monetary Union (EMU) and its successful launching in January 1999 has stimulated interest in the formation of currency union arrangements around the globe. Prior to the euro, other currency unions have been in existence, including the Central Africa Economic Monetary Union (CAEMU), the West African Economic Monetary Union (WAEMU), the Eastern Caribbean Currency Union (ECCU), and the Common Monetary Authority (CMA). Recently, five West African countries proposed to enter into a monetary union called the West African Monetary Zone (WAMZ[1]).

Since trade is the engine for growth and that currency union enhances growth via trade and the fact that the zone has not progressed much with growth, entering into monetary union could serve as a stimulus to economic growth. One of the potential benefits associated with monetary union is its effect in enhancing trade. The implication is that trade will increase as countries join the monetary union. This paper, however, differs from previous research in two folds: first it examined

[1] WAMZ members are The Gambia, Ghana, Guinea, Nigeria, and Sierra Leone

the benefit of currency union via fiscal discipline and credibility in macroeconomic policy. Second, we attached equal weights to output and inflation. The motivation for the study is the prone developing countries have particularly the WAMZ zone with high inflation rate, fiscal indiscipline, and credibility issues. This paper is organized as follows: In section 2 the literature on time inconsistency is examined; Section 3, contains the model; Section 4 contains the monetary union scenarios, Section 5 contains common monetary union rule. Concluding remarks are found in section 6.

II. Literature Review

The debate on rule versus discretion was pioneered by Kydland and Prescott (1977). Since its inception, the time inconsistency problem has received a great deal of attention from researchers and policymakers. In their paper, Kydland and Prescott outlined the fact that even with unanimous fixed social objective function and policymakers know the timing and magnitude of the effects of their actions, discretionary policy is a decision that is best given the current situation does not necessarily maximize social objective. The reasoned they outlined is that economic planning is a game against economic agents and not a game against nature. Consequently, there is no way control theory will deliver well in a game of economic planning where expectations are rational. In such setting, optimality and time consistency are mutually exclusive[2]. The economic planners are tempted to deviate from an announced policy for its own benefit, and economic agents acted based on information announced by planners in the previous year. Once agents comprehend the action of the planners, they too incorporate it in their future expectations. Consequently, the solution attained by policymakers is suboptimal, that is second-best. The first-best is unattainable so long as policy makers go by discretionary policy. The first-best can only be attained when there is an enforcement of the planner's policy announcement. This kind of situation is known in the literature as rule-based regime for macroeconomic planning.

The work of Kydland and Prescott surged research on time-inconsistency and optimality in economic planning. Many studies on

[2] In this kind of framework, a policy cannot be optimal and time- consistent at the same time.

monetary policy have referred to their work. Barro and Gordon (1983a) extended the Kydland and Prescott's unemployment and inflation model and used rational expectation to illustrate a discretionary monetary regime. In this framework with the given society's preferences, the optimal solution for the monetary policy with zero inflation is not time-consistent. With a discretionary monetary regime, monetary authority will desire to have some positive inflation. The private agents know the potential desire of the authority and they too include such information in their expectation formation. Given that expectations are always greater than zero and that in a rational expectation equilibrium setting, expected inflation rate equals actual inflation, it implies that actual inflation will always be greater than zero. The outcome is second- best since the first-best is unattainable. Considering the long run time horizon where unemployment rate equals the natural rate, the inflation rate will remain high. Barro and Gordon (1983b) proceeded further but included reputation. In a short-time frame game, a rule-regime provides better outcome as compared to a discretionary regime. A rule-regime and political pressure are incompatible when monetary policy is needed to overcome unexpected economic disturbances. However, with a reputationable regime in an infinite time frame alleviate the time inconsistency problem discussed earlier. Recurring interactions may lead to reputational enforcement through trigger-strategy equilibrium. The interaction between private agents and policymakers and in order to build reputation and credibility, the policymakers abide by the rule. Consequently, policymakers forgo a short term benefits from inflation shock in order to secure the gain from low average inflation. A scenario of this kind, there must be an outcome that is superior to the second-best under a discretionary regime in the game. A repeated game of this kind do not last long since the agents know that the monetary authority will eventually deviate in the final period and the trigger-strategy equilibrium loosen through a process of backward induction.

Rogoff (1985) offers a solution to this difficulty. The solution is demonstrated in his article entitled *the optimal degree of commitment to an intermediate monetary target*. He showed with a high inflation in the final period, it is still possible to sustain inflation rates close to zero. Despite the level of uncertainty, there is still some room for improvement in a discretionary regime. Rogoff further argued that having an agent to head the central bank reduces the time-consistent rate of inflation; it suboptimally raises the variance of employment when supply shocks are large. In his model, time-inconsistency problem arises as a result of labor market distortion that the monetary authority attempt to correct which can only be done with complete information at hand. Apparently, the first-best solution is attained if the labor-market distortion is completely removed. Removing the distortion at a low social cost, it would be possible to raise employment and lower inflation. A second-best solution would legally impose a complete state-contingent monetary rule. He argued that if the first and second best solutions are too costly or unattainable, then an appointment of a conservative central banker or monetary targeting such as price level, money supply, and interest rate, nominal GDP targeting should be used as a third best solution. He, however, pointed out that appointing conservative central banker or by providing the central banker with incentives to hit an intermediate monetary target, it is possible to induce less inflationary wage bargains. This outcome comes at a cost because the central banker cannot systematically raise employment; monetary policy can still be effective to stabilize inflation and employment around their mean market determined levels. Consequently, rigid targeting is only necessary on certain rear occasions. Rogoff (1985b) extends the analysis in his article *can International monetary policy cooperative be counterproductive*? Employing the framework used by his predecessors, he illustrated the potential danger with inter-central bank cooperation in that it exacerbates the credibility problem of the central bank and the private sectors. In this setting, domestic inflation is not only affected by domestic prices but also by foreign prices through the exchange rate mechanism. Moreover, each central bank may be tempted to inflate with pretext that the other will inflate. As a result, the real exchange rate discipline is lost. Monetary policy cooperation is mutually beneficial only in an institutional framework which eliminate or improve the central banks credibility problem vis-à-vis the private sector. In summary, monetary cooperation streamlined the two central banks' objective functions to a single problem. Hence Rogoff, extended the analysis of time-inconsistency problem in a multicountry framework. Using the above discussions as a framework, the time-inconsistency problem of a monetary policy is model in the following section.

III. Model

The model is a reduce form model of the Barro-Gordon (1983) type which is extended to included fiscal and monetary policy such as government expenditure and monetary expansion. I followed previous researchers by assuming the model is of a finite one with three period time horizon; The central bank chooses the inflation level; The government defines her fiscal policy namely taxes and expenditure. The private sector makes their expectation of future inflation (π^e). The timing of the game is as follows first, the monetary policy authority- the central bank sets the inflation level that dependent on shock. In a discretionary central bank, the setting of inflation is delayed and therefore this stage will not occur. Second, wage setters form their expectation of the inflation level (π^e) and set their wages to incorporate future inflation. Third, a shock occurs in the following period just after wage setters formed their expectation. Fourth, the government chooses a level of expenditure to neutralize the shock. The government finances the expenses incurred in the previous period by either monetizing or through tax or both. The game ends after the government chooses the level of expenditure to compensate for the shock. The private sector is at a disadvantage compared to the government in that they make their decision before the shock. The government, however, has an idea about the nature of the shock before taking any decision. Using an extension of Barro-Gordon (1983) the reduce form; we followed Hallerberg (2002) et al and solve the model by applying backward induction process. The government authority in the country wants to minimize the loss function which is given by

$$L = \frac{1}{2}\beta[y^* - y_1]^2 + \frac{1}{2}\beta[y^* - y_2]^2 + \frac{1}{2}\alpha\pi^2 \text{ ------------------------------ } (1)$$

We assumed that the government attached equal weights on output and inflation. From the equation 1, y_1 and y_2 are output for period one and two respectively; y^* is the government target level of output and π is inflation level which is equivalent to price difference between period one and two. The coefficients β and α are the weights government attached on output and inflation respectively. Output in periods one and two respectively is given by

$$y_1 = \bar{y} + X - \varepsilon$$

and--------------------------------------(2)

$$y_2 = \bar{y} + (\pi - \pi^e) - T$$

In the above equations in period one and two, $\bar{y}$ is the natural rate of output for the country. In the model the shock ε with mean zero occurred after the private sector made their expectation and before government expenditure X. Taxes T are levied, and/or monetized deficits πM are occurred thereafter.

As mentioned earlier, wages are determined by wage setters at the initial period and assuming that wages remain constant through out the periods under consideration. Wage setters set wages base on expected inflation by incorporating shocks. Wages, therefore, will be equal to the expected price in the following year when the shock occurred given as

$$w = E_{p1}[p_2]$$

And the expected inflation is

$$\pi^e = E_\varepsilon[\pi(\varepsilon)] \equiv \int \pi(\varepsilon) \text{ --- } (3)$$

This is equivalent to

$$\pi^e = E_\varepsilon[\pi(\varepsilon)] \equiv \int \pi(\varepsilon) = \mathrm{w - p_1}$$

Substituting equation *3* into equation *2* and rearranging we get

$$y_2 = \bar{y} + (\pi - \pi^e) - T \text{ -- } (4)$$

Inflation in this setting can be represented as a function of monetary growth, money demand[3], government expenditure, and taxes. Hence inflation is given as

$$\pi = \frac{X - T - \Phi}{M}$$

[3] The relationship between money demand and inflation and the derivation of the relationship with other variables is given in the Appendix.

Where $\Phi = rB - \frac{dB}{dt}$; M is a multiple of the money supply in the first period.

The tax function can be represented as a function of government expenditure, money supply, and money demand given as

$$T = X - \pi M - \Phi \text{ -- (5)}$$

From the above, tax is an increasing function of government expenditure. Substituting equation *5* into equation *4* and then the result into the loss equation *1* and then simplify we get

$$L = \frac{1}{2}\{\beta[y^* - \bar{y} + X - \varepsilon]^2 + \beta[y^* - \bar{y} - \pi - \pi^e - T]^2 + \alpha\pi^2\} \text{ -------- (6)}$$

As discussed, when a shock is realized, the government takes action and compensates for the shock. The budget used to compensate for the shock was planned to be used for the succeeding period[4]. In other words government borrowed and therefore need to pay back the loan. This kind of transfer from one period to another leads to *time-inconsistency problem* because the government is tempted to monetized the deficit to finance the deficit. In order to find the optimal inflation and government expenditure, backward induction is applied. First, we begin to find the optimal inflation level taking government expenditure (X) as given. Denoting the differences between output target and natural level of output by k , That is $k = y^* - \bar{y}$, then the loss function can written as

$$L = \frac{1}{2}\beta[k + \varepsilon - X]^2 + \frac{1}{2}\beta[k - \pi - \pi^e + X - \pi M - \Phi]^2 + \frac{1}{2}\alpha\pi^2 \text{ ------- (7)}$$

As period two begins, government expenditure X and expected inflation π^e are known. Subsequently, the government chooses inflation level as a function of government expenditure in the previous period. To minimize the loss function- equation *7* taking government expenditure as given, the optimal inflation level is given as

[4] Government use next year budget to compensate for the shock

$$\pi^*(X) = \frac{\beta[1+M]}{\beta[1+M]^2+\alpha}[k+X-(\pi^e+\Phi)]$$

When $k+X>\pi^e+\Phi$, then optimal inflation can be written as

$$\pi^*(X) = \frac{\beta[1+M]}{\beta[1+M]^2+\alpha}[k+X-(\pi^e+\Phi)]>0 \text{ -------------------------- } (8)$$

The implication is that the optimal inflation will always be greater than zero (unless $k+X=\pi^e+\Phi$) which results to time-inconsistency problem where zero inflation is unattainable.

Given the optimal inflation rate, expected inflation, and shock realized in the first period, we calculate optimal government expenditure. To proceed, we first rewrite the loss function, (equation *7*), where inflation is expressed as an explicit function of government expenditure. The loose function is now given as

$$L = \frac{1}{2}\beta[k+\varepsilon-X]^2+\frac{1}{2}\beta[k-\pi(X)-\pi^e+X-\pi(X)M-\Phi]^2+\frac{1}{2}\alpha\pi(X)^2$$

Using the loose function where inflation is expressed as an explicit function of government expenditure, we compute the optimal government expenditure. To determine the optimal government expenditure, we minimized the loose function and obtained

$$X^* = [\frac{1}{W+1}]\{k+\varepsilon-\pi^e[\beta(1-W)+W^2]+k[\beta(1-W)-W^2]\} \text{ ------- } (9)$$

Where, $W = \frac{\beta[1+M]}{\beta[1+M]^2+\beta}$

The optimal government expenditure is a function of shock and expected inflation. There is a negative relationship between government expenditure and expected inflation. To evaluate the optimal inflation as function of expected inflation, we substitute equation *9* into equation *8* to obtain an expression for inflation as a function of expected inflation

$$\pi^*(\pi^e) = W\{k + [\frac{1}{1+W}][k + \varepsilon + \beta(1-W)(k-\pi^e) - W^2(k+\pi^e)] - \pi^e\} \text{ -- (10)}$$

Equilibrium inflation is obtained with the assumption that expectation about inflation is consistent. Hence the expected inflation is

$$\pi^e = E_1[\pi] \equiv \int \pi$$

Assuming rational expectation and stochastic shock with mean zero, the expected inflation equilibrium is

$$\pi^e = \pi^* = \frac{W\{k + [\frac{1}{W+1}][k + k\beta(1-W) - W^2 k]\}}{1 + W[\frac{1}{1+W}]\{\beta(1-W) - W^2 + 1\}} \text{ --------------------- (11)}$$

Given $\beta(1-W) - W^2 > 0$, it implies that the expected inflation in equilibrium will always be positive given as

$$\pi^e = \pi^* = \frac{W\{k + [\frac{1}{W+1}][k + k\beta(1-W) - W^2 k]\}}{1 + W[\frac{1}{1+W}]\{\beta(1-W) - W^2 + 1\}} > 0$$

The first best response outcome is attained when inflation is set equal to zero. From equation *11*, such outcome can occur if and only if $W = 0$.

Expected inflation equilibrium is an increasing function of the weight government attached on output but a decreasing function of the weight government attached on inflation. On the one hand, the higher the output government desires, the higher the expected inflation equilibrium. On the other hand, the greater government concerns about inflation, the lower the expected inflation equilibrium.

Given, $T = X - \pi M - \Phi$, where $\Phi = rB - \frac{dB}{dt}$

If the government could commit to zero inflation, then government spending may not necessarily be equal to tax revenue unless Φ is zero; that is there is no debt servicing.

IV. Monetary union

Since the first-best solution is unattainable, ways of improving on second-best has received a lot of attention. Improving on the second-best is a problem that WAMZ member countries face since they gained political independence. A sounded macroeconomic economic frame work with policy credibility would open to foreign markets for zone's exports and reduce barriers to foreign investment. Government, however, should control their fiscal spending when shocks asymmetric. Controlling government spending minimizes the adversity of large exogenous shock that confront the economy. High government spending serves as an incentive to increase inflation which is equivalent to devaluation of the country's currency relative to foreign currency. This therefore leads to loss in credibility of the domestic currency. When countries enter into monetary union they become committed and have higher chance of minimizing potential problems. Using the same model outlined above with some modifications, we model the monetary union case where the loss function for each country within the zone is given as

$$L^j = \frac{1}{2}\beta[y^* - y_1^j]^2 + \frac{1}{2}\beta[y^* - y_2^j]^2 + \frac{1}{2}\alpha\pi^2 \text{ -------------------------- } (12)$$

Where, $y_1^j = \bar{y} + X^j - \varepsilon^j$ and $y_2^j = \bar{y} + (\pi - \pi^e) - T^j$ is the output for country j in period one and period two respectively.

Assuming that countries are similar in nature, that is, they have the same natural level of output target. However, they face different shocks and they maintain their level of government spending and tax level. By entering into monetary union, individual countries have no control on money supply. The money supply and monetary policy is undertaken and controlled by one main supranational central bank. Individual country in the union has no control over monetary policy. This is one of the main costs of entering into a monetary union. Following the same time sequencing as applied in a one country case in the previous section, where private individual form their expectation and wages are contracted. In the following period, shock are realized, individual government compensate for the shock by choosing spending level and the main central bank determine the inflation rate for the union. To obtain the union inflation rate, we sum all the loss functions of the entire zone. This is obtained by adding the loss functions for all countries in the zone. Hence the loss function for the monetary union is

$$L = \sum_{j=1}^{5} \{ \frac{1}{2}\beta[y * - y_1^j]^2 + \frac{1}{2}\beta[y * - y_2^j]^2 + \frac{1}{2}\alpha\pi^2 \} \text{----------------------} \quad (13)$$

Where individual countries range from 1 to n, (n= 5) reflecting the number of countries in the monetary union. The optimal average inflation is given as a function of government spending in the monetary union is

$$\pi^*(X) = \frac{1}{n}\frac{\beta[1+M]}{\beta[1+M]^2 + \alpha}\sum_{j=1}^{n}[k + X^j - (\pi^e + \Phi^j)] \text{--------------------} \quad (14)$$

Where $\Phi = rB - \frac{dB}{dt}$

Assuming that there exist no interest payment on individual government debt and no budget deficit financing by issuing debt, that is ($\Phi = 0$), then the optimal inflation for the union is

$$\pi^* = \frac{1}{n}\frac{\beta[1+M]}{\beta[1+M]^2 + \alpha}\sum_{j=1}^{n}[k + X^j - \pi^e] \text{---------------------------------} \quad (15)$$

Which is the same as

$$\pi^* = \frac{\beta[1+M]}{\beta[1+M]^2 + \alpha}[k + \overline{X} - \pi^e] \text{ Where } \overline{X} = \frac{1}{n}\sum_{j=1}^{n} X^j \text{ ---------------} \quad (16)$$

Assuming the average government spending for the union is given as $\overline{X}$. The optimal union inflation rate is similar to the individual country's average inflation rate. The main difference is that individual countries optimal inflation rates is a function of only their own government spending. In a monetary union, however, optimal inflation rate is a function of the overall average of the union government spending $\overline{X}$ [5]. Consequently, each government within the union will minimize her loss function to determine her government spending taking expected inflation as a function of her expenditure.

$$L^j = \frac{1}{2}\{\beta[k+\varepsilon^j - X^j]^2 + \beta[k-\pi-\pi^e + X^j - \pi M - \Phi]^2 + \alpha\pi^2\} \text{-- (17)}$$

The optimal government is found by minimizing the above loss function.

V. Common Monetary Union Rule

The supranational central bank of the monetary union has to come up with a common inflation rate. If central bank's inflation rate is different from the previous average member countries' inflation rate, then there is an improvement. Such an outcome is one of the main reasons behind one rule the central bank employ that forces the members to adopt the minimum preferred inflation among all countries. The minimum inflation rate that the central bank can implement depends on the level of individual countries government spending.

$$\pi^{CB*}(X) = \frac{\beta[1+M]}{\beta[1+M]^2+\alpha}[k+\overline{X}^L - \pi^e] \text{ ------------------------------ (18)}$$

Where $\overline{X}^L$ denoted the minimum average government spending by member countries. Subsequently, inflation rate will not be exclusively determined by one member country government spending. In other words, inflation rate is taken as given that is inflation rate π is fixed. Similarly, member countries take expected inflation as given after observing the exogenous shock; it implies that no member country in the union can monetize government debt. Consequently, optimal government spending is limited and is given by

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[5] Assuming the union used average inflation rate to determine the inflation rate for the entire monetary union.

$$X^{Ui*} = \frac{1}{2}\left[\pi(1+M) + \varepsilon^{j} + \pi^{e}\right] \text{---} (19)$$

The government with the lowest shock, however, chooses its individually optimal spending given as follows:

$$X^{L\varepsilon*} = \left[\frac{1}{W+1}\right]\{k + \varepsilon^{L} - \pi^{e}[\beta(1-W) + W^{2}] + k[\beta(1-W) - W^{2}]\} \text{ -- } (20)$$

The implication is that if $\varepsilon^{L} < \varepsilon^{j}$, then $X^{L\varepsilon*} < X^{Ui*}$. That is if a member of the union faces less than the average shock that confronts the union as a whole, the optimal government spending of the country (with less than average union shock) will be less than the average union government spending. This highlights one of the benefits of common monetary rule which enforces fiscal discipline to zone members. This arises because individual countries do not have the ability to monetize debt. For the wage setters, it encourages commitment. Wage setters do not need to worry much about inflation. Consequently, their expectations on inflation rate remain low which further lowers government spending.

VI. Conclusion

We revisit the time-inconsistency problem that confronts monetary policy. Here, we examined monetary policy conducted by discretionary central banker and monetary policy under one supranational central bank. We followed other researchers by employing a theoretical game model. The model highlights the gains that can derive from joining a monetary union. This approach provides some insights pertaining to the advantages that member countries can derive as they enter into a monetary union. First, as countries enter into monetary union, the inflation rate in the zone is lower. Second, monetary union serves as a disciplinary mechanism since individual countries cannot monetize their debt. Furthermore individual country’s optimal government spending may likely be lower than union government spending. It also encourages commitment among wage setters. Hence there is greater trust between private agent and government. Third, the low government spending lowers expected inflation. This subsequently lowers inflation rate. Finally, it encourages commitment among wage setters and increase trust between private agent and government.

Appendix

Equilibrium in the money market occurred where real money supply equals money demand. Using the above concept to formulate a demand for real money balances, and in equilibrium we have

$$\frac{M}{P}^{s} = \frac{M}{P}^{d}$$

$$\ln[\frac{M_1}{P_1}] = -\rho E_1[p_2 - p_1]$$

$$m_1 - p_1 = \rho E_1[p_1 - p_2]$$

$$m_2 - p_2 = 0$$

$$m_1 - p_1 = -\rho E_1[p_2] + \rho E_1[p_1]$$

$$m_1 + \rho E_1[p_2] = p_1 + \rho E_1[p_1]$$

$$m_1 + \rho p_2 = p_1[1+\rho]$$

$$p_1 = \frac{m_1}{[1+\rho]} + \frac{\rho}{1+\rho}[p_2]$$

$$p_1 = \frac{m_1}{1+\rho} + \frac{\rho}{1+\rho}[m_2]$$

$$\pi \equiv p_2 - p_1 = m_2 - [\frac{m_1}{1+\rho} + \frac{\rho E(m_2)}{1+\rho}]$$

$$m_2 = [1+\rho]\pi + m_1$$

$$M_2 = X - T + rB - \frac{dB}{dt} + M_1$$

But

$$\pi = \frac{1}{1+\rho}\ln[\frac{\mathrm{X - T + rB} - \frac{dB}{dt} - \mathrm{M}_1}{M_1}]$$

$$\pi = \frac{X - T + rB - \frac{dB}{dt}}{M}$$

$$\pi = \frac{X - T + \Phi}{M}$$

Where, $\Phi = rB - \frac{dB}{dt}$, and $M = [1+\rho]M_1$, and $T = X - \pi M + \Phi$

It is also standard in this type of model to treat inflation as the central bank's policy instrument. With money growth rate of m, the inflation rate is given by:

$$\pi = m + v - \gamma\varepsilon$$

This implies that money growth is given by:

$$m = \pi + \gamma\varepsilon - v$$

Where m is money growth rate, v Is the control error or velocity shock, and $\gamma\varepsilon$ Is the aggregate supply shock.

The government budget constraint is given as:

$$X - T + rB = \frac{dB}{dt} + \frac{dM}{dt}$$

Where, X Government level of spending excluding interest payment on government debt, T Tax revenue, r Interest rate on government debt, $\frac{dB}{dt}$ Deficit that is finance by issuing debt, and $\frac{dM}{dt}$ Deficit that is finance by monetizing debt.

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