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Applying Taylor Rule in a Heterogeneous Currency Union: Case of UMAC

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ABSTRACT: Our objective is to show that the Taylor rule is the monetary policy practice of BEAC its effectiveness is limited due to the structural and cultural heterogeneity of the currency union. In this light, we identify the reaction function of BEAC show that it includes additional variables namly, the interest rate and inflation differential with the Euro zone, as well as the currency reserve ratio that must cover at least 20% monetary issue. Given the objectives and instruments used and the reaction function built, we estimate a forward-looking Taylor rule using the GMM, similar to the one proposed by Clarida et al. (2000) and find that the interest rate setting of BEAC could be captured using a Taylor rule. From our estimations using the we actually find that BEAC's monetary policy or more precisely its interest rate setting can be effectively captured using a modified Taylor rule taking into consideration the specificities of the monetary union and external constraint despite the heterogeneous nature of the union. As seen from the results obtained we can realize that the Central Bank mainly focuses on the fight against inflation and mainly strives at maintaining internal stability in the sub region. This fight can be deemed successful given the low inflation results that are observed in our period of study, even though it can be mitigated with the influence of the region of anchor (the Euro zone) in this stability.

KEYWORDS: Taylor rule, currency union, heterogeneous, CEMAC, Currency Union

1. INTRODUCTION

The objective of this work was to verify the effectiveness of the Taylor (1993) rule in a heterogeneous Currency Union, considering UMAC[1] as our case study. Due to numerous problems caused by discretionary monetary policies, Central bankers and scholars such as Kydland and Prescott (1977) and, Barro and Gordon (1983) proposed rules that could pin down the expectation of economic agents in order to rebuild their confidence towards monetary authorities. In an attempt to analyze one of these rules, we consider the case where it has to be applied to a currency union with heterogeneous states and cultures. For this purpose we firstly highlight the different monetary policy practices which prevailed before the coming up of the Taylor rule and even those currently implemented by Central bankers. We consecutively analyze the classical intermediate inflation targeting through the different nominal anchors, then we further appraise the fashionable direct inflation targeting and its relation with the Taylor (1993) rule.

Theoretical evidence has shown that the Taylor rule has undergone a number of mutations through the works of some authors such as Clarida et al. (1998, 2000) or Judd and Rudebusch (1998), among others. However the basic properties of the original Taylor rule have been maintained (that is the nominal, real interest rates and the output and inflation gaps). From an empirical setting, the Taylor rule has largely been used by Central Bankers in recent years and has had different fortunes. It has been used in the developed world, the emerging economies as well as in the developing countries, but there has been evidence that the rule is good at either describing the conduct of the monetary policy of Central Bankers, or permitting them to enter into a cooperative game with other economic agents in order to solve the problems of expectations and the time inconsistency difficulties.

Our objective is checking the effectiveness of the Taylor rule under a heterogeneous currency union as UMAC. Our postulate is that is the monetary policy practice of BEAC[2] its effectiveness is limited due to the structural and cultural heterogeneity of the currency. In this light, we show that BEAC includes additional variables in its reaction function. These include the interest rate and inflation differential with the Euro zone, as well as the currency reserve ratio that must cover at least 20% monetary issue. Given the objectives and instruments used, we build the reaction function and estimate a forward-looking Taylor rule using the GMM,

[1] UMAC : Union Monetaire de l'Afrique Centrale

[2] BEAC: Banque des Etats de l'Afrique Centrale

similar to the one proposed by Clarida et al. (2000) and found that the interest rate setting of BEAC could be captured using a Taylor rule.

We estimate the fixed effects across countries and our results show that due to a high degree of heterogeneity, countries react diversely to interest rate targets. The interest rate smoothing coefficient estimated shows that, whenever an interest rate target is set, Gabon and the Central African Republic (CAR) react very highly to the slightest change comparatively to Congo or Cameroon. This proves therefore that countries respond asymmetrically to any interest rate chock because, while the chosen rate will be adapted to some countries leading to minimized inflation and output gaps, in other countries, the gaps widen. This illustration has shown that the traditional forward looking Taylor rule is not adapted in a heterogeneous monetary union as UMAC.

We estimated the fixed effects and our results show that there is a high degree of heterogeneity. The interest rate smoothing coefficient estimated shows that, when the interest rate is set at any given level for instance, Gabon and the CAR react very highly to the slightest change comparatively to Congo or Cameroon. This proves therefore that countries respond asymmetrically to any interest rate chock because, when BEAC sets a single interest rate that must be applied to all the countries of the sub region, this interest rate will be adapted to some countries and the inflation and output gaps will be minimized while for other countries the gap will widen. This illustration has shown that the traditional forward looking Taylor rule is not adapted in a heterogeneous monetary union as UMAC. However, we try a proposal of a more adapted rule which is not consistent with theory but is more robust and fits the sub region in a better way.

We proceed in the next section by giving a the overall evolution of monetary policy practice, both theoretically and institutionally, before presenting the data and methodology used in this work in section 3, while results and their discussions are given in section 4, and section 5 concludes the work.

2. INSTITUTIONAL AND THEORETICAL CHANGES IN MONETARY POLICY PRACTICE

Historically, Central Banks have used a nominal anchor to have a reliable unit of account. The main nominal anchor then was the gold standard or pegging the domestic currency to another strong currency, but the collapse of the Bretton Woods system of fixed exchange rates in the 1970s, combined with high inflation, led to a search for new anchors, notably monetary aggregates.

In the late 1960s, economists were in support of policies that are focused towards obtaining an output close to its full employment level at all times due to the existence of long run trade-off between inflation and unemployment (Phillips, 1958; Samuelson and Solow, 1960). According to advocates of this view, the monetary authorities could maintain a permanently low rate of unemployment by accepting some degree of inflation, and vice versa. However, Friedman (1968) and Phelps (1968) independently refuted this activist monetary policy supporters' point of view by arguing that, there is no long-term tradeoff between inflation and unemployment and they showed that the monetary policy makers face a long run Phillips curve that is vertical.

Indeed, the most severe recessions of the postwar period were experienced in 1973-74 and 1981-82, and the prevailing high levels of inflation confirmed this point of view. As a result, during the 1980s, monetarism became the principal monetary policy orthodoxy and Central Banks main aim was to control prices through money supply. This is because in the short term, higher prices could affect the production level, growth as well as unemployment. In the long term, due to the adaptive expectations of agents, they will want to regain their purchasing power and as such, will push their employers to bring back their wages to a corresponding level; consequently, output and unemployment will come back to its natural level (Friedman, 1968). The end result being higher inflation in the long term, with unemployment and output remain around their natural levels. This shows that « benefits » of expansionary policies (such as lower unemployment) are largely transitory, while the « cost » of such policies (such as inefficiencies in linked to higher inflation) tends to be permanent in nature. For these reasons and more, monetary authorities continuously develop strategies in order to control this long run inflation level.

Some studies such as those of McCandless and Weber (1995) followed by those of King (2000) show that there exist a correlation between an increase in money supply and an increase in inflation; De Gravwe and Polan (2005) try to verify if inflation is always a monetary phenomenon and they demonstrate this assertion at different levels[3]. Following this main reason, most if not all Central Banks embark on controlling the amount of money in circulation. These elements are outlined in different works with theoretical and empirical evidence, moving from traditional inflation targeting to modern forward and backward looking methods used by most Central Banks (Mishkin; 2009a, 2011).

2.1. Traditional intermediate inflation targeting

It is the responsibility of the Central Bank to establish and maintain a nominal anchor for the economy. This can generally take two forms: quantity-based nominal anchor and price-based nominal anchor. The final target for these sets of anchors is the

[3] They show that there exist a difference between highly inflationist countries and those responding less to quantitative pressures of money. This absence of proportionality is simply because the velocity of circulation varies from one country to the other.

inflation rate, but to attain them, we can either use a quantitative intermediate target concerned with money supply, or a price-based intermediate target, namely, the exchange rate and the interest rate.

a) Exchange rate anchor

Exchange rate anchor formerly dubbed "international monetarism" anchors the domestic inflation rate to that of a trading partner country and it could be adjusted based on some predetermined scale to affect their inflation differential (Corden, 1990). Despite the fact that this type of monetary policy framework is not very popular in recent literature, it has been revealed that 46.6% of IMF members practice exchange rate anchor as compared to 13.1% and 17.8% for monetary targeting and inflation targeting respectively[4]. Using exchange rates as nominal anchor for a country or group of countries restrains the monetary authority in practicing inflationary policies in order to send a credible signal to economic agents about inflation prospects. In this situation, it is the exchange rate that leads, that is the domestic country's currency is fixed to that of a low inflation country (usually Germany or the United States); this is why Dollarization[5] is still very high in such contexts.

This has taken the form of different types of monetary regimes including: fixed peg, crawling peg and managed float amongst others (Keller and Richardson, 2003). This monetary policy regime has a set of advantages but has numerous drawbacks, as we shall respectively see in the following paragraphs.

Dornbusch (1986), Yeager (1981), Dornbusch and Fischer (1986), Bruno et al. (1988) and Bruno (1991) showed that in almost all hyperinflation stabilization attempts, the use of exchange rates was highly successful due to the rapid effects it had in curbing inflation. Fischer (1986) investigated to find out whether a choice of exchange rates as a nominal anchor was reasonable by examining the case of a small open economy with a perfect mobility of capital and wage contracts set for one or two periods, thus explicitly bringing in some nominal stickiness. His model assumes rational expectations and that any change in policy will be instantaneously credible. He compares monetary anchor to exchange rate anchor in terms of the ratio of total loss of output to the fall in inflation rate over two periods to have the sacrifice ratio and he concludes that despite some exceptional cases, the exchange rate stabilization is less costly. He shows that for the same drop in inflation, there is a smaller fall in the quantity of money under reduced exchange rates adjustments than under a monetary option with a flexible exchange rate. This means that under exchange rate stabilization, with the smaller reduction in the quantity of money, given wage stickiness, output loss is smaller. However, Fischer shows that under a zero interest elasticity of the demand of money, exchange rate stabilization produces a higher sacrifice ratio than money growth stabilization.

Similar to Fischer's (1986) model, Howitt (1987) discusses an optimal disinflation policy of the Central Bank under two assumptions on wage stickiness that is a backward looking stickiness under a dynamic Phillips curve and a forward-looking stickiness arising from the lack of credibility. Under this model, the Central Bank is presumed to maximize an infinite sum of squared output and inflation terms. Under backwards stickiness, the optimal speed of disinflation becomes an increasing function of the weight attached to inflation of the objective function and the slope of the Phillips curve. He showed that a monotonic reduction of monetary expansion is not generally optimal. In addition, a similar result was found for forward looking stickiness resulting from lack of credibility, as private agents are not aware that the government has no tolerance of inflation. The speed of disinflation therefore depends on a variance ratio that measures the severity of the Central Bank's credibility.

The problem of credibility is a call for concern in countries with relatively "soft" governments where there could be a tendency for the government to influence the Central Bank to operate activist monetary policies in times of election without considering the future disequilibrium that could be caused by the consequent inflation. This situation encourages these governments to attach themselves to "strong" governments' conservative[6] Central Banks through a fixed exchange rate. Inflation prone countries such as France and Italy adopted this strategy in the 80s by tying their currency to the Deutsch Mark (Giavazzi and Giovannini, 1989, Bruno, 1991, Ftiti, 2010) and they were able to maintain a low inflation rate around 3% while the United Kingdom had a two-figure inflation rate within the same period. The entry of the United Kingdom in this European Monetary System in October 1990 made its inflation rate to drop from 10% to 3% in 1992.

Usually, the problem of credibility of Central Banks lies on the fact that other economic agents do not really believe when the monetary authority makes announcements and, even if it undertakes some measures, there is still doubt about their persistence. For this reason, it is usually asserted without any formal justification that the benefit of an exchange-rate anchor is its visibility, because everyone can easily observe it due to its simplicity and clarity (Mishkin, 1999). Bruno (1991) argues that exchange rate anchor has a great stabilizing effect as it can be observed on a daily basis while Persons and Tabellini (1994) say this will permit

[4]IMF Annual report on exchange rate arrangement for 2014.

[5]Most credits and loans and other transactions are denominated in Dollars.

[6]This is the case of Germany where the fight against inflation is a key element for the country and low infltion objective is even mentioned in their constitution.

the private sector directly monitor broken promises of the Central Bank. It is in this light that Keller and Richardson (2003) build a model to analyze the credibility and the visibility of actions of the Central Bank. This model relies on two assumptions: firstly, they assume that information on the Central Bank's actions is incomplete and the public is not sure of its true preferences, as a result, they try to predict these by using information from monetary authorities' past actions. Secondly, they assume that even if the authorities' actions were complete, the public cannot efficiently observe it and they will rather rely on noisy proxies of these actions. They conclude that, the Central Bank cannot convince the public by simply proclaiming that it is determined to reduce inflation. It must instead demonstrate its will with actions rather than announcements, and a commitment to a nominal anchor, such as a fixed exchange rate is one such action since this sends signals to the public that the government is willing to submit its actions to close scrutiny. This is simply because the public can easily detect changes in exchange rates whereas changes in the monetary base will only be detected after months (Keller and Richardson, 2003).

Despite these positive effects of exchange rate nominal anchor, several drawbacks could discourage Central Banks in using this as a monetary policy strategy. The exchange rate of any country just as the price of any other commodity must be realistic and adapted to the real value of the commodity in question. If this basic condition is not fulfilled, there shall be serious economic consequences just as what was seen during the 1980 debt crisis. The market condition must be considered because if a currency is overvalued for instance, it may lead to domestic currency flight and the development of parallel currency market that will be difficult to control by the Central Bank.

Many authors (Mishkin, 1999; Croce and Khan, 2000) have identified the different difficulties economies could face when practicing exchange rate nominal anchor. Even though inflation was successfully controlled in the 1980s by exchange rate anchor, this was for a short period. Undesirable effects of this policy could be felt, as chocks in the country on whose currency has been pegged could be imported. This was the case in Germany in 1992 where high interest rates experienced due to reunification of Eastern and Western Germany were exported to countries such as France, Italy, and England amongst others. The continuous adherence of these countries to fixed exchange rates significantly slowed down economic growth and consequently increased unemployment. Even though exchange rate anchor was successful in stabilizing inflation in most emerging countries, it becomes very risky for the economy due to movements of the capital market. In fact, disequilibrium experienced in the exchange position generally calls for devaluation. When agents on the financial market foresee this, they react through speculative attacks leading to severe financial crisis (Mishkin, 1999).

Given the above facts, many countries practicing an exchange rate target have progressively adopted new strategies such as currency boards (Argentina) or simply letting the currency to float freely. Currency boards have the advantage of easily curbing inflation but are also problematic as under this regime, the Central Bank does not have an independent monetary policy hence, it cannot intervene as lender of last resort thereby exposing the economy to a banking crisis, as was the case in Argentina in 2002. Adopting a floating exchange rate gives the Central Bank a certain degree of autonomy but it also causes the problems of credibility and the high exposure of the economy to external chocks. This therefore suggests that exchange rate can be used as anchor in the early stages of sharp stabilization but once credibility has been developed, the Central Bank should move towards a flexible exchange rate in order to moderate capital movements and provide a more active role for monetary policy. Therefore, despite the stabilizing effects exchange rate anchor on inflation, this cannot hold for the long term and this practice entails a lot of external constraints and risks. When external real shocks are predominant, it is not so important trying to establish a credible policy with the use of exchange rate anchor. In this case, a floating exchange rate is more adapted and this gives room for an autonomous monetary policy that usually takes the form of manipulating monetary aggregates.

b) Monetary targeting

Setting aside the disadvantages of using the exchange rate as nominal anchor, it will still be difficult for some countries or group of countries to implement this policy strategy due to their size, which prohibits them from having another currency apart from theirs on which they could have an anchor. In addition, for strategic reasons, some countries may prefer not to peg their currencies to other currencies. This justifies why exchange rate targeting cannot be an option for countries like the United States, Japan or even the European Monetary Union. The numerous problems caused by exchange rate anchor naturally call for alternative strategies amongst which monetary targeting. This policy framework consists of using monetary aggregates as an intermediary objective in order to attain the final objective of price stability. This follows the Monetarist point of view[7] which underlines the importance of money supply in influencing short term nominal GDP, as well as the long term general price level. Given that one of the main problems posed by exchange rate anchor was the control of long-term inflation, Friedman proposed this as an alternative strategy to obtain long-run price stability by showing that changes in nominal income were irrefutably linked, if not

[7] The founder of this school of thought is Milton Friedman (1968) who highlighted the fact that « inflation is always and everywhere a monetary phenomenom »

proportional[8], to changes in the money supply. Following a monetary policy with the use of monetary aggregates as intermediary target means that, the Central Bank will first determine the final inflation target and then increase money supply with respect to economic growth in order to attain this.

It is advantageous to use monetary aggregates because contrary to an exchange rate anchor, the Central Bank can freely define its monetary policy, sets its own inflation target that may be different from those of other countries and be able to adjust its policy to impact on output in case of any domestic chock (Mishkin, 1999). This means that monetary aggregates permit the Central bank to have an autonomous monetary policy, define its own objectives and intervene in other secondary objectives such as stabilizing economic activity. The frequent information that follows this strategy concerning monetary aggregates gives sufficient knowledge to the public as well as markets about the Central bank's monetary policy. This then makes the policymakers to be immediately accountable and not be time inconsistent. However, all these advantages of monetary targeting and any monetary policy strategy strongly depend on two conditions: a strong and reliable relationship between the target variable and the anchor and solid relationship between the targeted aggregate and the monetary policy instruments.

In fact, the monetarists' vision of monetary policy is demonstrated with the use of the Quantity Theory of Money (QTM), which stipulates that money supply must increase at the same rate with growth in production in order to stabilize prices. In fact maintaining price stability entails a proportionate increase of money supply and real growth rate, hence, the Central Bank does not have direct control on money supply. This suggests that the velocity of circulation must be very stable for a successful monetary targeting (Mishkin, 1999). In order to have a durable anchor for low inflation anticipation, other variables (GDP growth or its fluctuation) must guide the monetary authority's decisions, considering the observable instability of the velocity of circulation. In the 1980s the United States, Canada and the United Kingdom abandoned monetary targeting because it was not successful in controlling inflation. In fact, the relationship between monetary aggregates and inflation and nominal income had broken down because monetary targeting was not pursued seriously (Mishkin, 1999) and the velocity of circulation became very instable.

However, monetary targeting has been very successful in controlling inflation in some countries such as Germany and Switzerland. In fact, from potential output growth and velocity trends, a quantity-equation framework is used to back out the target growth rate for the monetary aggregate as shown by Neumann and von Hagen (1993), Bernanke and Mishkin (1992), Bernanke et al. (1999). Added to this, monetary targeting far from being rigid has been quite flexible in practice and there was a lot of communication and a high degree of transparency. This success has surely led to the existence of strong advocates of this policy regime and its use in the European Central Bank the official regime today (Mishkin, 1999).

The Central bank should equally be capable of controlling monetary aggregates well so that it will give out clear signals and be easily accountable. This is because, the relative ease in controlling M1, it is more complex for the other components of monetary aggregates (M2 and M3). The choice of the components of the monetary aggregates to be used as target is problematic due to the difficulty faced in determining the monetary aggregate to be used. By choosing narrow monetary aggregates (i.e. M1 and M2), prices of certain assets playing a key role on price stability may not be accounted for, but considering broad monetary aggregates (M3) permits the anchor variable to contain many assets valued at market prices, which are difficult to control (Ftiti, 2010). Due to perfect mobility of capital, monetary authorities find it difficult to identify the quantity of money in circulation making such policies to fail (Clarida and Gertler, 1997, Mishkin, 1999).

We notice from the above that monetary targeting has been able to solve the problem of long-term inflation control even though Germany and Switzerland did not follow a strict rule. Despite the fact that these countries did not apply this policy as Friedman advocated, they prepared the road for a new policy regime as the put the basis for direct inflation targeting by applying a "hybrid inflation targeting" with the use of key elements such as flexibility, transparency and accountability (Mishkin, 1999).

c) Taylor rule and direct inflation targeting

In the years leading up to Taylor's 1993 paper, various institutional and procedural transformations were creating a new policy-making environment and culture in the US and other countries. Due to the progressive breakdown of the relationship between monetary aggregates and inflation, scholars and central bankers they have continuously strived towards other frameworks for monetary policy. The two current "competing" frameworks are used in recent economics literature, for monetary policymaking: *instrument rules* and *targeting rules* (Svensson, 2003; McCallum and Nelson, 2005; Svensson, 2004b)[9]. Bernanke (2004) refers to these frameworks as *simple feedback policies* and *forecast-based policies* in order to avoid the connotations of the term "rule", which may suggests a rigid and mechanical policy prescription. The debate concerning these frameworks is based on how the monetary authority should formulate and implement his monetary policy in order to better attain the objectives of price stability

[8]Mentioned in Keller and Richardson (2003).

[9]See Bernanke, 2004

and full employment over time. The main difficulties to be dealt with, concern informational constrains and pinning down expectations (Bernanke, 2004). This is because it is very difficult to collect economic data without errors, added to the fact that most of this data becomes available with a lag, and Central Bank's interest rates do not measure the policy stimulus perfectly, as most of economic agents' decisions on long-term rates depend rather than short term rates.

Despite the difficulties, rules as opposed to discretion help policymakers to solve the credibility and time inconsistency problems (Kydland and Prescott, 1977; Barro and Gordon, 1983) and we are interested in knowing which type of rule is more adapted. There is a hence need for policymakers to stick to long-term goals so that they will not be tempted to deviate from them and take advantage of its benefits in the short run to the detriment of the long run. We are mainly concerned in analyzing simple feedback policies or instrument rules (particularly the Taylor rule), therefore, we shall first focus on the relevant literature concerning the Taylor rule then highlight its differences as compared to forecast-based policy.

2.2. Development of the Taylor rule

Policymakers just as individuals need to stick to a goal that requires a long-term commitment, which generally takes the form of a rule that will help them stay firm whenever they are tempted to deviate from it and gain something good in the short run. In the new monetary policy paradigm, interest rate is the main monetary policy instrument used by the Central Bank and Taylor rule permits the monetary authorities to commit themselves to a strict way of determining this interest rate. According to Jenifer Smith, "Taylor's rule is a formula designed to provide 'recommendations' for how a central bank should set short-term interest rates to achieve both its short-run goal for stabilizing the economy and its long-run goal for inflation". From a descriptive point of view, the Taylor rule is often used to study the behavior of a Central Bank in conducting monetary policy. The modeling of the reaction function of Central Banks permits them to have a more effective and robust monetary policy, making their actions more stable. It also helps other economic agents to understand the actions of monetary authorities on one hand and to anticipate temporal changes in short-term interest rates on the other hand.

a) Theoretical evolution

Taylor (1993) demonstrated that a simple reaction function with a policy instrument responds to movements of a relatively small number of macroeconomic variables. These variables can either be directly observed (such as employment and inflation) or estimated from current information (such as the economy's full employment level of output). He found out that this rule closely followed the observed path of the US economy between 1987 and 1992. Taylor rule has four components, that is, the Fed's long-term inflation target, the "natural" real federal funds interest rate as well as current or observed inflation and output. This is an interest rate rule that takes the form:

$$-\boldsymbol{i(t)} = \boldsymbol{r^*} + \boldsymbol{\pi^*} + \boldsymbol{\alpha}\,(\boldsymbol{\pi^t} - \boldsymbol{\pi^*}) + \boldsymbol{\beta}\,(\boldsymbol{Y(t)} - \boldsymbol{Y^*}) \qquad (\mathbf{1})$$

Where: i is the Central Bank's short term nominal interest rate, $\boldsymbol{r^*}$ the equilibrium short term interest rate, $\boldsymbol{\pi^*}$ the inflation target, $\boldsymbol{\pi^t}$ the current inflation rate, $Y(t)$ the real GDP $\boldsymbol{Y^*}$ potential GDP and α, β the reaction coefficients where $\alpha, \beta > 0$.

Taylor (1993) establishes this rule with the aim of bringing up a simple and easily understandable model, which could give results comparable to those got from simulations using many other models. He did not econometrically estimate this model but simply attributed some values to the parameters that he assumed could broadly describe the Fed's behavior during its glorious days of Allan Greenspan between 1987 and 1992. He did not intend to fully describe the behavior of the Central Bank, but simply give a normative recommendation on the way in which the interest rate had to be modified. Taylor (1993) attributes the values 0.5 to both $\alpha \; and \; \beta$ and this could still be written differently by replacing the nominal interest rate with the real rate and the parameters $\alpha \; and \; \beta$ shall be $\alpha = 1.5 \; and \; \beta = 0.5$:

$$\boldsymbol{i(t)} = \boldsymbol{i^*} + \mathbf{0.5}(\boldsymbol{\pi^t} - \boldsymbol{\pi^*}) + \mathbf{0.5}(\boldsymbol{y^t} - \boldsymbol{y^*}) \qquad \textbf{(2)}$$

Or $\boldsymbol{i(t)} = \boldsymbol{r^*} + \boldsymbol{\pi^*} + \mathbf{1.5}(\boldsymbol{\pi^t} - \boldsymbol{\pi^*}) + \mathbf{0.5}(\boldsymbol{y^t} - \boldsymbol{y^*}) \qquad \textbf{(3)}$

With $\boldsymbol{i^*}$ the real interest rate equals to $\boldsymbol{r^* + \pi^*}$.

In this same spirit, Nelson (2000) found similar coefficients to those found by Taylor with $1.3 \; and \; 0.5$ during the period 1992-97 even though the coefficients were very different for previous years, with coefficients on inflation much lower than 1 and varying output gap responses. Taylor (1999) equally gives an alternative to his 1993 rule, by attributing a greater weight to the output gap (that is a value of 1 rather than $0.5 \; to \; \beta$) but leaves the rest of the 1993 relation unchanged. According to him, it better describes the FOMC's response to economic conditions and he is supported by Yellen (2012) who demonstrates that the Taylor (1999) better matches the optimal control path if the Federal Funds Rate than the Taylor 1993 rule.

This rule has a stabilization role on both inflation and output as it prescribes that the Central Bank should "lean against the wind" when setting interest rates; that is, when current output is higher than its potential level (an overheated economy), the Central Bank must raise interest rates to stabilize the economy, vice versa. The same process must be followed when inflation is higher than its long-term target, but in this case, the nominal interest rate should be raised more than proportionately, meaning, the real

interest rate should be made higher than the natural rate whenever inflation is above the target. It should be noted that unless the long-run coefficient of inflation is above 1, the Central Bank will not attain its inflation target on average. This is called the "Taylor principle" (Carlstrum and Fuerst, 2003). In simple terms, considering Taylor (1993), this rule says that the nominal funds rate should be set at 2%[10] plus 0.5 times the deviation of inflation from its target, plus 0.5 times the output gap.

Taylor rule has however faced some criticisms because despite its apparent simplicity, it is usually difficult to estimate potential output and the real equilibrium interest rate (Jamie and Côté, 2000). In addition, there is a problem of stationarity as the results obtained with data used by authorities when they put in place the policy are usually different from those obtained after the data has been revised (Orphanides, 1998; Evans, 1998). As reported by some authors, Clarida et al. (1998, 2000), Judd and Rudebusch (1998), among others, estimated reaction functions for the recent period tend to show an aggressive response to deviations of inflation from some target value and a significantly smaller response to stabilization of the economic activity.

However, some answers and contributions to these criticisms have led to a number of modifications on the original Taylor rule in order to make it more appropriate and realistic. Some of these modifications describing the US monetary policy for the same period, that is, between the late 1980s and the early 1990s are presented in Table 1 below.

Table 1. Short List of Proposed Rules for the U.S. Data

Paper	Rule
1. Taylor (1993)	$i_t = 1.00 + 1.50\pi_t + 0.50y_t$
2. Clarida, Gali, and Gertler (2000)	$i_t = 0.79i_{t-1} + 0.21(r^* - 4.12 + 2.15E_t\pi_{t+1} + 0.93E_t y_{t+1})$
3. Orphanides (2001)	$i_t = 0.66i_{t-1} + 0.34(1.80 + 1.64E_t\pi_{t+4} + 0.97E_t y_{t+4})$
4. Ball and Tchaidze (2002)	$i_t = 1.47 + 1.54\pi_t - 1.67(u_t - u_t^*)$
5. Orphanides and Williams (2003)	$i_t = 0.72i_{t-1} + 0.28(r^* + 1.26\pi_t - 1.83(u_t - u^*) - 2.39(u_t - u_{t-1}))$

Source: Carare and Tchaidze (2005)

Besides the ease with which the Taylor rule represents a complex process with a small number of parameters, a number of studies for the US have shown that, it sufficiently describes how monetary policy has been conducted within the period studied. It has been shown that the Taylor (1993) rule actually tracts broadly the movements of the Fed's funds rate even though we can equally discover a good number of large and persistent misses. However, according to proponents of the rule, these misses are normal because Taylor rule was not designed to be followed mechanically but it was simply designed to serve as a guideline for monetary policy.

McCallum (1999a) assumed that, given the delay that occurs in policy response and considering that, it is not possible to have all the output and inflation data of the period within which the policy is being undertaken, it is more realistic to introduce lags. There has been equally the introduction of forward-looking behavior making short-term interest rates a function of the predicted output gap and inflation instead of their contemporary values. Other authors such as Clarida et al. (1998, 2000), Judd and Rudebusch (1998) and Kahn (2012) have attempted to fit the Taylor rule to real time data by using formal econometric approaches for interest rate-smoothing behavior (including a lagged short-term interest rate among the fundamentals). This is the single most popular modification of the Taylor rule and although the necessity of including an interest rate-smoothing term has not yet been proven theoretically, it seems rather intuitive for a number of reasons[11]. In this same light of estimating forward-looking Taylor rules, Coibion and Gorodnichenko (2011) have estimated forward-looking interest rate rules for the Fed to test the hypothesis of interest rate smoothing versus persistent shocks based on the Greenbook data set and on the Survey of Professional Forecasters (SPF) and their results show that the Fed practices interest rate smoothing[12].

Taylor (1999) and Orphanides and Williams (2003) show that as it is not possible for the traditional Taylor rule to account for all the factors affecting the economy due to reactions of policymakers to other movements such as the exchange rate, stock market and political developments, etc. Orphanides and Williams (2003) introduce a new variable which they call a policy shock variable, reflecting the judgmental element of the policymaking process. They suggest the use of unemployment gap as opposed to output gap, in order to improve the fit of the data, as suggested by Okun's (1962) law, which links the output gap and the unemployment gap. This type of rule tends to perform quite well in terms of stabilizing economic fluctuations, at least when natural rates of interest and unemployment are accurately measured.

[10]Taylor (1993) set the natural interest rate at 2% and the inflation target of the FOMC was equally 2%.

[11]See AlinaCarare and Robert Tchaidze (2005)

[12] See Nikolay Markov and Thomas Nitschka (2013)

Recently, there have been investigations on a potential non-linearity of Taylor rule. Gerlach and Lewis (2010) have estimated gradual regime switching Taylor rules for the ECB based on a Logistic Smooth Transition Regression (LSTR) methodology, where they found that there existed nonlinearities in the Taylor rule. In addition, following this reasoning, Owyang and Ramey (2004), Sims and Zha (2006), Assenmacher-Wesche (2006), Alcidi, Flamini and Fracasso (2011) have found nonlinearities in the Taylor rules of other Central Banks and for different periods. Kahn (2012) and Taylor (2014) show the use of policy rules is undoubtedly very important for the practice of monetary policy and they argue more attention must be paid to rules such as the Taylor rule. For Taylor (2014), the Fed practiced Taylor rule until around 2003 and from 2003 to 2006, a discretionary policy has been practiced and this must surely be one of the causes of the 2007 financial crisis. It is in this light that Kahn (2012) proposed that, during periods when both output and inflation are stable, reaction functions had to be estimated in order to guide policymakers' response to incoming data on output and inflation.

DamjanPfajfar and BlazZakelj (2015) study the effectiveness of an alternative monetary policy design in the case where there are deviations from inflation expectation from agents as well as deviations of current inflation from the target. Taylor-type rules are modified to respond to these two types of deviations. According to them when expectation formation is not perfectly rational, a forward-looking Taylor rule with a reaction coefficient of 4 where they find that it gives lower inflation variability as compared to that of 1.5 *or* 1.35. They find that instrumental rules that are less aggressive are more vulnerable to the emergence of potentially destabilizing forecasting mechanisms. A number of researchers amongst which Svensson (2003) are skeptical about the effective use of the Taylor rule and consequently advocate for an alternative rule for monetary policy. However, McCallum and Nelson (2005) as well as other proponents of the Taylor rule relentlessly defend the rule, as we shall see in the next paragraph.

b) Targeting versus instrument rules

Svensson (2003) highlights a number of reasons why he claims that targeting rules are superior to instrument rules in attaining monetary policy objective. According to Svensson, policy is not well defined by Taylor rule (an instrument rule) and policymakers should not follow it. He argues that commitment to a general targeting rule, which amounts to a commitment to a specified objective function and specific targeting rules amounting to first-order conditions are better than instrument rules for the conduct of monetary policy. He shows that as there is a lag between monetary policy actions and its impact on the Central Bank's target variable, monetary policy is more effective if it is guided by forecasts (Svensson, 2010). Policymakers should hence predict how the economy is likely to respond in the medium term to alternative plans for monetary policy and work at stabilizing inflation around a given target. This means that policymakers should take into consideration each policy plan and try to guess how the economy will evolve and equally assess the likelihood of other outcomes different from the principal scenario in case this plan is implemented. He defends his point of view with a number of criticism which he thinks shows "what is wrong with Taylor's rule". However, his points do not distract McCallum and Nelson who consider that the description made by svensson is inaccurate. They consequently bring forth points, which according to them justify the use of Taylor rule.

An instrument rule is an explicit formula for setting a controllable instrument variable (for example the interest rate) in response to variable that are currently observed (McCallum and Nelson 2005). Here, the instrument is closely linked to the behavior of variables that can either be observed or estimated. These variables usually reflect the objectives of the Central Bank and the policy instrument is adjusted in order to keep the variables at their desired level. A good example of such rules is the Taylor (1993) rule. However, Svensson (2003) argues that, simple instrument rules do not describe monetary policy adequately especially targeting rules. For him, these rules are simply guidelines and are too vague to be operational so it is not advisable to use it in describing monetary policy. He goes on by bringing forth some 'objections' that he thinks could be raised against instrument rules.

The first objection brought forth by Svensson is that a Taylor uses only two variables namely output gap and inflation, it will not be optimal to use this rule because other state variables such as real exchange rates, terms of trade, foreign output and foreign interest rates etc. are left out. So according to him, simple instrument rules do not contain all relevant variables so there is a problem of specification seriously reducing optimality, this is why they are not adapted for a small open economy. According to Ball (1999), adding the exchange rate to Taylor rule would add stabilizing properties in the case of a small open economy. But McCallum and Nelson (2005) counter these by arguing that the variables left out may not be important this is why in the case of a small open economy, Clarida et al. (2001) as well as McCallum and Nelson (1999a, 2000b) showed that an open economy, a model can also be formulated using only two variables as Taylor did.

Secondly, according to Svensson (2003), "A second problem, is that a commitment to an instrument rule does not leave any room for judgmental adjustments and extra-model information…" He argues that as the coefficients are given, all the duty of the Central Bank will be to in order to set interest rates will be simply to measure inflation and output gap every period. But, McCallum and Nelson (2005) reject this point of view by saying there is sufficient scope for adjustments when the need arises as the policy maker could deviate from the original rule by either setting above (or below) the rule. However, Svensson (2005) in answering to

McCallum and Nelson (2005) critics say that it is contradictory considering the spirit of 'policy rules', which is to depart from discretionary policies. For him, McCallum and Nelson (2005) seem to say that commitment to a rule could be consistent with discretionary adjustments, which is contradictory.

The third objection of objection Svensson brings forth is that if any central Bank commits to an instrument rule, there will not be any possibilities to react to a chock or any new information about transmission mechanisms. McCallum and Nelson (2005) as well as Taylor (1999, 2012, 2014) rather claim that the formula is not designed to commit to it mechanically but rather it is just a procedure that has to be followed so there must rather be commitment to a framework.

Svensson goes further to say that there has not been any Central Bank which has committed to an instrument rule because had it been the case, they would have announced publicly or published Taylor rule coefficients, output gap as well as inflation to gain more credibility. However, McCallum and Nelson (2005) reject this point of view by arguing that no Central bank has equally committed to an explicit objective function. They say if it were the case, deviations from the coefficient of the output gap would have been announced as well as the specified model used by the Central bank.

These and more points have been brought for the by Svensson (2003) countered by McCallum Nelson (2005), some of which include: the fact that instrument rules do not fit Central Banks behavior well and those of them known to follow inflation targeting have procedures which are more characterized by targeting rule than instrument rule. However, Svensson (2005) comes up again to show "what is wrong with McCallum and Nelson by defending his previous point of view and highlighting what he thinks is not logical with McCallum and Nelson (2005) points[13].

Nevertheless, Bernanke (2004) thinks that the best policy should be that which better solves the problem of informational limitations faced by policymakers and the need to account for private sector expectations.

3. EMPIRICAL JUSTIFICATION

Generally, when we establish a rule it is important to know the exceptions that exist to that rule. The Taylor rule does not depart from this reasoning, but here, we are interested in knowing whether it applies to every country or Central Bank and if yes, the way it applies to each country. This rule as any other theoretical developments would only be sufficiently consistent when it has been empirically tested and the results obtained show a good degree of robustness in the properties of the theory. It is no secret that the Taylor rule has seriously influenced theoretical debates on monetary policy within the last two decades. But has this rule been so influential as far as the practice of monetary policy is concerned? We think the answer to this question is 'yes' given the good number of reports of monetary policy meetings that mention this fact[14]. Asso et al. (2010) even think that "the Taylor rule have revolutionized the way many policy makers at Central Banks think about monetary policy". Martin (2014) recently noted that "since late 2008, the Taylor rule has prescribed a zero nominal interest rate, which coincides with the policy rate set by the FOMC". From different empirical works, we can note that the Taylor rule has actually been used either by Central Banks or by scholars to capture the behavior of the monetary authorities in a number of developed and developing countries. The particularity of these cases is that the Central Banks were those of single countries and most of these countries were under a floating exchange rate regime. The Franc zone is specific with regard to the above characteristics. In fact, it is divided into currency unions, which all have distinct monetary policies tilted towards the satisfaction of interest of member states. Nevertheless there exists a fixed exchange rate regime with the Euro area (formerly France) and some accords have been signed to assure a smooth and coherent monetary cooperation between France and its former colonies. This is why the Central banks of the main currency unions are faced with constraints that they have to respect while conducting their monetary policy. Our concern here is to know whether these Bank's policies could equally be understood using the Taylor rule and how their reaction functions may look like when estimated using the Taylor rule. We shall therefore consecutively examine the empirical evidence that the Taylor rule has actually been used or could be used in either the estimation of the nominal interest rates or in understanding the policies of these monetary entities in the UEMOA and CEMAC.

a) Monetary policy reaction functions in the BCEAO Franc zone.

For the BCEAO, monetary aggregates are the main instrument that it uses to attain its objectives. It indirectly manages the money supply using short term interest rate as its main policy instrument. Tenou (2002) used a rule to estimate a reaction function, which

[13]There are more developments about this part in Svensson (2005) and Jenifer Smith's notes on Policy reaction functions : inflation forcast targeting and Taylor rule.

[14] For example Governor Janet Yellen's remarks at the FOMC of January 1995 saying: «It seems to me that a reaction function in which the real funds rate changes by roughly equal amounts in response to deviations of inflation from a target of 2 percent and to deviations of actual from potential output describes reasonably well what this committee has done since 1986. … If we wanted a rule I think the Greenspan Fed has done very well following such a rule, and I think that is what sensible central banks do."

permits to understand the setting of the interest rule and its evolution in UEMOA. The specific rule that he uses is the Taylor rule and it is applied both for quarterly and yearly data for his estimations. His first estimates are done on yearly data between 1970 and 1999, where his results show that the Taylor rule describes in an adequate way Central Bank's interest rate between 1987 and 1999. He equally uses quarterly data to show how compatible his results were and he finds that between 1991 and 1999 the interest rate is relatively well explained by the reaction function and according to him, the results obtained show that fundamental economic variables played an important role in the conduct of monetary policy after the devaluation of the CFAF. He concludes that despite the good econometric results, the Taylor rule should not be used mechanically, but should nevertheless be used as a reference or an additional element that the Central Bank has to take into consideration when taking its decision.

Bationo (2013) undertook some studies for the BCEAO to estimate its reaction function in order to know the importance attributed to price stabilization as well as output growth by the monetary authorities. The objective of his study is to estimate a reaction function using an "augmented Taylor rule containing the main variable Targeted by BCEAO. This rule is particular because the fixed exchange rate of the sub region adds an additional constraint that the Central Bank must take into consideration when undertaking it monetary policy namely the exchange reserves coefficient. The data used is annual time series between 1970 and 2011 and the method used is the Generalized Moment Method where the Johansen co-integration test is used to see the long run relationship between the interest rate and its explanatory variables. This estimation is done within two periods: first the whole series (1970-2011) then a shorter series to take into considerations the policy reforms undertake in 1990 by the BCEAO (i.e. 1990-2011). The results obtained in the first estimation show that the fixing of the interest rate largely takes into consideration the exchange reserves meaning before the 1990 reforms constituting currency reserves was very important for the Central Bank. However he equally finds that the results of the second estimation of the sub sample (1990-2011) show that the monetary authorities gave much importance to inflation as well as output stabilization. This means that added to the currency reserves the BCEAO had to constitute, the Taylor rule equally shows that the fight against inflation and the minimization of the output gap or striving towards increasing economic growth.

b) Monetary policy reaction functions in the BEAC Franc zone.

Kamgna et al. (2009) estimate the reaction function of BEAC using the Taylor rule in order to see how credible the policy can be perceived by building a model which best represents the interest rate setting of the Central Bank. Given the special conditions under which BEAC conducts its monetary policy considering the monetary agreements with France due to the fixed exchange rate, they first estimate a rule in which they introduce the money supply growth as well as inflation differential with France to build an adapted reaction function with rational anticipations. They use quarterly data between 1986 and 2006, and apply GMM to estimate a forward looking rule and their results show here that the monetary policy is highly dependent of the past interest rate. Their rule describes the interest rate setting mechanism well and it shows that BEAC gives more weight to price stabilization than supporting output growth. This method however, according to the authors does not throw sufficient light on the stationarity of the output gap that is why the decide to estimate a second rule using the vector error correction model of Johansen (1991)and they had better results on the output gap calculated with the Hodrick and Prescott filter. However, they find that the rule estimated is more linked to the real monetary policy within the period after devaluation as Tenou (2002) obtained in his research.

Dramani (2010) also estimates the neutral or natural interest rate in CFA zone that is UEMOA and CEMAC using another generation of policy rules namely generalized Taylor rule that incorporatesto the Central Bank's reaction function other variables in addition to the original variables of the Taylor rule. He uses panel data estimations for the period 1970 to 1999 using iterative least squares and obtains a neutral interest rate between 1.65% for the CEMAC zone. From the results obtained, it could be concluded that BEAC has a preference for an interest rate smoothing rule even though the coefficient of the output gap was not very significant; he thinks the results are generally consistent with theory. However, the results obtained on the real and equilibrium interest rates show that BEAC's monetary policy is highly tilted towards the fight against inflation.

4. DATA AND METHODOLOGY

a) Data and variable description

The data used for this part of our study are yearly data within the time range 1993-2012 and they are got from different sources as follows: The GDP per capita at constant prices for CEMAC is constructed from the countries' data of the World Development Indicators (WDI, 2016) of the World Bank and it is taken in its log form. The inflation, exchange reserve coefficients and the interest rate data for CEMAC are got from BEAC database and the yearly reports of the Banque de France. The interest rate of the Euro zone is got from the yearly reports of Banque de France and the data base of BCE.

Concerning the variables used in this study, we have: The endogenous variable the interest rate, which is in fact, the main interest rate used by BEAC for refinancing operation and it is named " Taux d'intérêt d'Appel d'Offres (TIAO)". Inflation gap $(\pi_{Ft} - \pi^*)$ is

got from the arithmetical difference between the actual inflation of the CEMAC sub region and the implicit target of 3%. The output gap $(y_t - y^*)$ is got from the difference between the GDP per capita and the Hodrick-Prescott filter and considered in its quadratic form then taken in its log.

The graphs in appendix 1 present the evolution of these main variables and we can see that the interest rate has steadily decreased since the monetary reforms engaged in 1990. Concerning the inflation gap, we can equally observe that it has been very stable around zero except for 1994 where we have a peak of more than 30% due to the devaluation of the CFAF. The output gap has been very unstable from observation and the sub region has mostly been under its capacity except between 2004 and 2008, where the economy seems to have been over heated.

b) Methodology

We shall estimate our model in using the Generalized Moment Method to take into consideration the anticipations of agents. Given that agents conduct their behaviors with forward-looking expectations, GMM method is useful in obtaining consistent estimators for the model parameters. In this section, we lay out the forward-looking Taylor rule equation to be estimated by GMM and show how factors are added to the information set. This method shall equally permit us detect any signs of endogeneity in explanatory variables. The application of GMM may encounter a problem where the instruments are weakly correlated with the endogenous variables leading to the weak instruments or weak identification problem. If this occurs, the resulting GMM estimators would have non-normal sampling distributions and the following statistical inferences, such as point estimates, hypothesis tests and confidence intervals, are no longer reliable. That is why it is necessary to examine whether or not the instruments are weak before conduct the GMM estimation.

The starting point of the empirical analysis is to check whether the panel data is stationary. Therefore, we shall describe a panel-based framework to conduct panel unit root testing methodologies in order to determine the order of integration of all variables under study and correct the possible non stationarities in the series. Traditionally, the Dickey-Fuller (DF) or Augmented Dickey Fuller (ADF) tests are usually used to test for the presence of unit roots in univariate time series data, but in recent years, a number of investigators have proposed alternative tests. They include Maddala and Wu (1999), Hadri (2000), Levinet al. (LLC) (2002) and Im et al (IPS) (2003) who have developed panel-based unit root tests that are similar to tests applied to individual series, while Abuaf and Jorion (1990) and Taylor and Sarno (1998) have suggested a multivariate version of the augmented Dickey and Fuller test. Baltagi and Kao (2001) for instance, show that if a cross sectional dimension is added to the traditional unit root tests, it can increase the power of the tests due to the information in the time series is enhanced by that contained in the cross-section data. Given that the LLC and homogeneous type of Hadri test statistics are restrictive in the sense that all cross-sections have or do not have a unit root, we shall operate all the tests and focus more on less restrictive IPS and Fisher ADF Chi-square test statistics that can lead to more accurate results about integration properties of the variables.

We subsequently make panel regressions in order to identify variations in responses of individual counties to the application of its specific Taylor rule and how much of this variation is accounted for by each country. By having these effects, we shall be able to capture the heterogeneity, which is important because if we consider that all the individual states of the currency union behave in the same way this may lead us to important specification biases. We shall therefore need to detect these effects in order to account for the individual disparities that exist across countries. If we assume that in a panel data regression the inflation coefficient is significant for example, this means that the inflation coefficients in this case will be adapted to describe how countries respond to monetary policy. We shall thereafter estimate a new reaction function corrected from heterogeneities to present the most appropriate way to estimate the Taylor rule in case of asymmetrical responses to shocks.

Our exercise in illustrating heterogeneity then proposes a better model corrected from these heterogeneities. Therefore, we shall proceed in two stages:

Stage 1: we estimate the country-specific reaction functions based on panel data estimations in order to get an impression about the extent of existing heterogeneity, though we impose some degree of homogeneity by performing pooled or fixed-effects estimation. We are interested in knowing here whether when a general rule is established, it would be possible to say that such general specification is applicable to any country and at any given time. This is why we shall make cross-country comparisons of monetary policy dynamics in order to know whether the interest rate policy of BEAC can be efficiently applicable to each country of the CEMAC sub region.

Stage 2: The procedures we shall use to estimate the dynamic panel data equation across the countries of the CEMAC sub region is the two-steps SYS GMM. The preferred estimation for BEAC's reaction function shall be given by this estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998) who have significantly improved the original Arellano and Bond (1991) dynamic panel data GMM estimator. The basic idea of the original estimator is to first differentiate the equation to remove the

unobserved individual heterogeneity. Removing these heterogeneities will permit us have a corrected model which is more optimal than the simple model estimated by the GMM.

c) Econometric specification

Table 2: Econometric results of BEAC's monetary policy

Dependent Variable INTER	
Annual Data	**From 1994:01 To 2012:01**
Usable Observations	**19**
Degrees of Freedom	**13**
Mean of Dependent Variable	**6.036**
Std Error of Dependent Variable	**1.436**
Standard Error of Estimate	**0.320**
Sum of Squared Residuals	**1.337**
Durbin-Watson Statistic	**2.143**

Variable	Coeff	Std Error	T-Stat	Signif
1. a	6.078	1.530	3.970	0.000
2. i_{t-1}	0.302	0.162	1.859	0.062
3. $\pi_{Ft} - \pi^*$	-0.052	0.014	-3.712	0.000
4. $y_t - y^*$	-0.102	0.040	-2.532	0.011
5. $exc - 0,2$	-0.027	0.009	-2.979	0.002
6. $i_€$	0.336	0.081	4.123	0.000

From the above results we can observe that the behavior of the monetary authorities of BEAC can be depicted using a Taylor rule, but the sign of the coefficients of both inflation gap and output gap are not consistent with theory and their values equally do not follow the Taylor principle. However from observation, the output gap has a negative coefficient meaning when BEAC decreases the interest rate by 1 point, there is a tendency for the gap to widen by 10%. A similar situation can be observed concerning inflation gap with of $1: 0.05$ a ratio. Moreover, the "Taylor principle" is not respected here because despite the fact that BEAC has a price stability objective, its monetary policy only impacts at the rate of 5% on the inflation rate. This is probably because most of the low inflation results got in the sub region is due to imported stability from the Euro zone considering its fixed exchange rate regime with CEMAC. We can equally observe that the lagged interest rate is considerably accounted for. This should be due to the concern of the Central Bank to maintain its credibility and the fear to face adapting costs. These factors have

What then about external stability? As we can see from our results the coefficients attached to both the interest rate of the Euro and the reserve coverage ratio are significant and a lot of importance is comparatively put on the interest rate of the Euro area in setting the BEAC rediscount rate. This shows that the constraint faced by BEAC to respect the interest rate differential is taken serously by the monetary authorities. This is probably to make sure that the fixed exchange rate regime shouldn't cause a high capital inflow which may lead to high inflation that may be harmful to the relatively weak economies of the sub region. For the currency reserves, the quantity has been on average more than four times the desired amount due to the favorable position that the sub region as an oil exporting zone so, the Central Bank has not really been alarmed about constituting the required currency reserve.

The reaction function of BEAC is therefore as follows:

$$\boldsymbol{i_t = 6.07 + 0.302 i_{t-1} + 0.052(\pi_{Ft} - \pi^*) - 0.102(y_t - y^*) + 0.027(exc - 0{,}2) + 0.336 i_€} \qquad \textbf{(4)}$$

It is assumed that the monetary policy reaction function is common across the 6 countries of the sample. The policy instrument is the nominal interest rate as seen above and the policy goals are to stabilize the economy both internally and externally. For country j in period t, the following expression is given for the target level of the nominal interest rate:

$$\mathbf{i_t = a + \rho i_{t-1} + b(\pi_{Ft} - \pi^*) + c(y_t - y^*) + dE_t + \varepsilon_t} \qquad (5)$$

Where π_{Ft} is the inflation rate of the CEMAC zone; π^* the inflation rate targeted by the monetary authorities of CEMAC; $(y_t - y^*)$ the output gap, and; E_t the external elements taken into consideration by BEAC in its monetary policy practice. The above Equation (5) is a cross-country version of the Taylor (1993) rule adapted to the CEMAC region. However, as noticed by several authors in single country analyses, this static version of the rule is too restrictive to describe actual central banks' behavior. Essentially, it

assumes immediate adjustment of the monetary policy instrument and ignores the tendency of central banks to smooth interest rate changes. A more general approach can be taken by assuming a partial adjustment of the actual interest rate to its target level, as given by the following first-order partial adjustment model:

$$\mathbf{i_{jt} = a_0 + a_j + \rho i_{jt-1} + b(\pi_{Fjt} - \pi^*) + c(y_{jt} - y^*) + dE_{jt} + \varepsilon_{jt}} \qquad \textbf{(6)}$$

Where the constant $(a_0 + a_j)$ is decomposed into an observable country-specific heterogeneity which is stable over time a_j, and a common constant a_0. Knowing that according to (6), the central bank of country *j* adjusts the actual interest rate to the desirable level by (1 − ρ) each period *t*. The degree of interest rate smoothing is represented by ρ.

Our model corresponding to the Taylor rule relevant for empirical estimation is therefore equation (6). From this equation, we can be able to estimate the reaction function capturing heterogeneity across the different countries as see in the next section.

5. RESULTS AND DISCUSSION

a) Illustrating Heterogeneity: Country-Specific Reaction Functions

We shall not discuss the properties of the coefficients in table 3, because as we know, our model is a dynamic panel model and the coefficients estimated here are biased. What interests us, is the estimation of fixed individual or specific effects, even though it is obvious that the by "contagion", they must equally be biased. However, the fixed effects are very visible as we can see a large degree of heterogeneity across the countries. In fact, these effects are non-random and they vary considerably from one country to the other as can be seen in their chronological order of importance in table 1 of appendix 3.

Table 3: Estimation of fixed effects across countries.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$\boldsymbol{a}$?	4.170	0.448	9.298	0.000
$(\boldsymbol{\pi_{Fjt} - \pi^*})$	-0.023	0.010	-2.286	0.024
$(\boldsymbol{y_{jt} - y^*})$	0.021	0.038	0.548	0.584
$\boldsymbol{i_{€}}$	0.978	0.067	14.395	0.000
$\boldsymbol{exc - 0,2}$	-0.017	0.003	-4.686	0.000
Fixed ffects (Cross)				
_CMR--$\boldsymbol{a}$	-0.338			
_RCA--$\boldsymbol{a}$	0.768			
_CON--$\boldsymbol{a}$	-0.303			
_THC--$\boldsymbol{a}$	0.020			
_EQG--$\boldsymbol{a}$	-0.200			
_GAB--$\boldsymbol{a}$	0.053			

The chronological appearance of fixed effects across CEMAC, depicting high degree of heterogeneity, can be seen in table 1 in appendix 3. From table 3 above, we can see that there is a very large difference between RCA and CAM for instance. In fact these figures show that if the Central bank has to set an interest rate which must be adapted to each state, every country must have its own interest rate except for CON and CAM which have approximately the same response to interest rates movements. It should be reminded that the coefficient estimated here is the interest rate smoothing coefficient, therefore, when the interest rate is set at any given level, Gabon and the CAR react very highly to the slightest change comparatively to Congo or Cameroon. In such contexts, there is a serious problem because countries respond asymmetrically to any interest rate chock, given that, when BEAC sets a single interest rate that must be applied to all the countries of the sub region, this interest rate will be adapted to some countries and the inflation and output gaps will be minimized while for other countries the gap will widen. This means intuitively that, the same interest rates will largely increase or decrease inflation in some countries while in others it will be stabilized around the target. In this light, the specificities of each country must be taken into account when setting interest rates in order to let all the countries respect the convergence criteria. These asymmetrical socks therefore give rise to the different patterns as we can see from the graphs in appendix 2.

In appendix 2, we observe that every country has her pattern, which is sometimes totally opposite to the others. This means, for the same year, some countries may be having an expansion or even an overheating while others are having a recession or

underemployment. Therefore, some countries may need to have an inflation shock in order to boost production while for others the slightest increase in prices may be detrimental to the economy. These graphs clearly show us how the different countries behave and as we can see, almost all the countries have their individual movements, which therefore make it difficult to practice an inflation or output stabilizing policy with a single instrument, not taking into consideration all these movements. It is to solve this type of problem that we use a dynamic panel setting of Arellano and Bover (1995) and Blundell and Bond (1998) in order to clear all the possible heterogeneities and obtain an estimation which could be considered to fit most of the countries despite their heterogeneous nature. We shall hence proceed by estimating a corrected model that accounts for the heterogeneities and corrects them so that we could have an effective model for the sub region.

b) Robust estimation results

Taylor rule can only be effective if using it to set the interest rate, permits us to obtain a long term stability of macroeconomic variables. This means, in the long term the monetary policy should permit us have the convergence of the principal economic variables across countries. From our regression and estimations, we see that there has been the persistence of fixed effects over time and from the above graphs, we don't have the impression that the Taylor rule has stabilized the variables around the average across countries. This is why we think it is necessary to correct the rule such that it may in the long run permit the convergence and stability of the principal macroeconomic variables.

The preferred estimation considered here is given by the one-step SYS GMM estimator, proposed by Arellano and Bover (1995) and Blundell and Bond (1998). As mentioned before, it has significantly improved the original Arellano and Bond (1991) first-differenced GMM estimator. The esstimation results in table 4 indicate that BEAC follows anti-inflation monetary policy but the coefficient on CPI inflation is significantly less than one and negative but output gap coefficient is not significant, so this is different from the rule proposed by Taylor (1993). There is, however, a considerable interest rate smoothing, as captured by a first-order autoregressive term of 0.5 and some importance is still attached to the interest rate of the Euro zone even thought to a low extent with a significant coefficient of 0.3.

Table 4 : System dynamic panel-data estimation

One-step results

i_{jt}	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
i_{jt}						
L1.	.508	.062	8.18	0.000	.386	.630
$(y_{jt} - y^*)$	.034	.027	1.27	0.205	-.018	.087
$(\pi_{Fjt} - \pi^*)$	-.040	.008	-4.94	0.000	-.056	-.024
$i_{€}$	.299	.045	6.58	0.000	.210	.389
exc	-.023	.003	-6.14	0.000	-.030	-.015
_ a	2.893	.533 5	.42	0.000	1.848	3.939

The new rule that could be proposed for BEAC and that is more adapted the environment of the CEMAC sub region with new parameters is proposed in equation (5) below.

$$i_{jt} = 2.893 + 0.508 i_{jt-1} - 0.4(\pi_{Fjt} - \pi^*) + 0.034(y_{jt} - y^*) + 0.299 i_{€} - 0.023 exc \qquad (5)$$

6. CONCLUSION

Our objective in this chapter was to detail describe the BEAC's monetary policy as well as the institutional settings within which it is found. We have been able to attain this objective and we have seen that BEAC has one main objective of monetary stability, and in order to realize this goal, it uses a certain number of instruments namely refinancing limits, reserve requirements and above all the short term nominal interest rate. We assumed that the Central bank follows a rule in the implementation of its monetary policy and from the different objectives and instruments we have been able to construct a reaction function for BEAC passing through the objective or loss function. From our estimations using the Generalized Moment Method we actually found that BEAC's monetary policy or more precisely its interest rate setting can be captured using a modified Taylor rule taking into consideration the specificities of the monetary union and external constraints. As seen from the results obtained we can realize that the Central Bank mainly focuses on the fight against inflation or more, it mainly participates in maintaining internal stability in the sub region.

This fight can be deemed successful given the low inflation results that are observed even though it can be mitigated with the influence of the region of anchor (the Euro zone) in this stability.

Therefore, from what precedes it can be concluded that the application of the Taylor rule could be of great interest to BEAC not only in order to anchor the expectations of agents hence engage in a cooperative game which will enhance its credibility and consequently make it more effective, but equally give it an additional instrument in the conduct of monetary policy. Nevertheless, the above results though interesting may simply be under contexts of a particular country but not in the case of a monetary union made up of several countries (six for CEMAC). If every country was to apply its own Taylor rule in the CEMAC sub region would the same results be obtained? Or rather are the interest rate and the inflation target of the sub region an optimal one for every country in the monetary union? If the answers to these questions are negative, what could be proposed which fits best to the UMAC monetary union? We shall attempt to answer these questions in the following chapter.

We finally showed that the CEMAC sub region is a heterogeneous one and therefore the different countries react asymmetrically to the monetary policy of BEAC particularly the use of the traditional forward looking Taylor rule to estimate the reaction function. We therefore started by estimating the fixed effect (FE) with the SUR weighting in order to have the country specific reaction functions and illustrate the different heterogeneities that exist. It has been shown that this estimator gives biased results in the dynamic setting because of the correlation between the lagged dependent variable and the error term (Nickel, 1981). These heterogeneities are mainly cultural in nature, and could lead to numerous effects such as bias whereby residents of one country may prefer for instance the consumption of imported goods than those domestically produced thereby lowering regional trade and negatively affecting synchronization. Therefore, the interest rate policy gives different results as concerns external stability, particularly the currency reserve ratio. There is equally the possibility of heterogeneities originating from different degrees of nominal rigidities. Finally, we have performed specific GMM estimation for dynamic panel proposed by Arellano and Bover (1995), consisting in the differentiation of the mode and the expansion of the instruments. This transformation permits to remove the fixed effect from the equation, which is the source of bias in the previous case. This estimation gives us a more robust reaction function for BEAC that can better capture the interest rate setting clearing the first model from its heterogeneities.

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APPENDIX 1

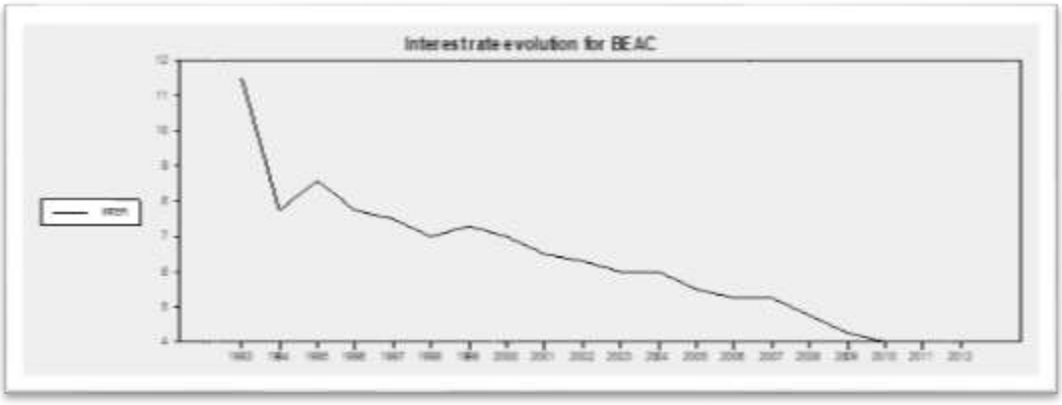

Figure 1: evolution of interest rate

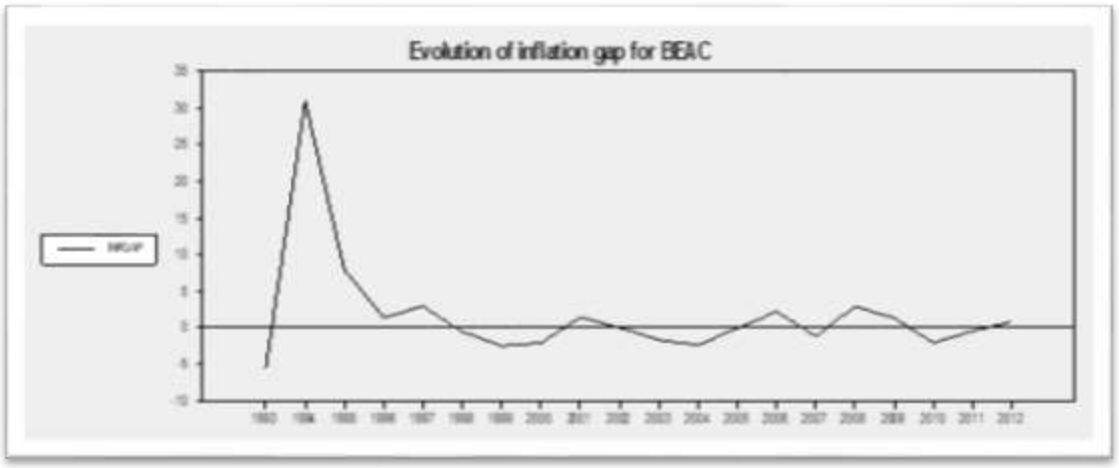

Figure 2: evolution of inflation gap

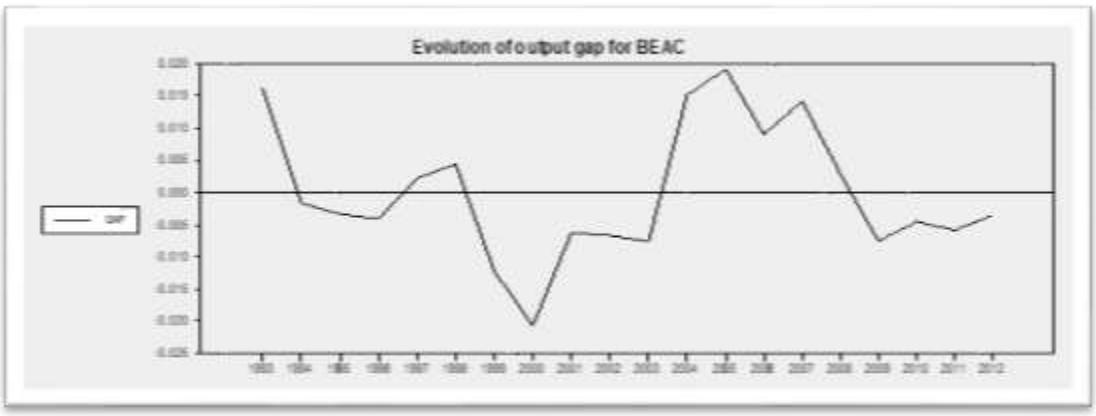

Figure 3: evolution of output gap

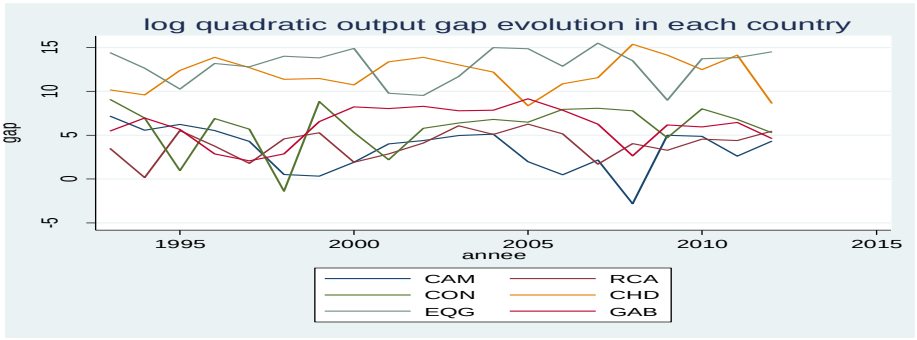

Figure 4

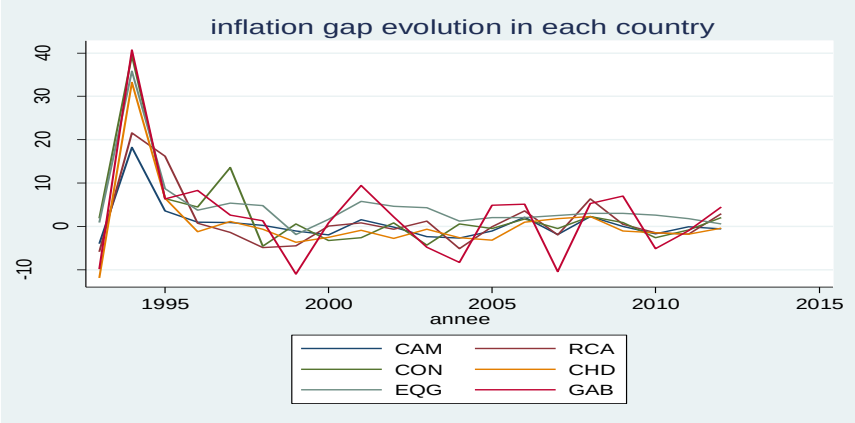

Figure 5

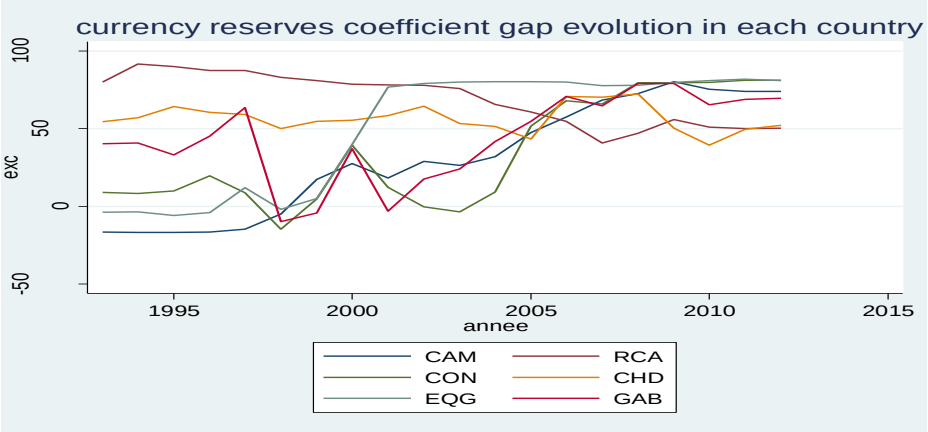

Figure 6

Appendix 3

Table 1

Fixed Effects (Cross)	
_RCA--a$_{RCA}$	0.768
_GAB--a$_{GAB}$	0.053
_THC--$\boldsymbol{a}_{TCH}$	0.020
_EQG--$\boldsymbol{a}_{EQG}$	-0.200
_CON--a$_{CON}$	-0.303
_CMR--a$_{CAM}$	-0.338