# BEAC

**Banque des Etats de l'Afrique Centrale**

BEAC Working Paper

*- BWP N° 01/22 -*

## CEMAC-GLOBAL : Introducing a macroeconomic model for a small open monetary union of oil-exporting developing countries


**ESSIANE Patrick-Nelson Daniel**

**Economiste**

**Direction des Etudes, de la Recherche et des Statistiques**

***essiane@beac.int***



BANQUE DES ETATS DE L'AFRIQUE CENTRALE

736, Avenue Monseigneur Vogt BP:1917 Yaoundé Cameroun

Tel :(237) 22234030 / 22234060

Fax : (237) 22233329

www.beac.int

# CEMAC-GLOBAL : Introducing a macroeconomic model for a small open monetary union of oil-exporting developing countries ✠ τ

Essiane Patrick-Nelson Daniel *

May 2022

## Abstract

Evaluating and analyzing the country-specific impacts of the monetary policy and the spillover effects of domestic shocks is a key policy concern in monetary unions. In order to address the relative lack of consideration of these issues in the literature on the Central African Economic and Monetary Community (CEMAC), this paper outlines the key features of a semi-structural multi-country macroeconomic model of the CEMAC economies called CEMAC-GLOBAL. Here, every country of the monetary union is modelled as a small open economy, with a single Central Bank in charge of the monetary policy. Based on a New Keynesian framework, this model incorporates (i) a distinction between oil and non-oil sector, (ii) real-financial linkages with credit cycles, (iii) CEMAC-specific monetary policy features related to the non-conventional fixed exchange rate regime of this monetary union, (iv) an explicit modelling of liquidity injections of the Central Bank and (v) national fiscal policies making an arbitrage between closing the output gap and stabilizing the public debt. The model is estimated with Bayesian methods in order to improve the empirical performances. Model simulations provide illustrations of (i) how the Central Bank could respond to various shocks, (ii) the asymmetric effects of the monetary impulses on CEMAC economies or (iii) the spillover effects of fiscal policy shocks. Historical decompositions replicate key stylized facts about the recent oil-crisis and COVID-19 pandemic.

**Keywords :** Semi-structural modeling ; Multi-country models ; spillover effects ; Monetary Union ; Africa ; Monetary Policy ; Fiscal Policy ; Heterogeneity ; Macroeconomic modeling

**JEL Classification :** C54 ; E37 ; E52 ; E62 ; O55

✠. I am deeply thankful to Junior Maih for the availability, the patience and the priceless comments on this model. I am also thankful to Carlos de Resende and the African Training Institute staff of the IMF's Institute for Capacity Development for having largely inspired the launch of this research project. I am also full of gratitude to Désiré Avom, Leo Spencer Keungne and Kenneck Massil for their comments and discussions during the Bank of Central African States's (BEAC) research seminars. I would like to extend my sincere thanks to Gabin Afomongono, Jacques Landry Bikai, George Diffo, Blaise Ehowe, Armand Fossouo, Dorel Maleo Batoumeni, Franck Mba Eyene, Evrard Mounkala, Emile Thierry Mvondo, Francis Ngomba Bodi, Julie Onomo, Mustafa Taher and my colleagues form the Economic studies, Research and Statistics Department of the BEAC for their precious advice, in-depth discussions and their availability during this modelling process. I also wish to thank the participants of 23rd Central Bank Macroeconomic Modelling Workshop and the 2020 BEAC research seminar for the rich discussions and suggestions. I'd also like to extend my gratitude to the BEAC's Director in charge of Research, Mr. Hamadou Abdoulaye, and the governing board of the BEAC for having allowed the funding of this research.

$\tau$. This is a working paper, and hence it represents research in progress. It is not meant to represent the position or opinions of the BEAC or its Members, nor the official position of any staff members Any errors or mistakes are the faults of the author.

$*$. Economist, Bank of Central African States (BEAC), Department of Economic Studies, Research and Statistics. essiane@beac.int

**Résumé**

L'évaluation et l'analyse du degré d'asymétrie des effets de la politique monétaire ainsi que des effets de débordement des chocs spécifiques à des pays membres est une préoccupation essentielle en union monétaire. Face à la relative faible considération de ces enjeux dans la littérature portant sur la CEMAC, ces travaux présentent les principales caractéristiques d'un modèle macroéconomique semi-structurel multipays des économies de la CEMAC appelé CEMAC-GLOBAL. Ce modèle considère chaque pays de la CEMAC comme une petite économie ouverte disposant d'une Banque Centrale en charge de la politique monétaire commune. CEMAC-GLOBAL repose sur un cadre théorique nouveau keynésien incorporant (i) une distinction entre secteur pétrolier et non pétrolier ainsi que (ii) des liens entre secteur réel et financier intégrant des cycles du crédit. En outre, le modèle prend en considération (iii) les spécificités liées au régime de change fixe non conventionnel de la CEMAC, ainsi (iv) qu'une modélisation explicite des injections de liquidités dans le comportement de la Banque Centrale en plus de la règle de détermination du taux d'intérêt. Également, le modèle incorpore (v) des politiques budgétaires nationales qui font face à un arbitrage entre annulation de l'écart de production national et maîtrise de leur niveau d'endettement. Le modèle est estimé avec une approche bayésienne dans l'optique d'en améliorer les performances empiriques. Les simulations opérées permettent entre autres d'illustrer (i) comment la Banque Centrale pourrait répondre à différents chocs, (ii) le degré d'asymétrie des effets de la politique monétaire entre les pays membres ainsi que (iii) les effets de débordement des chocs de politique budgétaire. En outre, les décompositions historiques répliquent les principaux faits stylisés relatifs à la crise pétrolière de 2014 ainsi qu'à la pandémie de COVID-19.

**Keywords :** Modèles semi-structurels ; Modèle multipays ; Effets de débordement ; Union Monétaire ; Afrique ; Politique monétaire ; Politique budgétaire ; Hétérogénéités ; Modélisation macroéconomique

**Classification JEL :** C54 ; E37 ; E52 ; E62 ; O55

## Résumé non-technique

Une Banque Centrale conduit sa politique monétaire dans l'optique d'atteindre des objectifs macroéconomiques déterminés dans son mandat. A cette fin, elle effectue une analyse rétrospective et prospective de l'économie de sa zone d'émission ainsi que de l'environnement international. Sur cette base, elle ajuste ses instruments (taux directeurs, coefficients de réserves obligatoires, injections de liquidités, etc.) de manière à obtenir la réaction la plus en adéquation possible de l'économie de sa zone d'émission vis-à-vis de ses objectifs de politique monétaire.

Exercice habituellement réalisé sur un seul pays, il gagne nettement en complexité lorsqu'il est conduit dans le cadre d'une union monétaire. L'un des principaux problèmes dans la conduite de la politique monétaire en union monétaire réside dans le degré plus ou moins élevé d'hétérogénéité des pays sur laquelle elle s'exerce. En effet, la situation devient alors semblable à celle d'un pilote de drone devant guider plusieurs appareils en même temps avec une seule télécommande : sa réussite dépendrait non seulement de la similarité des drones à sa charge, mais également de la nature et du degré de synchronisation des évènements qui affecteraient chacun d'eux. C'est la raison pour laquelle les courants orthodoxes de la théorie économique suggèrent que seuls des pays similaires fassent partie d'une même union monétaire (cf. Théorie des zones monétaires optimales).

Toutefois, en réalité, il est rare que tous les pays membres d'une union monétaire (voire même les régions d'un même pays) soient suffisamment proches économiquement, géographiquement ou institutionnellement pour correspondre à 100% à ce que recommande la théorie économique standard. En pratique, les États membres d'une union monétaire cherchent à faire converger leurs structures et politiques économiques de sorte à atténuer leurs dissemblances et faciliter la conduite des politiques économiques et, en particulier, celle de la politique monétaire.

L'hétérogénéité des économies membres d'une union monétaire n'étant jamais totalement éliminée, il est donc important d'évaluer non-seulement les potentiels effets asymétriques de la politique monétaire sur les économies de ladite union, mais également d'apprécier les effets de débordement des chocs économiques spécifiques à chaque économie de l'union sur les autres membres. De la sorte, la Banque Centrale peut non seulement mieux apprécier l'incidence de son action tant à l'échelle de l'union que sur celle de chaque

pays membre, mais également concevoir de meilleures stratégies de réponse lors de la survenance de chocs affectant un sous-ensemble de sa zone d'émission.

Les chercheurs en économie se sont depuis longtemps intéressés à ces problèmes. La littérature économique a ainsi enregistré de nombreuses contributions dans ce sens, en particulier depuis l'entame du processus de création de la zone Euro au cours des années 1990. Un accent important a tout spécialement été mis sur la création d'outils susceptibles de répliquer à petite échelle les éléments importants de ces économies à des fins de simulations de politiques économiques et de prévisions. Certains de ces outils (ou modèles macroéconomiques) ont tout spécialement été conçus pour évaluer et guider la politique monétaire dans un environnement relativement complexe.

Toutefois, l'effort de recherche en matière de modélisation macroéconomique en union monétaire s'est essentiellement concentré sur les économies avancées (zone Euro en tête), s'intéressant relativement peu aux unions monétaires des pays en développement. La Communauté Économique et Monétaire des États de l'Afrique Centrale (CEMAC), pourtant l'une des plus anciennes unions monétaires de l'Histoire, a ainsi fait l'objet de peu de travaux cherchant à la modéliser à des fins d'analyse des effets asymétriques de sa politique monétaire ainsi que des effets de débordement des chocs spécifiques à des pays membres de l'union monétaire. Le présent travail ambitionne d'adresser ce problème.

En particulier, cet article présente les principales caractéristiques du modèle CEMAC-GLOBAL, un modèle macroéconomique semi-structurel multipays conçu pour les économies de la CEMAC (Cameroun, République Centrafricaine, Congo, Gabon, Guinée Équatoriale et Tchad). Il s'agit d'un modèle d'équilibre général dynamique stochastique (DSGE) dont la base repose sur les fondements théorique de l'école des nouveaux keynésiens, mais dont plusieurs extensions ont été incorporées pour permettre de prendre en compte des caractéristiques spécifiques aux économies de la CEMAC. Ainsi, il inclut (i) une distinction entre secteur pétrolier et non pétrolier, (ii) une inter-relation entre sphère économique réelle et financière, (iii) des spécificités liées au régime de change fixe non conventionnel de la CEMAC, (iv) une prise en compte explicite du comportement d'injections de liquidités de la Banque Centrale ainsi (v) que des politiques budgétaires nationales faisant face à un arbitrage entre atteinte du potentiel de leurs économies nationales respectives et maîtrise de leur niveau d'endettement.

Afin de faire correspondre le comportement empirique du modèle CEMAC-GLOBAL aux principaux faits stylisés des économies de la CEMAC, il est nécessaire de donner des valeurs aux paramètres des différentes équations qui le composent. Dans cette optique, une approche séquentielle a été adoptée. Tout d'abord, la technique de la *limited information impulse response matching* a été utilisée pour un premier calibrage des paramètres relatifs à chacun des pays de la CEMAC. Cette technique vise à déterminer une combinaison de paramètres qui permet de répliquer qualitativement et, dans la mesure du possible, quantitativement, le comportement des économies en terme de réponses à différents chocs. Pour y parvenir, le modélisateur doit en général se reposer sur des travaux antérieurs ayant partiellement adressé certains aspects du modèle, les résultats de modèles similaires portant sur d'autres pays, ou encore sa connaissance des économies qu'il modélise. Une fois les différentes combinaisons des paramètres pertinentes obtenues, celles-ci sont considérées comme priors d'une estimation bayésienne. Schématiquement, l'estimation bayésienne consiste à combiner l'information *a priori* sur les paramètres à estimer et l'information contenue dans les données empiriques des économies étudiées. La combinaison de ces deux sources d'informations permet d'obtenir les valeurs dites "*a posteriori*" des paramètres du modèle. Celles-ci sont une sorte de "mise à jour" de la connaissance des économies étudiées sur la base des données utilisées pour l'estimation. Dans le cadre de ces travaux, une estimation bayésienne est conduite sur des versions mono-pays de CEMAC-GLOBAL, afin d'alléger la charge de calcul. L'estimation repose sur un algorithme d'optimisation par biomimétisme répliquant le comportement de recherche de nourriture d'un essaim d'abeilles mellifères. Cette technique est particulièrement intéressante pour l'optimisation de fonctions complexes à de nombreuses dimensions comme celle relative à la maximisation de la distribution *a posteriori* des paramètres du modèle CEMAC-GLOBAL. Une fois ces paramètres obtenus, les versions estimées mono-pays sont consolidées pour obtenir le modèle CEMAC-GLOBAL estimé.

Afin d'apprécier la pertinence du modèle estimé, des analyses de fonctions de réponses impulsionnelles suite à des chocs de (i) politique monétaire, (ii) de demande domestique, (iii) sur les prix du pétrole, (iv) des biens alimentaires mondiaux ainsi que (v) de politique budgétaire ont été réalisées. Les principaux résultats montrent que la politique monétaire a des effets asymétriques dans la CEMAC, avec un impact relativement plus important dans les pays dotés d'un secteur pétrolier moins proéminent. En outre, les effets de débordement des chocs spécifiques aux pays semble relativement faible, et sont dépendants de la taille des pays d'où ils surviennent. Également, les premières simulations montrent que des hausses de dépenses publiques coordonnées ont plus d'impact sur l'activité globale de la CEMAC que des choc budgétaires isolés, bien qu'ayant un effet négatif plus important sur les réserves de change et augmentant les primes de risque pays. Compte-tenu de la taille importante du modèle, il est évident qu'un nombre plus important de chocs et de simulations peuvent être simulés, ce qui en fait un outil intéressant pour les analyses de politique économique.

Sur le plan empirique, des décompositions historiques ainsi que des prévisions intra-échantillon ont été réalisées sur la base de données trimestrielles officielles publiées par la Banque des Etats de l'Afrique Centrale, les Institutions en Charge des Statistiques des pays de la CEMAC, le Fonds Monétaire International, la Banque Centrale Européenne ainsi que la Réserve Fédérale Américaine allant de 2006 à 2020. Globalement, les principaux faits stylisés relatifs à la crise pétrolière de 2014 ou encore l'incidence de la pandémie de COVID-19 ont été répliqués. En outre, les performances en matière de prévision à moyen terme sont intéressantes, suggérant une certaine utilité en matière de prévisions macroéconomiques pour les pays de la CEMAC.

Comme tous les modèles macroéconomiques, CEMAC-GLOBAL est un outil appelé à constamment évoluer tant dans sa structure que sa paramétrisation. Il s'inscrit donc dans un processus de modélisation toujours en cours. Plusieurs pistes d'amélioration subsistent, notamment relativement à la modélisation de l'économie étrangère, à une désagrégation de son bloc d'analyse de l'inflation, à la prise en compte d'une structure par terme des taux d'intérêts ou encore à l'intégration de changements de régimes. Enfin, il est à noter que CEMAC-GLOBAL constitue une sorte de module de base pouvant, avec une relative facilité (du fait de son caractère semi-structurel), intégrer des modules supplémentaires liés par exemple à des analyses de l'emploi, des agrégats de monnaie ou encore des projections sectorielles. N'ayant pas pour objectif l'exhaustivité (ce qui n'est d'aillaurs pas souvent recommandé en matière de modélisation macroéconomique), ces différents aspects ne sont pas abordés dans les présents travaux. Ils pourraient toutefois être adressés dans des recherches ultérieures.

# Contents

# Introduction

One of the most important economic policy questions when analyzing a monetary union is whether the common monetary policy has the same effects in all member states. This is because differences in the transmission of the common monetary policy to the member economies of a monetary union could lead to asymmetries in the evolution of business cycles and thus make the monetary policy decision-making process more difficult Clausen and Hayo (2006). In addition, the policymaker in a monetary union needs to evaluate the spillover effects of country-specific shocks to design the best stabilization policy response. Although these issues have received a fair amount of attention in the literature on currency unions in developed countries (mainly the Eurozone), few studies have focused on these phenomena in developing country currency unions. In particular, the CEMAC [1], despite being among the oldest monetary unions in the world, has not received much attention [2], especially concerning the construction of macroeconomic models able to conduct such analysis.

To address this issue, this paper introduces CEMAC-GLOBAL, a multi-country semi-structural macroeconomic model for policy analysis and forecasting in the CEMAC [3]. In addition, this modelling work is in line with several reforms engaged since the early 2010's by the Bank of Central African States (hereafter BEAC [4]) in order to improve its analytical framework for monetary policy purposes (see Mvondo (2019b) for a discussion).

One of the key aspects of these reforms is the improvement of the macroeconomic modeling framework. The historical tool for policy analysis at BEAC is based on the financial programming framework of the IMF. However, since the beginning of the 2010s, several studies conducted by BEAC's staff have intended to propose new forecasting and simulation tools mainly based on (i) time series analysis [5] and (ii) DSGE modelling. On this last point, the studies were essentially focused on analyzing the monetary policy trans-

1. French acronym for *Communauté Economique et Monétaire d'Afrique Centrale* (Economic and Monetary Community of Central African States)

2. This same issue in the "twin" monetary union of the Franc Zone, the West African Economic and Monetary Union (UEMOA for the French acronym standing for *Union Economique et monétaires Ouest Africaine*) could also be analyzed in future papers.

3. The country members are : Cameroon, Central African Republic, Congo, Gabon, Equatorial Guinea, and Chad.

4. French acronym for *Banque des Etats de l'Afrique Centrale.*

5. For papers based on time series analysis, see for example Fossouo Kamga (2015), Bikai and Kenkouo (2019), Bikai and Essiane (2017) or Bikai and Ngomba Bodi (2019).

mission channels and the effectiveness of BEAC monetary policy (Keungne K. *and al.*, 2016; Mvondo, 2019b).

However, most of these studies have considered the CEMAC as a single homogeneous entity (Keungne K. *and al.*, 2016; Mvondo, 2019b,a), a collection of countries analysed separately (Fossouo Kamga, 2015) or both (Bikai and Essiane, 2017; Bikai and Mbohou Mama, 2018; Bikai and Ngomba Bodi, 2019; Bikai and Kenkouo, 2019). These approaches are quite limited to study the spillover effects of the monetary policy and various other shocks through the member states of a monetary union. More, an issue with this approach is the relative inability to provide country-specific forecasts and simulations that are coherent with monetary-union level forecasts and simulations. Then, the need for a comprehensive multi-country modeling approach for policy analysis becomes critical. The objective of this paper is to address this issue.

The CEMAC economy has its own specificities which constitute an interesting case for macroeconomic modelling. First, it's a monetary union of developing countries. There is a quite rich literature on semi-structural macroeconomic modelling in the Eurozone (Clausen and Hayo, 2006; Dieppe *and al.*, 2018; Lang and Welz, 2018; Georgiadis *and al.*, 2021) [6], which is a monetary union of developed economies, but few existing papers extensively focus on monetary unions of developing countries. Second, most CEMAC countries are oil exporters, which implies a slightly different behavior of these countries when facing oil price shocks compared to oil importers. In particular, the fiscal policies of CEMAC countries are strongly dependent on oil revenues, which in turn makes debt sustainability heavily dependent on oil sector shocks (Wiegand, 2004). Third, CEMAC economies, like many developing countries, record a low level of financial development, which has consequences on the monetary policy transmission, especially with the low effectiveness of the interest rate transmission channel (Mishra and Montiel, 2013; Mishra *and al.*, 2014; Bikai and Kenkouo, 2019). Fourth, the CEMAC exchange rate regime is an unconventional fixed exchange rate regime where the Central Bank doesn't intervene in the Forex to stabilize the parity of the currency. This situation leads to a different design of the monetary policy framework in a fixed exchange regime. Here, there is still space for monetary policy intervention on the economy beyond the currency stability purposes, contrary to standard

6. The literature on semi-structural models in the developed world also incorporates several papers focusing on one country like in Lemoine *and al.* (2019)

fixed exchange regime frameworks (Mvondo, 2019a).

The model developed in this study is a semi-structural DSGE model. Following the seminal works of Poloz *and al.* (1994); Black *and al.* (1994); Coletti *and al.* (1996), it consists of a reduced-form New Keynesian general equilibrium model expanded with some *ad-hoc* features (Bokan and Ravnik, 2018). Its structure is largely inspired by the GPM6 of Carabenciov *and al.* (2013, 2008a) and ECB-Global of Dieppe *and al.* (2018). Like these works, it's a multi-country model that considers real-financial linkages in a New Keynesian framework. But, contrary to GPM6 and ECB-Global, the model presents a small open monetary union where all the member states are explicitly modelled. CEMAC-Global is also inspired by the works of Hlédik *and al.* (2018) and Chafik (2019) which build semi-structural models for oil-exporting countries in a fixed exchange rate regime.

Following the key features of the CEMAC economy, CEMAC-GLOBAL model departs from these previous models in several ways. First, the specific features of the non-conventional fixed exchange rate regime of CEMAC are explicitly modeled, to better replicate the policy implications of the CFA Franc (XAF) currency arrangements. Second, it develops a more detailed monetary policy transmission mechanism beyond the traditional interest rate transmission by including liquidity injections and credit cycles. Third, the model distinguishes an oil sector and a non-oil sector and links them through fiscal policy. Fourth, the monetary policy rules (interest rate and liquidity injections) integrate the currency stability and the financial stability objectives, according to the current policy orientations of the BEAC.

This modelling approach has several advantages. First, it permits to take into account the asymmetric effects of monetary policy shocks on the monetary union member states. Second, it can be used to simulate various country-specific shocks and analyze their spillover effects in the monetary union. Third, as mentioned by Carabenciov *and al.* (2013) and Dieppe *and al.* (2018), the semi-structural structure adopted for CEMAC-GLOBAL combines the advantages of fully structural models and those composed of reduced-form equations. On the one hand, the structural nature of the model makes the equations and shocks of the model have an explicit economic interpretation. On the other hand, the reduced-form structure of the model "facilitates modifying the model in a flexible manner so that it can be adapted relatively straightforwardly" (Dieppe *and al.*, 2018)[7].

7. As noted by Carabenciov *and al.* (2013), the semi-structural approach of macroeconomic modelling

Following Carabenciov *and al.* (2013), CEMAC-GLOBAL parametrization is a combination of calibrated and estimated parameters. This approach is suitable to increase the empirical performances of the model and replicate key stylized facts of the CEMAC economy. The main structural parameters and trade-related parameters are calibrated, while the rest of the parameters are estimated with a bayesian approach.

The main properties of the model are illustrated in this paper by examining a set of policy-relevant shocks and scenarios. First, monetary policy shocks seem to generate an asymmetric response in CEMAC, with a less pronounced asymmetric effect when manipulating liquidity injections. In addition, liquidity injections seem to have a lower delay of impact on CEMAC countries than the interest rate manipulation. Second, domestic demand shocks have limited spillover effects in the CEMAC, suggesting a low level of business cycle synchronization in the monetary union. Third, only oil price shocks seem to generate a common though heterogeneous response in the monetary union, reflecting the high vulnerabilities of the member states to external factors. Fourth, the low level of trade integration diminishes the negative expected impact of non-coordinated country-specific fiscal policy shocks on the other economies.

Some empirical properties have been enlightened through historical decompositions. They replicate the key stylized facts about the impact of the oil-price crisis of 2014 and the Covid-19 pandemic. In addition, they show the importance of supply and foreign shocks on inflation dynamics. More, the decompositions show asymmetric contributions of the CEMAC-countries to economic growth.

The rest of the paper proceeds as follows. Section 1 presents some stylized facts about CEMAC economies, section 2 presents an intuitive overview of CEMAC-Global and section 3 presents the model equations in detail. Section 4 summarises the parametrization approach while sections 5 and 6 respectively analyze some shocks and examine the historical decompositions of some observed variables. Section 7 mentions some possible extensions of the model and the last section concludes.

allows the researcher to adopt an intermediary position between a DSGE and purely time series model.

# 1 A brief overview of CEMAC Economies

The CEMAC economy is an economic and monetary union composed of six developing countries. Created in 1994 [8], this Community is shaped by two main Unions : (i) the Economic Union of Central Africa (UEAC) and (ii) the Monetary Union of Central Africa (UMAC). The goal of UEAC is mainly to promote economic cooperation and integration within the CEMAC Zone, while UMAC structures monetary cooperation and strengthens coordination between monetary and fiscal policies. It should be noted that this monetary union exists since 1972 with the adoption of the CFA Franc (XAF) as the common currency and the Bank of Central African States (BEAC) as the central bank of the CEMAC area. Thus, UMAC is one of the oldest monetary unions in History.

The CEMAC economy gets some interesting features. Here, we'll briefly review some key stylized facts that CEMAC-global tries to capture. Especially, we insist on the fact that (i) CEMAC is a monetary union of developing countries with (ii) an unconventional hard peg regime. Besides, the CEMAC experiences a (iii) low financial development and (iv) quite ineffective fiscal policy. Also, (v) the CEMAC economies are characterized by a low level of unemployment and systemic underemployment evolving in a large informal sector.

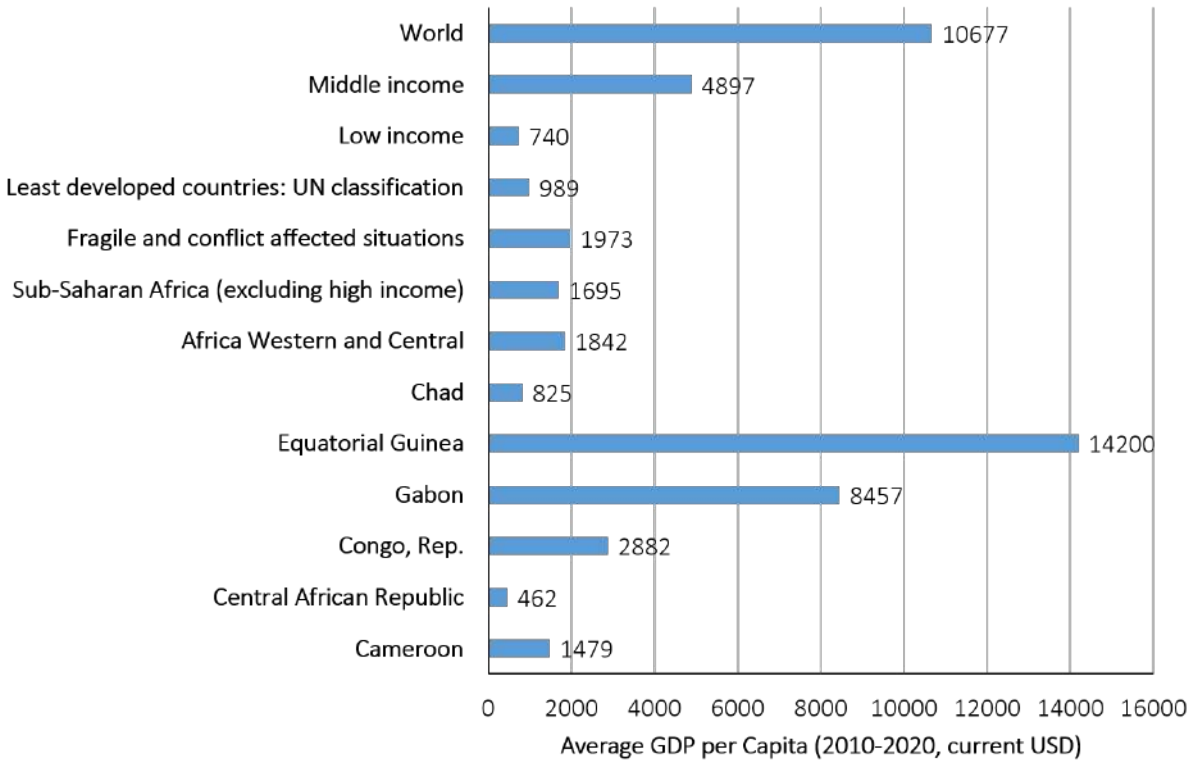
## 1.1 A small open monetary union of oil-exporting developing countries

The member states of the CEMAC [9] are small open developing economies (Figure 1). All of them, except the Central African Republic (CAR), are oil exporters. Oil and gas rent represents on average 24% of CEMAC's average GDP on 2010-2020 (Figure 2b).

8. But the economic cooperation amongst the member states started historically in June 1959 with the Equatorial Customs Union (UDE for the french acronym), with the Central African Republic, the Republic of Congo, Gabon, and Chad as member States. In 1961, Cameroon joined the UDE before the creation of the Economic and Customs Union of Central Africa (UDEAC) in December 1964. Equatorial Guinea joined UDEAC in march 1984, ten years before the creation of CEMAC.)

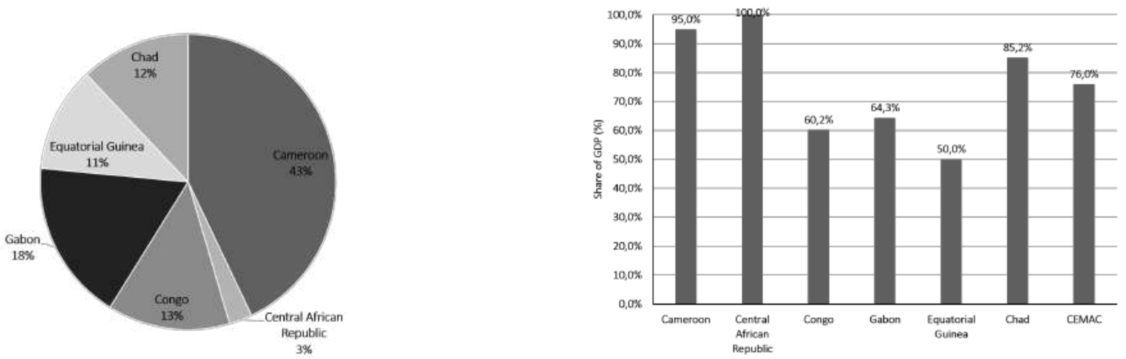
9. Cameroon, Central African Republic (CAR), Congo, Gabon, Equatorial Guinea and Chad

**Figure 1** – *Average GDP per Capita - 2010-2020 (Current USD)*




*Source : World Bank, 2022 (World Development Indicators)*

**Figure 2** – *Some GDP characteristics of CEMAC countries*




**(a)** *Average share of CEMAC countries in CEMAC GDP (2010-2020)*

**(b)** *Share of non oil GDP in global GDP in CEMAC (Average 2010-2020)*

*Source : Bank of Central African States (2022, Monetary Policy Report of first quarter)*

This economic dependence on oil rents leads to an important exposure to oil price volatility. For example, the 2014 oil prices drop had dramatic consequences on fiscal revenues and, thus, on the economic performances of CEMAC countries.

## 1.2 An unconventional hard peg regime

Contrary to conventional fixed exchange rate regimes with imperfect capital mobility, the fixed exchange rate regime of CEMAC is ruled by an agreement between the French treasury and the member states of UMAC. Simply stated, the Central Bank isn't obliged to defend the parity of the currency with interventions on the Forex. The French Treasury guarantees the convertibility of the XAF [10] and, in return, the BEAC has a remunerated current account opened at the French Treasury where 50% of the international reserves are on deposit. The main constraint faced by the Central bank here is to maintain the ratio of the foreign asset to the Central bank's Short-term liabilities ( *TCE* [11]) superior to 20%. But, empirically, the monetary policy authority sets a target quite largely above 20%.

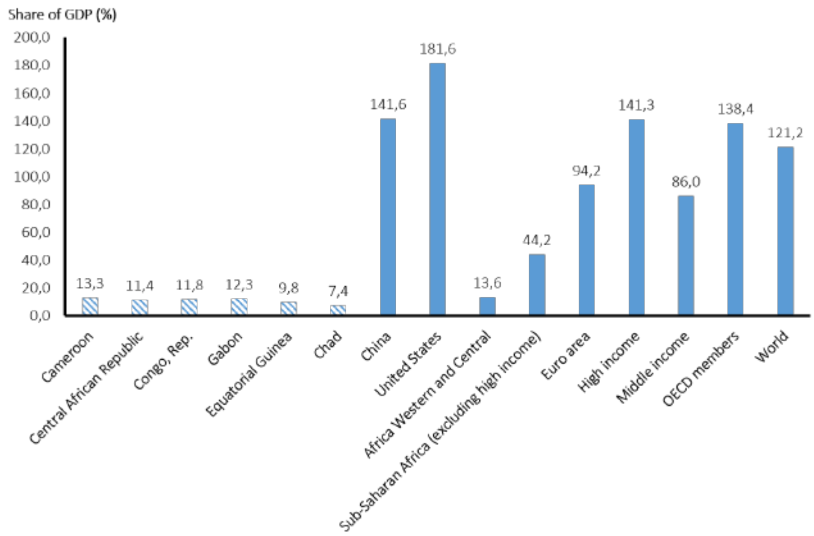
These characteristics lead to important changes in the way the fixed exchange rate regime is managed and, then, modeled. First, as the nominal exchange rate with the Euro is "*law-determined*" instead of "*market-determined*" there are no direct connexions between the nominal policy rate and the nominal exchange rate. In other words, the Central bank is in a fixed exchange rate where it's not necessary to target the nominal exchange rate : the monetary policy can still have some autonomy (at least, in the short run). Second, as there's imperfect capital mobility, the monetary policy autonomy is (again) reinforced. Third, the agreement with the French Treasury discourages speculative attacks. The pool of international reserves of the monetary union and the convertibility guarantee given by the French Treasury lower the probability of a devaluation (relatively to other fixed regimes in developing and emerging countries) and then makes speculative attacks more costly for financial markets.

## 1.3 Low financial development

As mentioned in the literature, African developing countries have a low level of financial development. CEMAC countries are no exception, with an access bank rate estimated at 15% in 2015. More, the global financial market capitalization is about 0.4% of CEMAC GDP in 2018.

10. Currency code of the CFA Franc of CEMAC
11. French acronym for *Taux de couverture exterieure de la monnaie* (External currency coverage ratio).

**Figure 3** – *Credit to private sector (% of GDP, average 2010-2018)*




*Source : World Bank, 2022 (World Development Indicators)*

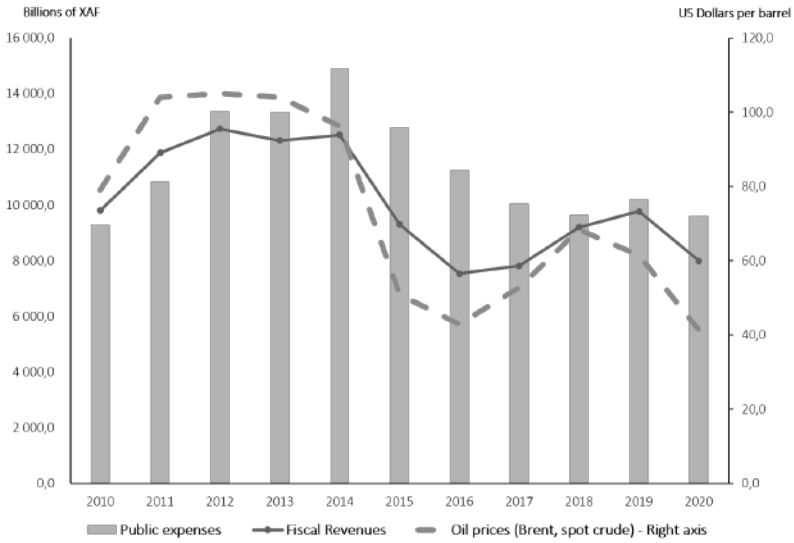
As a consequence, the bank lending channel [12] is generally considered the prominent transmission channel of monetary policy in CEMAC (Bikai and Essiane, 2017; Bikai and Kenkouo, 2019). However, even if the banking sector is one of the main financing sources for the private sector in CEMAC, the credit to GDP ratio is relatively low (Figure 3). Thus, more than 80% of credit to the private sector is captured by big firms, which reveals some limited lending opportunities for small and medium enterprises (SMEs) (Fouopi Djiogap and Ngomsi, 2012; Mandiefe Piabuo *and al.*, 2015).

## 1.4 An Oil-dependent fiscal policy

Fiscal policies in CEMAC economies are heavily dependent on the dynamics of the oil sector. In most cases, oil production is realized by foreign consortiums that share the oil rent with the governments.

12. See Dwarkasing *and al.* (2017) for a literature review on banking lending channel of monetary policy.

**Figure 4** – *CEMAC fiscal revenues, CEMAC public expenses and oil prices*




*Source : IMF, World Economic Outlook (2022) and Bank of Central African States (2022)*

The 2010 decade is an illustration of the structural dependence on oil rent of the public sector in CEMAC. It has been characterized by a depletion of oil resources in many CEMAC countries, which led to a diminution of global oil production, especially in Equatorial Guinea. But the main shock that affected the CEMAC Economy has been the oil price drop in 2014, which dramatically impacted the value of oil exports.

As a consequence, CEMAC countries experienced simultaneous fiscal stress which has conducted the governments of CEMAC to adopt fiscal consolidation plans with the IMF since 2017.

## 2 Intuitive Overview of the model

The model described in this paper could be classified as a semi-structural gap model that takes into account the main features of a Neo-Keynesian model, following the approach of Poloz *and al.* (1994), Berg *and al.* (2006) and Carabenciov *and al.* (2008b). The model also integrates specific equations in order to capture empirical characteristics of the CEMAC economy.

First, the model is constructed as a small open monetary union of oil-exporting economies. The six countries of CEMAC[13] are modeled symmetrically except for the Central

13. Cameroon, Central African Republic, Congo, Gabon, Equatorial Guinea, Chad

African Republic, which is not an oil producer. Each country has six blocs : (i) production, (ii) prices, (iii) fiscal policy, (iv) financial sector, and (vi) exchange rate and interest rate parity. A single Central Bank conducts monetary policy with its impulses on the policy interest rate and liquidity injections on a simplified interbank market.

Second, the specificities of the CFA Franc peg regime are captured with (i) a fixed nominal exchange rate with Euro and (ii) a monetary policy rule which sets the interest rate to manage international reserves dynamics [14] beyond traditional output-inflation trade-off.

Third, the model includes real-financial linkages. In particular, following the approach proposed by Bianchi and Bigio (2022), the model explicitly includes the credit channel of monetary policy, which is also prominent in the CEMAC economy. The interbank rate is influenced by the main policy interest rate, the liquidity injections of the Central Bank and the bank system stability of CEMAC. The interbank rate in turn affects the real interest rate, which is a determinant of the credit cycle dynamics. Then, the credit cycle influences the business cycles, which also affects the credit supply, exerting a feedback effect on the credit cycle.

Fourth, the model distinguishes an oil output and a non-oil output for every CEMAC country except the Central African Republic. The oil production dynamics are exogenous, due to the "offshore" feature of the oil industry in CEMAC. Meanwhile, the oil production dynamics influence the fiscal oil revenues, which in turn has an impact on the public expenses dynamics. This modelling approach permits to assess quite simply the importance of the oil prices and production for the fiscal policy, the business cycles and the bank stability in CEMAC.

Fifth, the model includes some hysteresis effects. This is a useful feature to address the long-term effects of short-term policies across the monetary union. Hysteresis effect in CEMAC-GLOBAL goes mainly through the country-specific fiscal policies. Following the results of Delong and Summers (2012) and Fatás and Summers (2018), the potential output is affected by the public expenses dynamics, which are themselves affected by the economic growth (which takes into account both output gap and potential output). This constitutes a supplementary distinction of CEMAC-Global from most semi-structural and

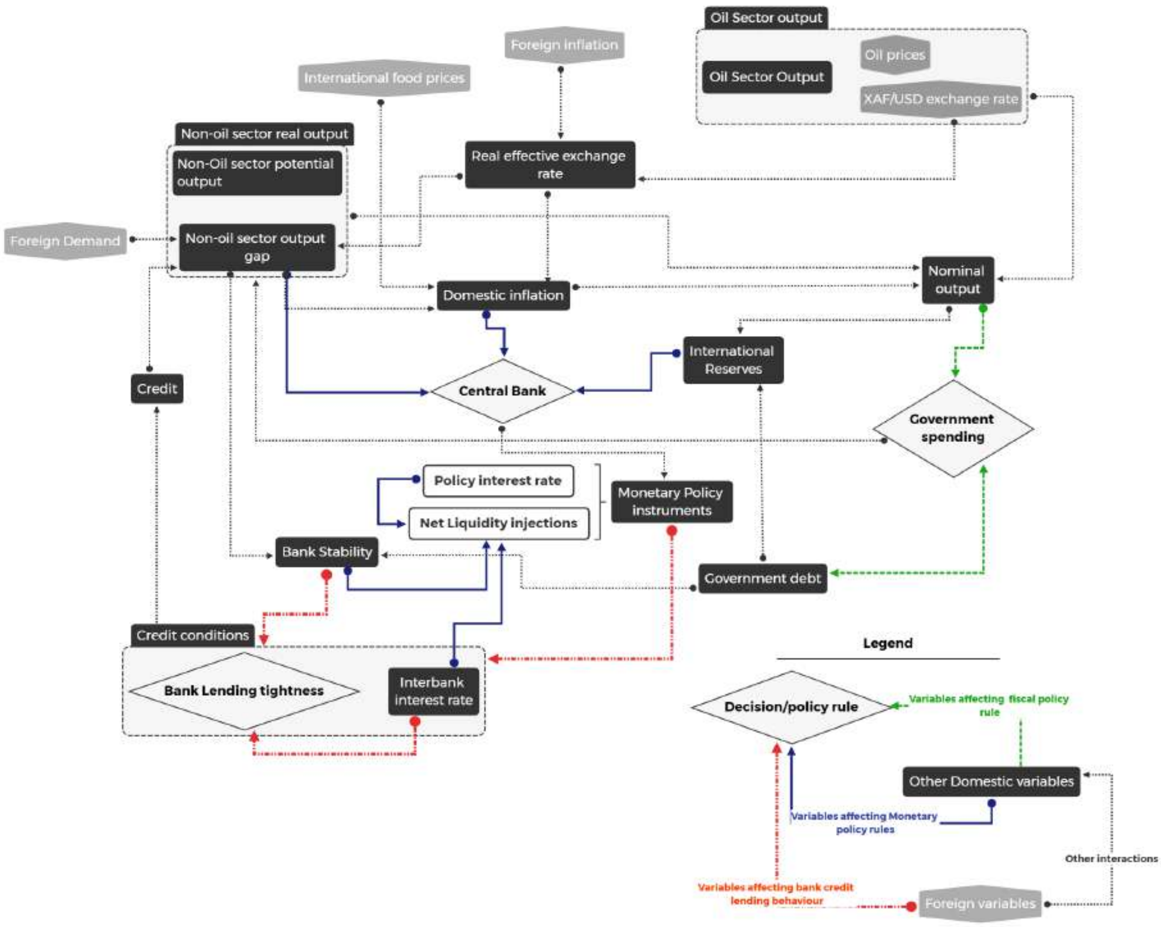
14. As required by the monetary cooperation agreement between CEMAC countries and France.

micro-founded DSGE models in which, as noted by Shaughnessy (2011) usually ignore hysteresis effects [15].

For simplification purposes, and considering that CEMAC is a small open economy, oil prices and foreign output and prices are modeled as exogenous.

Figure 5 describes the typical structure of a country in CEMAC-GLOBAL [16].

**Figure 5** – *CEMAC-GLOBAL Scheme : Structure of each CEMAC country*




*Source : Author*

15. Even the orthodox Arrow-Debreu general equilibrium model ignores hysteresis effects, as the equilibrium is considered as independent of past shocks (Cross, 1993)
16. Except for the Central African Republic, which don't have an oil sector.

# 3 Model Equations

## 3.1 Notations

This section describes the key equations of CEMAC-Global. As mentioned above, countries of the CEMAC economy are modeled symmetrically except the Central African Republic, which is not an oil producer.

Deviations from trends (or "gaps") are denoted by hats :

$$\widehat{x_t} = log(\frac{X_t}{\bar{X}_t}) \tag{1}$$

$\Leftrightarrow$

$$\widehat{x}_t = x_t - \bar{x}_t \tag{2}$$

where $x_t$ is the log of the level variable $X_t$ and $\bar{x}_t$ the log of its trend.

Trends variables are generally modeled as the sum of its own lagged value plus a quarterly growth rate and a disturbance term that permits a permanent level shift :

$$\bar{x}_t = \bar{x_{t-1}} + G(\bar{x}_t) + \varepsilon_t^{\bar{x}_t} \tag{3}$$

The quarterly growth rate is proportional to its long-term value and, when mentioned, growth rates of other endogenous variables. This feature is used to link "endogenously" trends of some variables of the model :

$$G(\bar{x}_t) = \alpha g x^{ss} + (1-\alpha)G(\bar{H})_t + \varepsilon_t^{G(\bar{x})} \tag{4}$$

Where $G(\bar{H})_t$ is the trend growth rate of the variable (or group of variables) $H$. Besides, $\Delta$ refers to the quarterly growth rate and $\Delta^4$ to year on year (y-o-y) growth rate.

Following Carabenciov *and al.* (2008b) and Benes *and al.* (2017), the distributed lag of some variables could be considered in the model. This feature is used to replicate a hump-shaped response of a given variable after a shock and then avoid abrupt reactions of the system. The distributed lag of a given variable $x$ is noted as follows :

$$DL(x_t) = 0.04x_{t-1} + 0.08x_{t-2} + 0.12x_{t-3} + 0.16x_{t-4} + 0.20x_{t-5} + 0.16x_{t-6} + 0.12x_{t-7} + 0.08x_{t-8} + 0.04x_{t-9} \quad (5)$$

## 3.2 Production equations

The log of headline GDP of country $i$ at time $t$ $Y_{it}$ is the weighted sum of the oil and non-oil GDP [17] ($y_{it}^{oil}$ and $y_{it}^{nonoil}$). These two subcomponents are themselves the sum of a "gap" and a trend component. We then have :

$$y_{it} = sh_{it}^{oil} y_{it}^{oil} + (1 - sh_{it}^{oil}) y_{it}^{nonoil} \quad (6)$$

where $sh_{it}^{oil}$ is the share of oil GDP in the headline GDP of country $i \in$ [Cameroon, Central African Republic [18], Congo, Gabon, Equatorial Guinea and Chad],

and

$$y_{it}^{k} = \widehat{y}_t^{\,k} + y_t^{k,ss} \text{ , with } k \in [oil, nonoil]. \quad (7)$$

For each CEMAC country $i$, the non-oil output gap ($\widehat{y}_{i,t}^{noil}$) depends on its own lead and lagged values, and also depends on the domestic credit gap ($\widehat{cr}_{i,t}$), the foreign demand (non-CEMAC countries, $\widehat{y}_{i,t}^{*}$, and CEMAC countries, $\widehat{y}_{i,t}^{CEMAC}$), the real exchange rate gap ($\widehat{z}_{i,t}$), the current public expenditures gap ($\widehat{g}_{i,t}$), and a domestic demand shock ($\varepsilon_t^{\widehat{y}^{noil}}$).

$$\widehat{y}_{i,t}^{noil} = a_0^{1,i} \widehat{y}_{i,t-1}^{noil} + a_1^{1,i} \widehat{y}_{i,t+1}^{noil} + a_2^{i} \widehat{cr}_{i,t} + a_3^{1,i} \widehat{z}_{i,t} + a_4^{1,i} [(1 - \sum_{j=1}^{5} w_{i,j}) \widehat{y}_{i,t}^{*} + \widehat{y}_{i,t}^{CEMAC}] + a_5^{1,i} \widehat{g}_{i,t} + \sigma_i^{\widehat{y}^{noil}} \varepsilon_{i,t}^{\widehat{y}^{noil}} \quad (8)$$

17. Except for the Central African Republic, where the headline GDP corresponds to the non-oil GDP.
18. As the Central African Republic is not a net oil exporter, this parameters equals to zero in the calibration of the model

with

$$\widehat{y}_{i,t}^{CEMAC} = \sum_{j=1}^{5} w_{i,j}\widehat{y}_{j,t} \text{ , with } j \neq i$$

and $w_{i,j}$ the weight of CEMAC country $j$ in foreign trade of CEMAC country $i$.

Contrary to the typical IS curve described in the literature (Poloz *and al.* (1994), Carabenciov *and al.* (2008a), Carabenciov *and al.* (2008b), Dieppe *and al.* (2018) or Benes *and al.* (2017)), the output gap here is affected by the credit gap. This feature is adopted due to the importance of the credit channel in CEMAC and the low financial markets development [19]. This approach is also inspired by the literature on credit incidence on business cycle (Bernanke and Gertler (1995), Borio (2012), Huizinga and Laeven (2019)). Also, from a more empirical perspective, the data availability issue on private interest rates could be overcome by using credit data, which is available at a monthly frequency.

The growth rate of the non-oil sector potential output $(\overline{G(y)}_{i,t}^{noil})$ is specified as a function of its long term value $(gy_i^{noil})$, its lagged value, the quarterly growth rate of public expenditures's trend $(\Delta\overline{g_{i,t}})$ [20] and a productivity shock $(\varepsilon_t^{G(y^{noil,ss})})$.

$$\overline{G(y)}_{i,t}^{noil} = a_0^{3,i}\overline{G(y)}_{i,t-1}^{noil} + (1 - a_0^{3,i})[(1 - a_1^{3,i})\overline{gy^i} + a_1^{3,i}\Delta\overline{g_{i,t}}] + \sigma^{\overline{G(y)}^{noil}} \varepsilon_t^{\overline{G(y)^{noil}}} \quad (9)$$

The oil industry in CEMAC (like in most African oil-exporting countries) is quite disconnected from other sectors of the economy. The production is quasi exclusively realized by foreign multinationals allowed by governments to exploit oil and gas fields (African Development Bank and African Union, 2009; Diouf and Laporte, 2018). These multinationals operate in the vast majority with imported physical and, often, human capital, which implies that the oil sector has little connexion with other sectors. In order to simply capture this characteristic, the oil output $(y_{i,t}^{oil})$ dynamics is exogenous :

$$y_{i,t}^{oil} = y_{i,t-1}^{oil} + \Delta pr_{i,t}^{oil} + \sigma_i^{y_{i,t}^{oil}} \varepsilon_{i,t}^{y_i^{oil}} \quad (10)$$

19. The global financial market capitalization in CEMAC was about 0.5% of the GDP in 2019, which is likely to lower the interest rate transmission channel. See https://www.financialafrik.com/2019/10/29/cemac-la-bvmac-se-dote-dun-plan-daction-ambitieux-et-offensif/

20. See Fatás and Summers (2018) and Cerra *and al.* (2020).

with the growth rate of oil production $\Delta pr_{i,t}^{oil}$ given by :

$$\Delta pr_{i,t}^{oil} = pr_{i,t}^{oil} - pr_{i,t-1}^{oil} \tag{11}$$

with oil production ($pr_{i,t}^{oil}$) dynamics described by :

$$pr_{i,t}^{oil} = pr_{i,t-1}^{oil} + G(pr)_{i,t}^{oil} + \sigma_i^{pr_i^{oil}} \varepsilon_{i,t}^{pr_i^{oil}} \tag{12}$$

and

$$G(pr)_{i,t}^{oil} = a_{0,o}^{1,i} G(pr)_{i,t-1}^{oil} + (1 - a_{0,o}^{1,i}) gpr_i^{oil} + \sigma_i^{G(pr)_i^{oil}} \varepsilon_{i,t}^{G(pr)_i^{oil}} \tag{13}$$

where $gpr_i^{oil}$ is the long-term growth rate of the oil production trend of country $i$.

## 3.3 Phillips Curve

Headline quarter-on-quarter (q-o-q) inflation ($\pi_{i,t}^q$) modelling follows a forward-backward Phillips curve. Its dynamics is defined to be a function of the non-oil output gap, the real exchange rate gap ($\widehat{z_{i,t}}$), the quarterly world food price dynamics and ($\pi_{i,t}^{food}$) a cost-push shock ($\varepsilon_{i,t}^{\pi^q}$).

$$\pi_{i,t}^q = b_0^{1,i} \pi_{i,t+1}^q + b_1^{1,i} \pi_{i,t-1}^q + b_2^{1,i} \widehat{y}_{i,t}^{noil} + b_3^{1,i} \widehat{z_{i,t}} + b_4^{1,i} \pi_{i,t}^{food} + \sigma_i^{\pi^q} \varepsilon_{i,t}^{\pi^q} \tag{14}$$

## 3.4 Fiscal policy

Fiscal policy intervention is determined by two opposite objectives. On one side, the government aims to stabilize the nonoil sector output gap, and, on the other side, it tries to stabilize the public debt dynamics. Here, the key policy instrument is the fiscal expenditures [21].

21. It's assumed that the government has a little influence on fiscal revenues in the short run, so no explicit rules are designed to manage them.

### 3.4.1 Public spending gap

The public spending gap $(\widehat{g}_{i,t})$ is a function of its lagged value, the non oil sector output gap $(\widehat{y}_{i,t}^{noil})$, the public debt growth $(\Delta DEBT_{i,t-1})$ and a short term fiscal policy shock $(\varepsilon_{i,t}^{\widehat{g}})$ :

$$\widehat{g}_{i,t} = c_0^{1,i}\widehat{g}_{i,t-1} + c_1^{1,i}\widehat{y}_{i,t}^{noil} + c_2^{1,i}\Delta DEBT_{i,t-1} + \sigma_i^{\widehat{g}}\varepsilon_{i,t}^{\widehat{g}} \tag{15}$$

### 3.4.2 Public spending trend

The structural public spending growth $(G(\overline{g}_{i,t}))$ rate is a function of the nominal output growth :

$$\begin{aligned} G(\overline{g}_{i,t}) = c_0^{3,i}G(\overline{g}_{i,t-1}) + (1 - rsh_i^{oil})[c_1^{3,i}(G(\overline{y})_{i,t-1}^{noil} + \pi_{i,t}^{q})] \\ + rsh_i^{oil}[c_2^{3,i}(G(y)_{i,t-1}^{oil} + \Delta\overline{p}_{t-1}^{oil} + \Delta USD_t)] + \sigma_i^{G(\overline{g})}\varepsilon_{i,t}^{G(\overline{g})} \end{aligned} \tag{16}$$

where $rsh_i^{oil}$ is the share of oil revenues in total fiscal revenues of country $i$, $\pi_{i,t}^{q}$ the quarterly inflation, $\Delta\overline{p}_{t-1}^{oil}$ the yearly average of the oil price q-o-q variation and $\Delta USD_t$ the q-o-q variation of the XAF/USD exchange rate.

### 3.4.3 Public debt

For simplification purposes, the public debt growth $(G(debt)_{i,t})$ is a function of the difference between the public spending growth rate $(G(g)_{i,t})$ and the nominal output growth $(G(ny)_{i,t})$ [22].

$$G(debt)_{i,t} = cd_0^{1,i}G(debt)_{i,t-1} + (1 - cd_0^{1,i})[G(g)_{i,t} - G(ny)_{i,t-1}] + \sigma_i^{G(debt)}\varepsilon_{i,t}^{G(debt)} \tag{17}$$

Thus, equation (18) describes the public debt evolution :

22. The nominal output growth is considered here as a proxy of the fiscal revenues growth.

$$debt_{i,t} = debt_{i,t-1} + G(debt)_{i,t} + cd_1^{2,i} \Delta USD_t + \sigma_i^{debt} \varepsilon_{i,t}^{debt} \quad (18)$$

### 3.5 Exchange rate

According to the Franc Zone agreements between France and the CEMAC countries members, the parity of the CFA Franc (XAF) is fixed. Nevertheless, this fixed exchange rate parity is not a conventional one. As noted in section 1.2, the evolution of the nominal exchange rate does not depend on the Central Bank's interventions in the currency market. Thus, CEMAC-GLOBAL considers the general specification of the nominal exchange rate presented by Fall and Sy (2019) (through the uncovered interest rate parity) :

$$\begin{aligned} s_t = \gamma_2(s_{t-1} + \Delta s_t^T/4) + (1-\gamma_2)[\zeta_1(s_{t-1} + \frac{1}{2}\Delta \bar{s}_t) \\ + (1-\zeta_1)E_t s_{t+1} + (i_t^* - i_t + PREM_t)]/4 + \varepsilon_t^s \quad (19) \end{aligned}$$

where $S_t$ is the nominal exchange rate, $\Delta S_t^T$ is the desired exchange rate variation, $\bar{S}_t$ is the equilibrium exchange rate variation, $i_t^*$ the foreign interest rate, $i_t$ the domestic interest rate, $E_t$ the expectations term, and $PREM$ the country risk premium. The $\gamma_2$ coefficient is the level of fixity of the exchange rate. Fall and Sy (2019) as working on the WAEMU zone [23] set $\gamma_2$ close to 1, according to the fact that the WAEMU evolves in a fixed exchange rate regime.

In this paper, $\gamma_2$ is set to 1 and $\Delta S_t^T$ is set to 0, since the evolution of the nominal exchange is exclusively affected by the authorities. As noted by Benlamine *and al.* (2018), the nominal exchange rate "is an exogenous policy choice variable. Without an ad hoc policy decision, its value does not change." (p.11). Following the Benlamine *and al.* (2018) approach, the nominal exchange rate between the XAF and the Euro ($S_t^{euro}$) is given by :

$$s_t^{euro} = s_{t-1}^{euro} + \sigma_i^{s^{euro}} \varepsilon_{i,t}^{s^{euro}} \quad (20)$$

23. The "twin" monetary union of CEMAC, whose have barely the same exchange rate regime agreement with France.

The real effective exchange rate dynamics ($\Delta z_{i,t}$) is simply a weighted average between the real exchange rate of the XAF relative to the Euro and the dollar [24] :

$$\Delta z_{i,t} = d_0^{3,i}(\Delta s_t^{euro} + \pi_{i,t}^{euro,q} - \pi_{i,t}^{q}) + (1 - d_0^{3,i})(\Delta s_t^{usd} + \pi_{i,t}^{us,q} - \pi_{i,t}^{q}) \quad (21)$$

where $\Delta s_t^{euro}$ and $\Delta s_t^{usd}$ represent the nominal exchange rates dynamics of the XAF relative to the Euro and US Dollar respectively, and $\pi_{i,t}^{euro,q}$ and $\pi_{i,t}^{us,q}$ represent the q-o-q inflation rates for the eurozone and the US.

## 3.6 Financial sector

### 3.6.1 Country risk premium

The country risk premium ($PREM_{i,t}$) is a function of the spread between the domestic real interest rate ($i_t^*$) and the foreign interest rate ($\pi_t^*$), the equilibrium real exchange rate ($z_i^{ss}$), the gap between the actual and the targeted level of international reserves (in months of exports) ($\text{RESMIMP}_t - resmimp$), the evolution of the public debt ($\Delta Debt_{i,t}$) and the gap between the current debt-to-GDP ratio ($Debt_{i,t}^{gap}$) and the multilateral limit of the debt-to-GDP ratio [25] and a risk premium shock ($\varepsilon_{i,t}^{PREM}$).

$$\begin{aligned} PREM_{i,t} &= d_0^{4,i} PREM_{i,t-1} + (1 - d_0^{4,i})[\overline{r}_{i,t} - (i_t^* - \pi_t^*) - z_i^{ss}] \\ &- d_1^{4,i}(\text{RESMIMP}_t - resmimp) - d_2^{4,i}\Delta Debt_{i,t} - d_3^{4,i} Debt_{i,t}^{gap} + \sigma_i^{PREM}\varepsilon_{i,t}^{PREM} \end{aligned} \quad (22)$$

### 3.6.2 Bank Stability

Since the 2008 global financial crisis, the importance of financial stability in economic literature and macroeconomic policy has arisen significantly (Agénor *and al.*, 2011; Smets, 2014; Bauducco *and al.*, 2014). In Africa and CEMAC in particular, this evolution is illustrated by changes in macroprudential and monetary policy (see section 3.7) and a

24. For simplification purposes, the other regions have been ignored. Most of the financial international transaction relations are denominated in Euro and US Dollar in the CEMAC region. Nevertheless, more currencies could be incorporated into the model in future versions of the model (see section 7)
25. This modelling approach is adopted to considerate both the dynamics and the level of the public debt in the evolution of the risk premium.

greater need for bank (in)stability indicators (see Bikai and Mbohou Mama (2018) for a discussion).

For simplicity purposes, bank stability is affected through 2 main channels : the public debt dynamics (see Das *and al.* (2010) and Assoumou (2017)) and the headline economic growth [26].

$$STAB_{i,t} = h^4_{0,i} STAB_{i,t-1} + (1 - h^4_{0,i})[-h^4_{1,i} \Delta Debt_{i,t-1} + (1 - h^4_{1,i}) \Delta y_{i,t-1}] + \sigma_i^{STAB} \varepsilon_{i,t}^{STAB} \quad (23)$$

#### 3.6.3 Bank Lending Tightness

Following Carabenciov *and al.* (2008a,b, 2013) or Benes *and al.* (2017), the model integrates a bank lending tightness ($BLT_{i,t}$) indicator, which captures the country-specific constraints on credit to private sector [27]. Here, the bank lending tightness is influenced by (i) the expected non-oil sector's output gap ($\widehat{y}^{noil}_{i,t+1}$), (ii) the country-specific bank stability dynamics ($\Delta STAB_{i,t-1}$), (iii) the evolution of the interbank interest rate ($\Delta i^{interbank}_{i,t}$), (iv) the progression of the central bank liquidity injections ($\Delta cbinj_{i,t}$) and (v) a credit supply shock ($\varepsilon^{BLT}_{i,t}$).

$$BLT_{i,t} = h^1_{0,i} BLT_{i,t-1} + (1 - h^1_{0,i})[-h^1_{1,i} \widehat{y}^{noil}_{i,t+1} - h^1_{2,i} \Delta STAB_{i,t-1} + h^1_{3,i} \Delta i^{interbank}_{i,t} + h^1_{4,i} \Delta cbinj_{i,t}] + \sigma_i^{BLT} \varepsilon_{i,t}^{BLT} \quad (24)$$

26. The rationale behind this modelling approach is quite simple : the banks mainly are exposed to credit risk, which in turn are highly dependent on the economic dynamics of the oil and non-oil sector. It is well documented that the economic conditions are key determinants of the quality of bank's credit portfolios and the evolution of non-performing loans (NPL) in the economy (Fofack, 2005; Beck *and al.*, 2013). These factors, in turn, tend to exacerbate bank instability (de Bandt and Hartmann, 2000; Benoit *and al.*, 2016). For simplicity purposes, CEMAC-GLOBAL links directly the economic growth dynamics to bank stability. Obviously, in future versions of the model, NPL could be explicitly modeled.

27. According to Abuka *and al.* (2019)'s results, the bank lending tightness indicator influences both volumes and rates of credit in CEMAC-global.

### 3.6.4 Credit

The credit gap $\widehat{cr}_{i,t}$ is influenced by its lagged value, the bank lending tightness indicator $BLT_{i,t}$, and the real interest rate gap $\widehat{r}_{i,t}$ and :

$$\widehat{cr}_{i,t} = h^2_{0,i}\widehat{cr}_{i,t-1} + (1 - h^2_{0,i})[-h^2_{1,i}BLT_{i,t} - h^2_{2,i}\widehat{r}_{i,t}] \tag{25}$$

and the growth rate of credit to private sector's trend ($\overline{G(cr_{i,t})}$) is linked to the nominal headline economic growth rate $G(ny)_{i,t}$.

$$\overline{G(cr_{i,t})} = h^3_{0,i}\overline{G(cr_{i,t-1})} + (1 - h^3_{0,i})(h^3_{1,i}G(ny)_{i,t}) + \sigma_i^{\overline{G(cr)}}\varepsilon_{i,t}^{\overline{G(cr)}} \tag{26}$$

## 3.7 Central Bank

The Bank of Central African States [28] (BEAC [29]) sets its nominal interest rate according to its monetary policy objectives : (i) the "internal" monetary stability objective (price stability) and (ii) the "external" monetary stability objective (Banque des Etats de l'Afrique Centrale, 2017). This latter objective is implied by the particular exchange rate regime of the monetary union (see section 1.2).

Also, the Central Bank also monitors bank stability [30]. In 2017, the monetary authority created a special lending facility to help banks facing liquidity stress [31]. The liquidity injections of the Central Bank can be seen as a relevant tool for financial stability purposes [32]. Beyond this objective, liquidity injections are used by the Central Bank to minimize the gap between the interbank market rate and the nominal policy rate.

28. The Central Bank of CEMAC.
29. Acronym for *Banque des Etats de l'Afrique Centrale*
30. see Caruana *and al.* (2011) for a more general discussion on the evolution of central banking in Africa
31. Decision N°17/CPM/2017 of September 17, 2017 (available here https://www.beac.int/wp-content/uploads/2016/10/Decision_12_CPM_2017.pdf)
32. This is even more accurate with the sharp increase of liquidity injections (+108.3 % for 2020Q1) in the interbank market after the Covid-19 shock.

### 3.7.1 Nominal Policy rate

It should be noted here that there is a vivid debate amongst the policymakers and analysts about the more appropriate specification of the policy interest rate rule in CEMAC and, more globally Franc Zone. In particular, there is no consensus about the way the external stability objective of the Central Bank should be modelled. Strictly, the indicator considered in the BEAC mandate is the external coverage rate of the money (ECRM) [33], which is a ratio between the foreign assets and the current liabilities of the CEMAC economy [34]. But the literature on the interest rate rule of CEMAC shows that alternative indicators could be considered to capture the external monetary objective of the Central Bank. Some papers integrate into the monetary policy rule the net foreign assets (Bikai and Mbohou Mama (2016)), others consider the international reserves (Mvondo, 2019a, 2020) and, in a few cases, some papers simply ignore the external monetary stability objective (Keungne K. *and al.*, 2016; Mvondo, 2019b). When looking at the "twin" monetary union of the CEMAC - the West African Economic and Monetary Union (WAEMU) [35] -, researchers are also considering the external monetary objective in various ways. But the most common feature is to simply ignore the external coverage rate of the money (ECRM) or any other external monetary stability-related aggregate or indicator (Fall and Sy, 2019; Diaw and Sall, 2018; Assemien *and al.*, 2019). Instead, the focus is mainly on the exchange rate stabilization process and the level of capital controls (Fall and Sy, 2019) [36].

In this version of the CEMAC-GLOBAL model, the policy interest rate rule departs from specifications founded in the literature in three ways. First, we consider the international reserves in months of imports as the indicator of external monetary stability. This choice is guided by the monetary policy strategy stated in the monetary policy reports of BEAC (Banque des Etats de l'Afrique Centrale, 2021) : "From an operational perspective, the external monetary stability is achieved when the level of international reserves represents 60% of the Central Bank short term liabilities, which is equivalent to at least 3 months of goods and services imports." (p.6). Second, the monetary policy rule only considers the non-oil output gap as the activity indicator. This specification is in line with

33. "Taux de couverture extérieure de la monnaie" in french.
34. Which could be proxied by the broad money, see Mvondo (2018b) for a discussion.
35. Which members are Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo.
36. which seems to be a general approach for fixed exchange rate regimes for scholars from the International Monetary Fund (see Benlamine *and al.* (2018); Hamiani *and al.* (2020)).

the fact that the monetary policy transmission process hardly affects the oil sector evolution, which is mainly driven by exogenous factors : CEMAC countries are price-takers on the global oil market, and the oil production capacities are given by the country-specific natural resources endowment. These features should lead the central bank to be focused on the behavior of the non-oil sector business cycle when conducting its monetary policy [37]. Third, the monetary policy targets the annual average inflation, instead of the q-o-q inflation as considered by Bikai and Mbohou Mama (2016), Keungne K. *and al.* (2016) and Mvondo (2019b). This choice is guided by the official objectives of the Central Bank Banque des Etats de l'Afrique Centrale (2017) and the operational framework of the monetary policy as clarified in the BEAC's monetary policy reports Banque des Etats de l'Afrique Centrale (2021).

Thus, in CEMAC-GLOBAL, the Central bank sets the nominal policy interest rate, $i_t^{POLICY}$, considering three main objectives : (i) Price stabilization, (ii) International reserves and (iii) output stabilization. In addition, in the long run, the policy rate is equal to the neutral interest rate of the CEMAC region ($i_t^{N,CEMAC}$) [38].

$$\begin{aligned} i_t^{POLICY} = e_0^1 i_{t-1}^{POLICY} + (1-e_0^1)[i_t^{N,CEMAC} + e_1^1(\pi_{t+1}^{4m,CEMAC} - \overline{\pi}) \\ + e_2^1 \widehat{y}_t^{noil} + e_3^1(\mathrm{RESMIMP}_t - resmimp)] + \sigma^{i^{POLICY}} \varepsilon_t^{i^{POLICY}} \end{aligned} \quad (27)$$

where $\pi_{t+1}^{4m,CEMAC}$ is the yearly average of the CEMAC inflation, $\overline{\pi}$ is the inflation "target" of the Central Bank [39], $\mathrm{RESMIMP}_t$ is the level of international reserves (in months of imports of goods and services) and $resmimp$ is the Central Bank target of the international reserves (in months of imports of goods and services).

37. This specification of the monetary policy rule should not let the reader think that the oil sector dynamics does not affect the behavior of the Central Bank. CEMAC-GLOBAL is structured in such a way that the oil and non-oil sectors interact. For example, the non-oil output gap is affected by the oil sector through fiscal policy. In addition, the fluctuations of the international reserves (which are considered in the monetary policy rule) depend on the oil exports

38. which is a linear combination of the country-specific neutral interest rates.

39. Stricto sensu, the mandate of the BEAC does not define an inflation target. In practice, the Monetary Policy Committee takes into consideration the inflation criteria of the CEMAC multilateral surveillance framework (yearly average of 3%).

### 3.7.2 Liquidity injections

The Central bank sets its liquidity to minimize the spread between the interbank interest rate and the policy rate (Mvondo, 2018a) [40], manage liquidity in the bank system and address financial stability issues (Banque des Etats de l'Afrique Centrale, 2019, 2021). Here, liquidity injections ($INBCR_t$) are set according to the spread between the policy rate and the interbank interest rate, and the global bank stability of the monetary union.

$$CBINJEC_t = i_0^2 CBINJEC_{t-1} + (1 - i_0^2)[i_1^2(I_t^{INTERBANK} - I_t^{POLICY}) - i_2^2 \Delta STAB_t^{CEMAC}] + \sigma^{CBINJEC} \varepsilon_t^{CBINJEC} \quad (28)$$

where

$$STAB_t^{CEMAC} = \sum_{i=1}^{6} sh_i STAB_{i,t} \quad (29)$$

with $sh_i$ the share of country in CEMAC real GDP and $sh_i \in [0,1] \forall i$ and $\sum_{i=1}^{6} sh_i = 1$.

## 3.8 Interbank interest rate

The interbank interest rate evolves according to the nominal policy rate ($I_t^{POLICY}$), the Central Bank liquidity injections ($INBCR_t$) and the bank stability index of CEMAC ($STAB_t^{CEMAC}$).

$$I_t^{INTERBANK} = i_0^1 I_t^{INTERBANK} + (1 - i_0^1)[I_t^{POLICY} - i_1^1 CBINJEC_t - i_2^1 STAB_t^{CEMAC}] + \sigma^{I^{INTERBANK}} \varepsilon_t^{I^{INTERBANK}} \quad (30)$$

40. Again, the preamble of the monetary policy reports of BEAC (Banque des Etats de l'Afrique Centrale, 2021) states that "To reach its objective, the approach chosen by the BEAC is to intervene on the Money market, through open market operations, either by liquidity withdrawal or liquidity injections, in order to drive the interbank interest rate around the main policy interest rate." (p.6)

### 3.9 Foreign Economy

For simplicity, and as CEMAC could be considered as a small open economy, the foreign economy is a collection of exogenous variables [41]. The foreign demand gap, the nominal exchange rates of commercial partners, the world price food index, and the oil price are random walks. The nominal foreign interest rates and the foreign inflation rates are given by AR(1) processes with constant terms.

# 4 Parametrization

Due to the large dimension of CEMAC-Global, a mixture of calibration and Bayesian estimation is envisioned to parametrize the model (see Carabenciov *and al.* (2013) for a discussion on this parametrization approach). Following Dieppe *and al.* (2018), the parameters are divided into three groups : (i) those defining the balanced growth path the nonstationary variables, (ii) trade and sectoral weights, and (iii) parameters with a structural interpretation.

The first two groups are calibrated with historical data of CEMAC Countries, and the third end fourth ones are estimated through a 3-steps procedure (see section 4.3).

Model solving and simulations are carried out in RISE Toolbox (Maih, 2019).

### 4.1 Calibration of balanced growth path parameters

CEMAC-GLOBAL is a non stationary model. As a consequence, key parameters for the dynamics of the model are the term growth rate of the non stationary variable's trends (cf. parameter equation 4). They are typically computed as follow :

$$\hat{\theta}(G(\bar{x_t})) = median[\bar{HP}(\Delta X_t))] \quad (31)$$

where $\bar{HP}()$ is an operator for the trend component of the Hodrick-Prescott filter and $\hat{\theta}()$ is the symbol for calibrated value.

41. A key future extension of the model could be the improvement of this bloc. See section 7

## 4.2 Trade and sectoral weights

All the bilateral trade weights are computed with the international trade data from the Atlas of Economic Complexity (The Growth Lab at Harvard University, 2019) [42] :

$$w_{i,j} = \frac{(\text{imports}_{i,j} + \text{exports}_{i,j})}{\sum_{j=1}^{5}((\text{imports}_{i,j} + \text{exports}_{i,j}))} \tag{32}$$

## 4.3 Estimation of structural parameters

The estimation of structural and shocks-related parameters follows a 3-steps procedure (Figure 6).

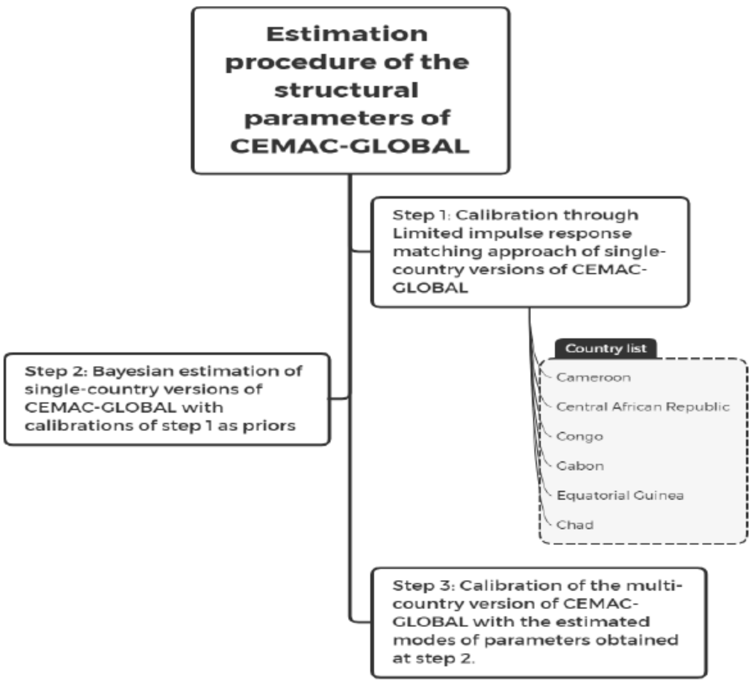



**Figure 6** – *Estimation procedure of structural parameters of CEMAC-GLOBAL*

### 4.3.1 Country-specific calibration through "Limited information" impulse response matching

The first step of the parametrization of CEMAC-GLOBAL is the calibration of the country-specific versions of CEMAC-GLOBAL through the limited information impulse

42. See Table 10.

response matching approach, described in Dieppe *and al.* (2018). In Dieppe *and al.* (2018), the parameters with a structural economic interpretation is calibrated using the *limited information impulse response matching* technique. This technique permits finding a configuration of the parameter values that are consistent with findings of empirical and theoretical literature concerning the economy studied, especially in terms of the plausibility of the impulse response functions for standard shocks. This approach is implemented in two key steps. First, initial values are set by drawing on the literature on semi-structural models as Carabenciov *and al.* (2008a, 2013); Dieppe *and al.* (2018); Benes *and al.* (2017); Hlédik *and al.* (2018); Chafik (2019) as well as fully-structural models with a focus on emerging and developing countries such as Liu *and al.* (2009), Peiris and Saxegaard (2010), Berg *and al.* (2015), Alpanda *and al.* (2011) and Mvondo (2019b). In addition, some stylized facts of CEMAC countries have been considered during the calibration exercise such as low price elasticity of foreign trade (Essiane and Ngomba Bodi (2018)), low fiscal multipliers ((Bikai *and al.*, 2017)) or high inertia of inflation ((Fossouo Kamga, 2015)). The second step consists of fine-tuning the values of the key parameters and assessing the plausibility of the impulse response functions. Following Dieppe *and al.* (2018), the parameters are chosen to informally minimize the distance between impulse-response functions implied by CEMAC-Global and those found in the literature. However, this step appears particularly tricky in the case of CEMAC-GLOBAL, due to the relative lack of empirical papers on the CEMAC which analyze the macroeconomic relations presented in the model. In particular, the spillover effects of the monetary and fiscal policy in CEMAC are barely analyzed, analyzing the empirical plausibility of the impulse responses quite difficult [43].

### 4.3.2 Bayesian estimation

As noted by Carabenciov *and al.* (2008a), the strength of bayesian estimated models resides in the combination of reasonable fit to data, coherent structural results from a theoretical perspective, and quite sound insights and results for policy decisions. In the case of CEMAC-GLOBAL, parameters' priors are given by the calibration exercise conducted in the first step with *limited information impulse response matching* approach.

43. Nevertheless, this situation is challenging and could be a good incentive for further research in this particular domain.

Then estimation is conducted, using the *bees algorithm* developed by Yuce *and al.* (2013) [44] as an optimization algorithm to obtain the posterior mode and standard deviations. The bees algorithm is a computational model of swarm intelligence which mimics the foraging behavior of honey bees to find the optimal solution to a given optimization problem. This algorithm is particularly suitable when facing a high dimension optimization problem, which is the case with a large number of model parameters. The estimation procedure has been implemented with 10000 iterations and 20 scout bees (see Yuce *and al.* (2013), p.652). The data used for the estimation are presented in the appendix.

#### 4.3.3 Parametrization of the multicountry version of CEMAC-GLOBAL

Following the approach of Carabenciov *and al.* (2013), the estimated modes of the country-specific estimation step are used to parametrize the multi-country version of CEMAC-GLOBAL. Then the common parameters (especially the monetary policy-related parameters) are calibrated following the "limited information" impulse response matching to replicate the key stylized facts of the CEMAC region. The parameters are detailed in the appendix.

# 5 Analysis of some shocks

In order to assess key characteristics of CEMAC-GLOBAL, some key shocks will be analyzed here : (i) Monetary policy shocks, (ii) Domestic demand shocks, (iii) oil price shock (iv) foreign demand shock, (v) international food price shock, and (vi) fiscal policy shocks.

## 5.1 Monetary policy shocks

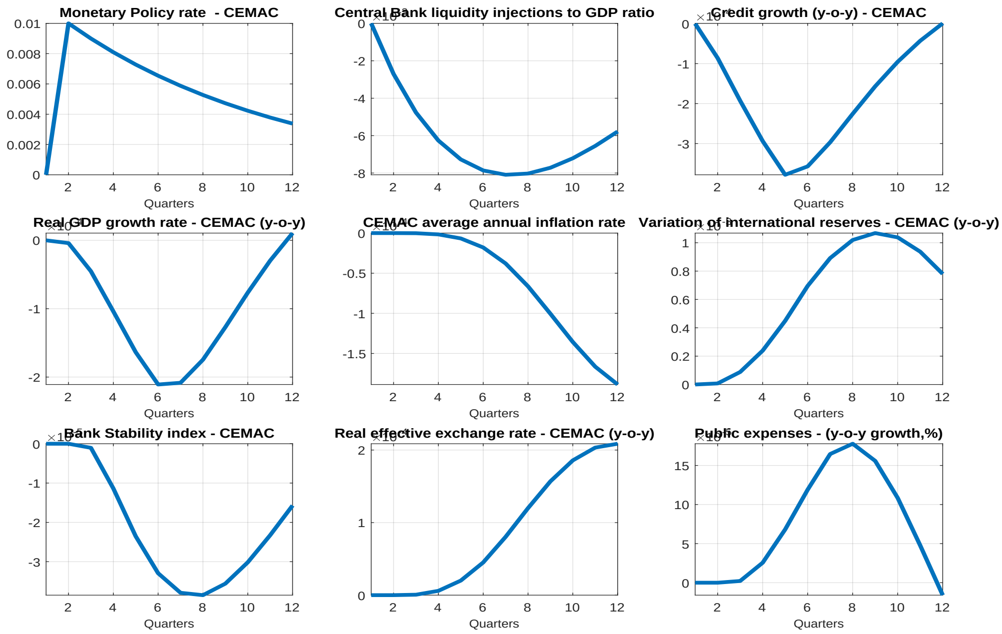
Monetary policy shocks are analyzed through 2 instruments : policy interest rate [45] and liquidity injections.

When the Central Bank raises its main policy interest rate, the level of liquidity

44. Coded by Maih (2019) in the RISE toolbox.
45. Reflecting the manipulation of the *TIAO* (french acronym for "Taux d'intérêt d'appels d'offres"), which is the principal policy rate of BEAC

injections is lowered in order to reduce the supply of money in the interbank market and exert pressure on the interbank interest rate to minimize the interbank spread. This leads to a tightening of the bank credit to the private sector, which negatively affects the output gap (and the economic growth) and the inflation (figure 7). In addition, a lower demand, combined with a depreciation of the real exchange rate, leads to an increase in international reserves[46].

**Figure 7** – *100 basis points policy rate shock : Aggregated impulse responses functions of some CEMAC variables*



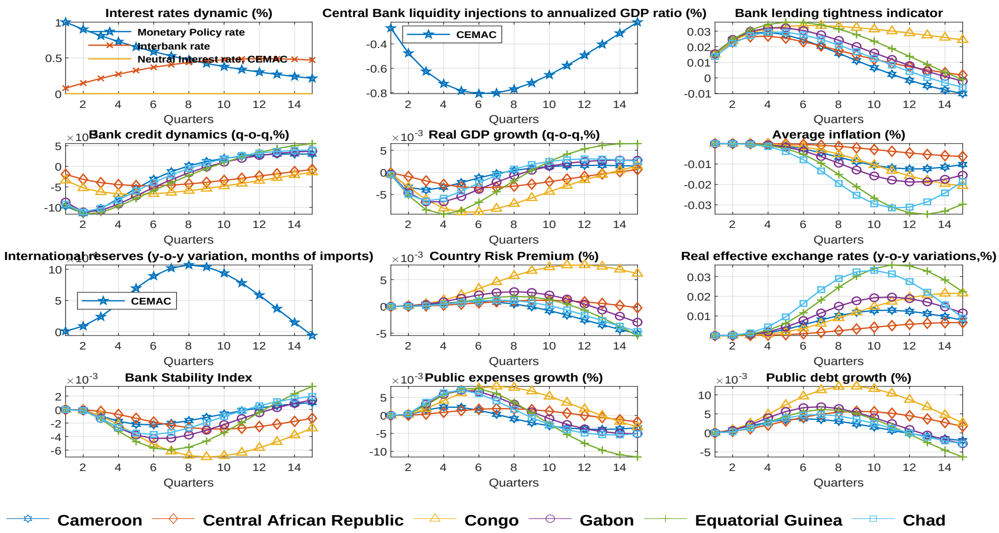

*Source : Author*

When looking at the disaggregated effects of monetary policy shock, the results show an asymmetric response of the CEMAC countries (Figure 8). The amplitude of the shocks is quite different, with Congo having a greater reaction to the monetary policy tightening. The key explanation here is the low level of effectiveness of the fiscal policy reaction to interest rates hike. As estimated fiscal multipliers are smaller than the average of CEMAC countries, fiscal policy stimulus does not generate enough growth to mitigate the effect of the monetary policy tightening. Thus, the combined effect of the recession and the increase in public expenses deteriorate the debt situation in Congo more than in the

46. The intuition behind this dynamics is that a depreciation of the real exchange rate tends to boost exports through price competitiveness effect (see Bahmani-Oskooee and Ratha (2004)).

other CEMAC countries.

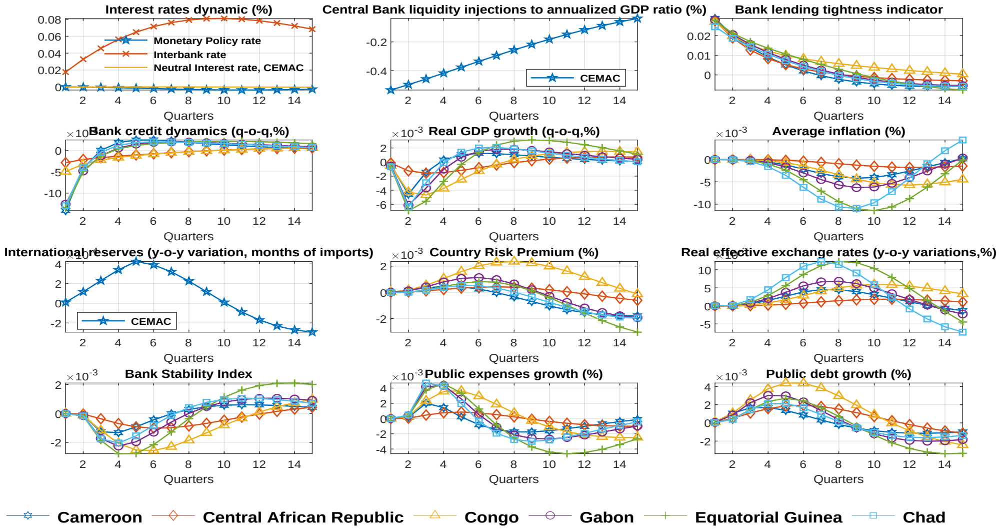
**Figure 8** – *100 basis points policy rate shock : Disaggregated impulse response functions*




*Source : Author*

When the monetary policy shock starts from the central bank liquidity injections (Figure 9), the transmission scheme to credit is similar, but the effect on inflation and international reserves seems more rapid, with a less heterogeneous impact on the different CEMAC countries (except for Congo). This result is similar to those of Bikai and Essiane (2017) and Bikai and Kenkouo (2019), who noted that the liquidity channel seems to be more effective than the interest rate channel in CEMAC.

**Figure 9** – *Central bank liquidity shock : Disaggregated impulse response functions*




*Note : For comparability purposes, the size of the liquidity shock has been calibrated in order to have the same negative variation of the liquidity injections at time 1 than the policy interest rate shock described in figure 8.*

*Source : Author*

Another key message here is that monetary policy can still have some effectiveness despite the fixed exchange rate regime of the CFA zone with the eurozone. Contrary to the conventional understanding of monetary policy under a fixed exchange rate regime (Mundell, 1963; Swoboda, 1973; Frankel *and al.*, 2004; Obstfeld *and al.*, 2005; Rose, 2011), the Central Bank in CEMAC still has some ability to manipulate its nominal interest rate for stabilization purposes. The key factor behind this characteristic is the unconventional peg regime permitted by the legal agreement between the French treasury and the CFA countries. This agreement (i) exempts the Central Bank to sterilize its interventions on the Forex to maintain the fixed exchange rate and (ii) protects the monetary union from speculative attacks. Also, the capital controls applied by the monetary authority reinforce this autonomy of the monetary policy.

## 5.2 Domestic demand shocks

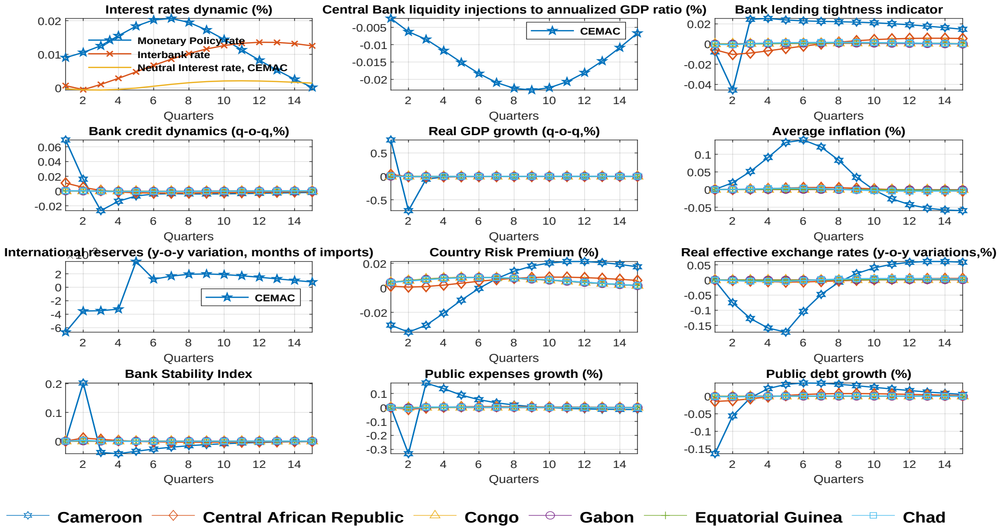
Two domestic demand shocks are simulated : (i) Cameroon's demand shock (Figure 10) and (ii) Central African Republic's demand shock (Figure 11). These two countries are respectively the largest and the smallest economies of CEMAC. Two main findings could be highlighted.

First, CEMAC-GLOBAL reproduces typical demand shock reaction identified in the literature (see Benes *and al.* (2017); Benlamine *and al.* (2018)). After the demand shock, output and inflation rise and international reserves fall, leading to a hike in the nominal policy interest rate. A higher level of economic activity improves bank stability and stimulates credit, in line with real-financial linkages literature (see Bernanke *and al.* (1999)). Here, the fiscal policy is counter-cyclical, with public spending decreasing after a positive demand shock[47].

Second, the spillover effects are quite small, even though the Cameroonian shock has a larger effect on the other CEMAC countries than its Central African Republic's counterpart. This could be explained by the low level of trade integration in the monetary union (see Table 10). However, the impact of country-specific demand shocks on larger economies seems to have a positive impact in the short-run on these economies, and a negative impact on the other countries of the region. This is a consequence of the negative impact of the demand shock on international reserves, which increases the risk of external monetary instability in the monetary union. The monetary policy tightening that follows this sequence of responses contributes to bringing the system back to the balanced growth path.

47. This result could appear counter-intuitive, considering several trends in the literature on fiscal policy cyclicality in developing countries (see Gavin and Perotti (1997); Kaminsky *and al.* (2004); Talvi and Végh (2005); Carmignani (2010); Bouanza *and al.* (2018)), but this model shows that the fiscal policy response depends on the nature of the shock that hits the economies of CEMAC (cf. section 5.3)

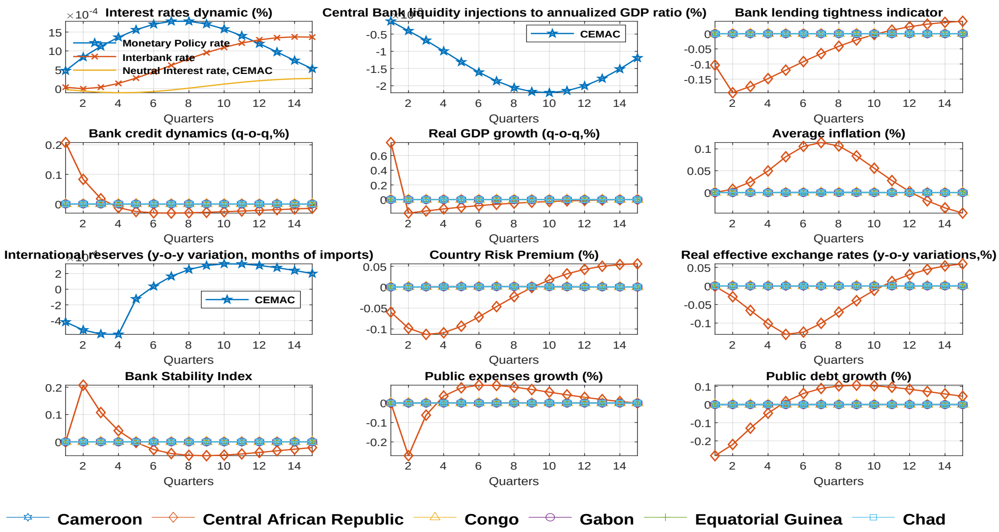
**Figure 10** – *Cameroon's demand shock : Disaggregated impulse response functions*




*Note :The shock is calibrated to simulate a 100 percentage point increase of the non-oil output gap.*

*Source : Author*

**Figure 11** – *Central African Republic Demand shock : Disaggregated impulse response functions*




*Source : Author*

## 5.3 Oil price shock

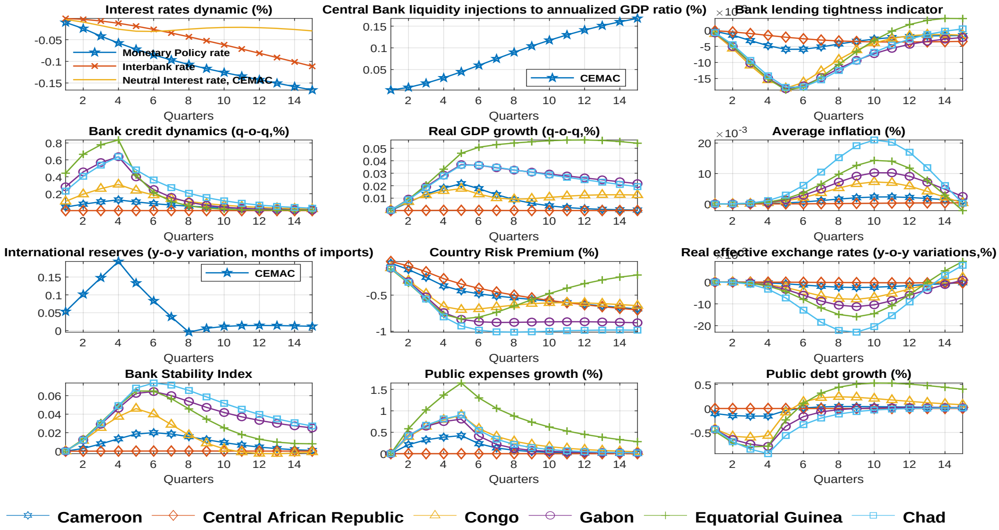
Three main results could be highlighted after a 10 percent increase shock in the oil price (Figure 12).

First, an increase in the oil price leads to higher growth and inflation in oil-exporting economies. A higher level of oil prices broadens fiscal revenues, thus extending the fiscal policy space of oil-exporting countries. This larger policy space facilitates the expansion of public expenses, reduces the country risk premiums of the oil-exporting economies, and ease the credit conditions of most countries in the monetary union. These combined effects boost the economic activity in the non-oil sector. This transmission scheme is in line with several results in the literature on the procyclicality of fiscal policy in Africa or oil-exporting developing economies (see Thornton (2008); Ilzetzki (2011); Mbemba (2011); Berg *and al.* (2015); Bikai (2015); Bova *and al.* (2016); Chuku *and al.* (2018)).

Second, the results show that monetary policy reaction to an oil price shock is procyclical. This reaction stems from the external constraint faced by the Central bank due to its policy objectives. The unconventional fixed exchange regime of CEMAC conducts the Central Bank to target a level of international reserves (see Mvondo (2019a); Ngomba Bodi (2022)). An increase in international reserves after a positive oil price shock leads to a monetary easing, which exacerbates the procyclical behavior of the banking system and the fiscal policy.

Third, an increase in the oil price has a positive, though relatively limited, impact on the banking sector in Central African Republic, although it's not an oil exporter country. The monetary easing that follows the oil price shock, combined with the lower risk premium of the monetary union, lead the banking sector to ease credit conditions in Central African Republic.

**Figure 12** – *Response to a 10 % increase in the Oil price*

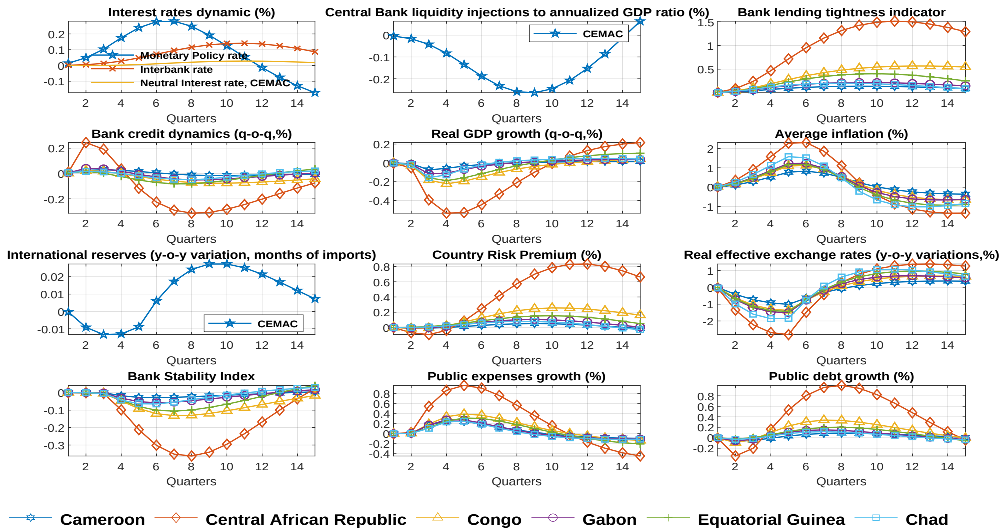



*Source : Author*

## 5.4 International food price shock

Like many developing economies, CEMAC countries are significantly dependent on food imports, making food price shock a key policy concern. A food price shock in CEMAC-GLOBAL increases headline inflation and reduces the level of international reserves (more expensive imports) (Figure 13). In front of the monetary instability induced by the increase in international food prices, the Central Bank tightens its policy by increasing the interest rate and cutting the liquidity injections, to bring back the inflation its the target. This sequence of responses tends to have a recessive effect on the economy, increase the risk premium and generate instability in the banking system. In addition, the Central African Republic seems to be the most harmed economy of CEMAC after an increase in international food prices. This behavior could be explained by a narrower supply of domestic food, which exposes the country to international food price shocks more than other CEMAC countries.

**Figure 13** – *International food price shock : Disaggregated impulse response functions*




*Source : Author*

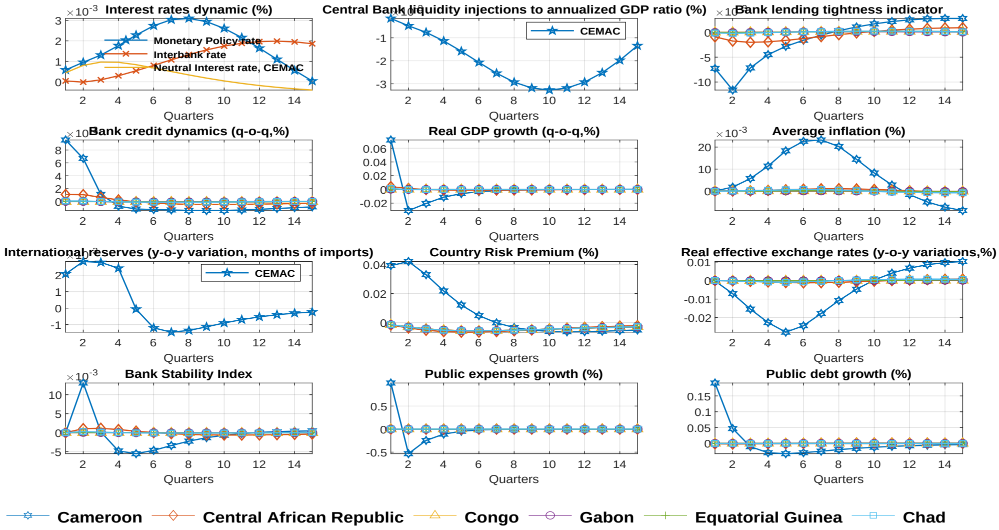
## 5.5 Fiscal policy shocks

Fiscal policy in a monetary union is a key issue in economic literature both on developed and developing countries [48]. In particular, a key concern is the level of coordination of fiscal policy in monetary unions. Two fiscal policy scenarios has been simulated : (i) A single country-specific shock (Figure 14) and (ii) a coordinated fiscal policy shock (Figure 15).

Country-specific fiscal stimulus increases demand, following the same scheme described in section 5.2, except for public debt, country risk premium, and international reserves. Here, the fiscal stimulus in Cameroon increases public debt and the Cameroonian risk premium. The expansion of external debt temporarily increases the level of international reserves and contributes to mitigating the monetary policy tightening induced by the fiscal policy stimulus. Again, the spillover effects is low, with a noticeable effect only on the Central African Republic.

48. See Avom (2007) for a discussion on CEMAC economies.

**Figure 14** – *Cameroon's fiscal policy shock : Disaggregated impulse response functions*

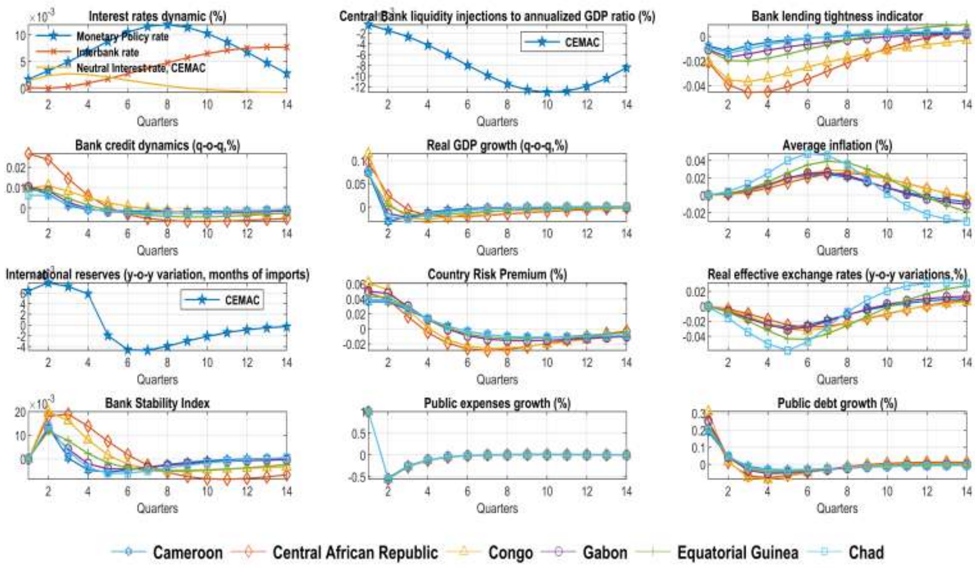



*Source : Author*

The coordinated fiscal shock impulses have the same qualitative evolution as the country-specific ones. This result is not surprising, considering the low level of trade and financial integration in CEMAC [49].

49. Another possible reason could be found in the structure of the model, which only connects the outputs gaps of the countries of the monetary union. A future extension of the model could address this issue by integrating also the trends. Nevertheless, the spillover effects could be *a priori* similar, considering the low level of trade integration in CEMAC.

**Figure 15** – *Coordinated fiscal policy shock : Disaggregated impulse response functions*




*Source : Author*

# 6 Historical decompositions

The modelling approach of CEMAC-GLOBAL permits analyzing the contribution of the shocks to the variables' dynamics through both geographic and economic perspectives. This is an advantage if the policy analyst wants, for example, to understand if the policy interest rate evolution responds to symmetric or asymmetric dynamics of the economies of a monetary union.

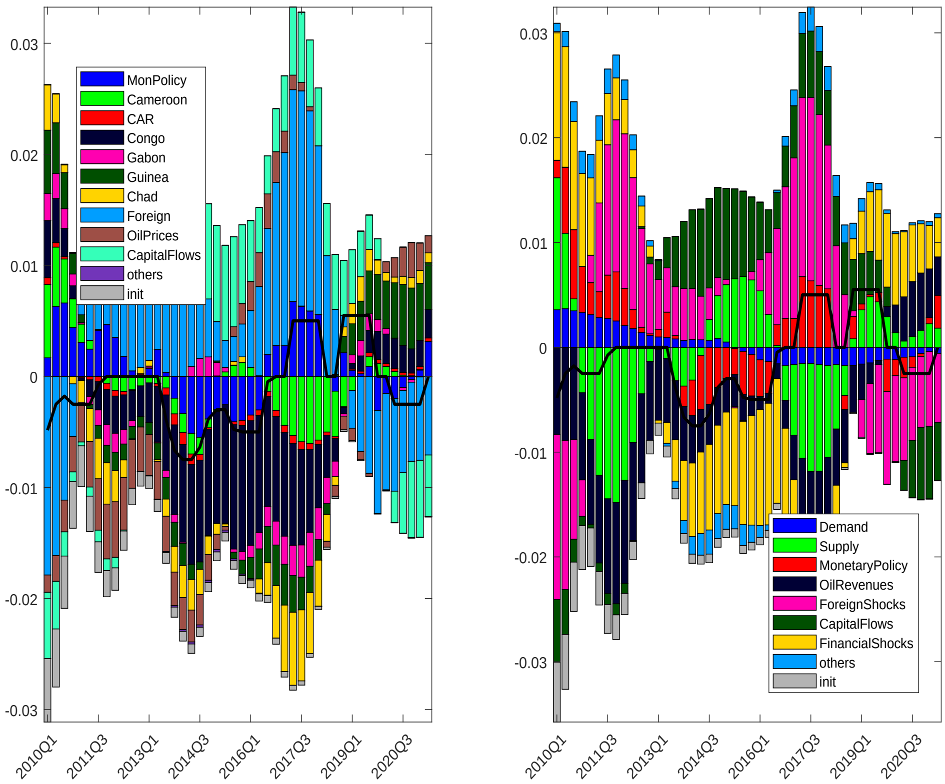
The decomposition of the main policy interest rate of BEAC [50] shows that the country-specific economic shocks affected the TIAO in the same direction during the 2010 decade (Figure 16). In the early 2010s, CEMAC countries positively contributed to the evolution of the policy interest rate, in a context of financial conditions easing and a greater demand affecting the economic activity (Figure 31 page 117), inflation (Figure 32 page 118) and international reserves (Figure 33 page 119). Then, a second phase followed, characterized by a negative contribution to TIAO of every CEMAC country. This phase regrouped

50. The TIAO, see section 5.1

two very different economic situations. First, the favorable profile of oil prices before the second semester of 2014 significantly contributed to the evolution of international reserves, thus relaxing the external constraint faced by the Central Bank. In addition, the low level of inflation during this period didn't encourage the Central Bank to tighten its monetary policy. Second, the reversal of the oil price dynamics after the 2014 shock deteriorated the economic growth in CEMAC (Figure 31). Combined with inflation still low in the region, the monetary policy maintained its accommodative stance till late 2016. Then the third phase started, with positive contributions to interest rate dynamics of every CEMAC country, caused by their negative impact on international reserves evolution and the impact of the COVID-19 pandemic.

This kind of analysis could be conducted for every variable of the model. For parsimony purposes, only a few historical decompositions are presented in this paper (see appendix, page 117).

**Figure 16** – *Historical decomposition of monetary policy rate (variations, y-o-y)*




*Source : Author*

# 7 Future extensions

CEMAC-GLOBAL is an ongoing modelling project and the version presented in this paper is a baseline specification. Although this version of CEMAC-GLOBAL is useful for spillover analysis of several shocks in CEMAC and the study of the asymmetric effect of monetary policy shocks, it could be improved in several ways. First, a more structural specification of the foreign economy could be implemented, following Carabenciov *and al.* (2013) or Dieppe *and al.* (2018). This approach would improve the simulation capacities of the model concerning foreign shocks. Second, the model could disaggregate the inflation dynamics to analyze the evolution of core, food and energy inflation more explicitly. Considering the rising issues concerning inflation since the COVID-19 pandemics, this refinement of the inflation analysis could be interesting (see Benlamine *and al.* (2018)). Third, the model could take into consideration the term structure of the interest rates, in order to integrate yield curves analysis in the simulations, following Dieppe *and al.* (2018) and Benes *and al.* (2017). Fourth, this version of CEMAC-GLOBAL does not explicitly consider the degree of capital control in the monetary policy rule, contrary to Benlamine *and al.* (2018). Even if the Central Bank does not explicitly apply strict capital control, including this feature could serve for policy simulation purposes. Fifth, the model could include regime-switching features, to reflect various macroeconomic regimes that could lead to different economic policy behaviors, as noted in Mvondo (2019a). These limitations can be addressed in future extensions of the model.

# Conclusion

This paper introduced a semi-structural macroeconomic model for policy analysis, risk assessment, and forecasting in the CEMAC monetary union. It departs from previously known models of the CEMAC economy mainly by modelling every country of the monetary union, which allows studying the asymmetric effects of the monetary policy and the spillover effect of various shocks like national fiscal policy shocks. The model also (i) captures the features of the unconventional fixed exchange rate regime of the CEMAC, (ii) distinguishes the oil and non-oil output with an interaction between these sectors through fiscal policy, (iii) specifies a detailed monetary policy transmission by considering liquidity injections and a simple interbank interest rate dynamics, (iv) includes real-financial linkages with a credit cycle dynamics affecting the business cycle and (v) integrates some hysteresis effects with fiscal stimulus depending on the headline economic growth.

The potential use of the model has been illustrated by discussing country-specific and monetary-union level responses to monetary policy shocks, demand shocks, oil price shock, foreign demand shock, international food price shock, country-specific and coordinated fiscal shocks and credit supply shock. In addition, the empirical performance has been assessed through the historical decomposition of the GDP growth, inflation, international reserves, and bank credit. These simulations showed that monetary policy has an asymmetric effect on CEMAC countries, with a greater impact on countries with a less prominent oil sector. In addition, the size of the spillover effects seems to increase with the size of the country where the shock occurs. Also, coordinated fiscal impulses have a greater positive impact on the CEMAC output than country-specific ones, however with a negative impact on international reserves and the country risk premium. Obviously, a vast variety of simulations and scenarios can be analyzed with CEMAC-GLOBAL, and numerous studies could explore specific policy issues based on this model.

CEMAC-GLOBAL is still an ongoing modelling process and future versions could address progressively its limitations, among which are the lack of granularity of inflation dynamics, the oversimplified foreign sector modelling, or the absence of regime-switching behavior.

# References


Abuka, C., Alinda, R. K., Minoiu, C., Peydró, J. L. and Presbitero, A. F. (2019) ; « Monetary policy and bank lending in developing countries : Loan applications, rates, and real effects » : *Journal of Development Economics*, **139**(November 2018), p. 185–202

African Development Bank and African Union (2009) ; *Oil and gas in Africa* : Oxford University Press, 231 p.

Agénor, P.-R., da Silva, L. A. P. and da Silva, L. A. P. (2011) ; « Macroeconomic Stability, Financial Stability, and Monetary Policy Rules » : *Ferdi Working Papers*, (29)

Alpanda, S., Kotzé, K. and Wolgom, G. (2011) ; « Forecasting Performance Of An Estimated Dsge Model For The South African Economy » : *South African Journal of Economics*, **79**(March), p. 50–67

Assemien, A., Esso, L. J., Kanga, K. D. and Esso, L. J. (2019) ; « Can Monetary Policy Influence Employment ? The case of West African States » : *Revue d'Economie Politique*, **129**(5), p. 777–813

Assoumou, O. (2017) ; « Public debt and financial stability : The case of economic community and monetary union of central Africa (EMCCA) » : *Journal of Economics and International Finance*, **9**(9), p. 89–94

Avom, D. (2007) ; « La coordination des politiques budgétaires dans une union monétaire : l'expérience récente des pays de la CEMAC » : *Revue Tiers Monde*, **4**(192), p. 871–893

Bahmani-Oskooee, M. and Ratha, A. (2004) ; « The J-curve : A literature review » : *Applied Economics*, **36**(13), p. 1377–1398

de Bandt, O. and Hartmann, P. (2000) ; « Systemic risk : A survey » : *SSRN Electronic Journal*

Banque des Etats de l'Afrique Centrale (2017) ; « Statuts de la Banque des Etats de l'Afrique Centrale » :

Banque des Etats de l'Afrique Centrale (2019) ; « Bulletin du Marché Monétaire » : **Décembre**

Banque des Etats de l'Afrique Centrale (2021) ; « Rapport sur la Politique Monétaire (Décembre 2021) » : *Rapport technique*, Banque des Etats de l'Afrique Centrale

Bauducco, S., Christiano, L. J. and Raddatz, C. E. (2014) ; « Macroeconomic and financial stability : an overview » : *Series on Central Banking Analysis and Economic Policies*, (19) Beck, R., Jakubik, P. and Piloiu, A. (2013) ; « Non-performing loans : What matters in addition to the economic cycle ? » : *ECB Working Paper Series*, (1515)

Benes, J., Clinton, K., George, A., Gupta, P., John, J., Kamenik, O., Laxton, D., Mitra, P., Nadhanael, G., Portillo, R., Wang, H. and Zhang, F. (2017) ; « Quarterly Projection Model for India : Key Elements and Properties » : *IMF Working Paper Series*, (WP/17/33)

Benlamine, M., Bulíř, A., Farouki, M., Horváth, Á., Hossaini, F., Szilágyi, K., Taamouti, M. and Vávra, D. (2018) ; « Morocco : A Practical Approach to Monetary Policy Analysis in a Country with Capital Controls » : *IMF Working Paper Series*, (WP/18/27)

Benoit, S., Colliard, J.-E., Hurlin, C. and Pérignon, C. (2016) ; « Where the risks lie a survey on systemic risk » : *Review of Finance*, (p. 1–44)

Berg, A., Karam, P. and Laxton, D. (2006) ; « Practical Model-Based Monetary Policy Analysis — A How-To Guide » : *IMF Working Paper Series*, (WP/06/81)

Berg, A., Yang, S.-C. S. and Zanna, L.-F. (2015) ; « Modeling African Economies : A DSGE Approach » : *Dans* Monga, C. and Lin, J. Y. (Rédacteurs) *The Oxford Handbook of Africa and Economics*, tome 1 : Context, (p. 1–30)

Bernanke, B. S. and Gertler, M. (1995) ; « Inside the Black Box : The Credit Channel of Monetary Policy Transmission » : *Journal of Economic Perspectives*, **9**(4), p. 27–48

Bernanke, B. S., Gertler, M. and Gilchrist, S. (1999) ; « The financial accelerator in a quantitative business cycle framework » : *Handbook of Macroeconomics*, **1**(PART C), p. 1341–1393

Bianchi, J. and Bigio, S. (2022) ; « Banks, Liquidity Management, and Monetary Policy » : *Econometrica*, **90**(1), p. 391–454

Bikai, J. L. (2015) ; « Règles de surveillance multilatérales et pro cyclicité de la politique budgétaire dans la zone CEMAC » : *BEAC Working Paper Series*, **2015**(BWP N°07/15)

Bikai, J. L. and Essiane, P.-N. D. (2017) ; « Politique monétaire, stabilité monétaire et croissance économique dans la CEMAC : une approche SVAR bayésienne » : *BEAC Working Paper Series*, (BWP 08/17)

Bikai, J. L. and Kenkouo, G. A. (2019) ; « Analysis and evaluation of the transmission channels of monetary policy in CEMAC : A SPVAR-X approach » : *Mondes en développement*, **185**(1), p. 109–132

Bikai, J. L. and Mbohou Mama, M. (2018) ; « Stabilité bancaire et stabilité macroéconomique dans la CEMAC » : *BEAC Working Paper Series*, (12/18)

Bikai, J. L. and Ngomba Bodi, F. G. (2019) ; « Les prévisions conditionnelles sont-elles plus précises que les prévisions inconditionnelles dans les projections de croissance et d'inflation en zone CEMAC ? » : *BEAC Working Paper Series*, (03/19), p. 30

Bikai, J. L., Yogo, T. U. and Essiane, P.-N. D. (2017) ; « Quantification du multiplicateur budgétaire dans les pays de la CEMAC » : *BEAC Working Paper Series*, (BWP 07/17)

Bikai, L. and Mbohou Mama, M. (2016) ; « Une fonction de réaction pour la Banque des Etats de l'Afrique Centrale dans un contexte de dominance budgétaire » : *BEAC Working Paper Series*, (BWP 04/16), p. 1–28

Black, R., Laxton, D., Rose, D. and Tetlow, R. (1994) ; « The Steady-State Model : SSQPM » : *Dans The Bank of Canada's New Quarterly Projection Model*, chapitre The Steady, Bank of Canada

Bokan, N. and Ravnik, R. (2018) ; « Quarterly Projection Model for Croatia » : *Croatian National Bank Surveys*, (S-34)

Borio, C. (2012) ; « The financial cycle and macroeconomics : What have we learnt ? » : *BIS Working Papers*, (395)

Bouanza, J. R. F. K., Ngassa, T. C. and Ndinga, M. M. A. (2018) ; « The Effects of Regulatory Quality on the Pro-Cyclicality of Fiscal Policy in Countries in the Central African Economic and Monetary Community (CA EMC) » : *Modern Economy*, **09**(07), p. 1228–1246

Bova, E., Medas, P. and Poghosyan, T. (2016) ; « Macroeconomic Stability in Resource-Rich Countries : The Role of Fiscal Policy » : *IMF Working Papers*, (WP/16/36)

Carabenciov, I., Ermolaev, I., Freedman, C., Juillard, M., Kamenik, O., Korshunov, D. and Laxton, D. (2008a) ; « A Small Quarterly Projection Model of the US Economy » : *IMF Working Papers*, **08**(278), p. 1

Carabenciov, I., Ermolaev, I., Freedman, C., Kamenik, O., Juillard, M., Korshunov, D., Laxton, D. and Laxton, J. (2008b) ; « A Small Quarterly Multi-Country Projection Model » : *IMF Working Papers*, **08**(279), p. 1

Carabenciov, I., Freedman, C., Garcia-Saltos, R., Laxton, D., Kamenik, O. and Manchev, P. (2013) ; « GPM6 : The Global Projection Model with 6 Regions » : *IMF Working Papers*, **13**(87), p. 1

Carmignani, F. (2010) ; « Cyclical fiscal policy in Africa » : *Journal of Policy Modeling*, **32**(2), p. 254–267

Caruana, J., Hawkins, P., Jeanneau, S., Christensen, B. V. V., Christensen, B. V., Rangasamy, L., Mihaljek, D. and Yunus, M. (2011) ; « Central Banking in Africa : Prospects in a Changing World » : *BIS Papers*, (56)

Cerra, V., Fatás, A. and Saxena, S. C. (2020) ; « Hysteresis and Business Cycles » : *IMF Working Paper Series*, (WP/20/73)

Chafik, O. (2019) ; « Monetary Policy in oil exporting countries with fixed exchange rate and open capital account : expectations matter » : *MPRA Paper*, (92558), p. 0–33

Chuku, C., Simpasa, A. and Oduor, J. (2018) ; « Macroeconomic Consequences of Commodity Price Fluctuations in African Economies » : *African Development Review*, **30**(4), p. 329–345

Clausen, V. and Hayo, B. (2006) ; « Asymmetric monetary policy effects in EMU » : *Applied Economics*, **38**(10), p. 1123–1134

Coletti, D., Hunt, B., Rose, D. and Tetlow, R. (1996) ; « The Dynamic Model : QPM » : *Dans The Bank of Canada's New Quarterly Projection Model*, chapitre The Dynami, Bank of Canada

Cross, R. (1993) ; « On the Foundations of Hysteresis in Economic Systems » : *Economics and Philosopy*, **9**(October 2009), p. 53–74

Das, U. S., Papapioannou, M., Pedras, G., Ahmed, F. and Surti, J. (2010) ; « Managing Public Debt and its Financial Stability Implications » : *IMF Working Papers*, **10**(280), p. 1

Delong, J. B. and Summers, L. (2012) ; « Fiscal Policy in a Depressed Economy » : *Brookings Papers on Economic Activity*, **43**(1 (Spring)), p. 233–297

Diaw, A. and Sall, A. K. (2018) ; « Inflation Targeting : What Rule for the Central Bank of West African States ( BCEAO ) ? » : *Revue d'Economie du développement*, **26**(2), p. 5–49

Dieppe, A., Georgiadis, G., Ricci, M., Robays, I. V. and van Roye, B. (2018) ; « ECB-Global : introductin ECB's global macroeconomic model for spillover analysis » : *Economic Modelling*, **72**(June 2018), p. 78–98

Diouf, A. and Laporte, B. (2018) ; « Oil contracts and government take : Issues for Senegal and developing countries » : *Journal of Energy and Development*, **43**(2), p. 213–234

Dwarkasing, M., Dwarkasing, N. and Ongena, S. (2017) ; « The Bank Lending Channel of Monetary Policy : A Review of the Literature and an Agenda for Future Research » : *Dans The Palgrave Handbook of European Banking*, (p. 383–407)

Essiane, P.-N. D. and Ngomba Bodi, F. G. (2018) ; « Estimation des élasticités du commerce extérieur dans des économies en développement riches en ressources naturelles : le cas des pays de la CEMAC » : *BEAC Working Paper Series*, (BWP 05/15)

Fall, A. and Sy, D. (2019) ; « La politique monétaire de la BCEAO face au double ancrage : ciblage d'inflation et ciblage du taux de change » : *Revue d'Economie du développement*, **27**(4), p. 129–175

Fatás, A. and Summers, L. H. (2018) ; « The Permanent Effects of Fiscal Consolidations » : *Journal of International Economics*, **112**(May 2018)

Fofack, H. (2005) ; « Nonperforming loans in Sub-Saharan Africa : causal analysis and macroeconomic implications » : *World Bank Policy Research Working Paper Series*, (3769)

Fossouo Kamga, A. L. (2015) ; « Etude des propriétés de long terme de l'inflation dans les pays de la CEMAC : Une approche ARFIMA » : *BEAC Working Paper Series*, (04/15)

Fouopi Djiogap, C. and Ngomsi, A. (2012) ; « Determinants of Bank Long-Term Lending Behavior in The Central African Economic and Monetary Community ( CEMAC ) » : *Review of Economics and Finance*, (May 2012), p. 107–114

Frankel, J., Schmukler, S. L. and Serven, L. (2004) ; « Global transmission of interest rates : monetary independence and currency regime » : *Journal of international Money and Finance*, **23**(5), p. 701–733

Gavin, M. and Perotti, R. (1997) ; « Fiscal Policy in Latin America » : *NBER Macroeconomics Annual*, **12**(1997), p. 11–61

Georgiadis, G., Hildebrand, S., Ricci, M., Schumann, B. and Roye, B. V. (2021) ; « ECB-Global 2.0 : a global macroeconomic model with dominant-currency pricing, tariffs and trade diversion » : *ECB Working Paper Series*, **March 2021**(2530)

Hamiani, E., Buessing-loercks, M. and Fleuriet, V. (2020) ; « Monetary Policy Under an Exchange Rate Anchor » : *IMF Working Paper Series*, (WP/20/180)

Hlédik, T., Musil, K., Rysanek, J. and Jaromir, T. (2018) ; « A macroeconomic Forecasting Model of the FIxed Exchange Rate Regime for the Oil-Rich Kazakh Economy » : *Czech National Bank Working Paper Series*, (11)

Huizinga, H. and Laeven, L. (2019) ; « The Procyclicality of Banking : Evidence from the Euro Area » : *ECB Working Paper Series*, (2288)

Ilzetzki, E. (2011) ; « Rent-seeking distortions and fiscal procyclicality » : *Journal of Development Economics*, **96**(1), p. 30–46

Kaminsky, G. L., Reinhart, C. M. and Végh, C. A. (2004) ; « When It Rains, It Pours : Procyclical Capital Flows and Macroeconomic Policies » : *NBER Macroeconomics Annual*, **19**(October), p. 11–53

Keungne K., L. S., Mounkala, E. U. H. and Mukam M., A. (2016) ; « Optimalité de la politique monétaire de la BEAC depuis 2001 » : *BEAC Working Paper Series*, (03/16)

Lang, J. H. and Welz, P. (2018) ; « Semi-structural credit gap estimation » : *ECB Working Paper Series*, (2194)

Lemoine, M., Turunen, H., Lepetit, A., Zhutova, A., Clerc, P. and Laffargue, J.-p. (2019) ; « The FR-BDF Model and an Assessment of Monetary Policy Transmission in France » : *Banque de France Working Paper Series*, (736)

Liu, G., Gupta, R. and Schaling, E. (2009) ; « A new-keynesian DSGE model for forecasting the South African Economy » : *Journal of Forecasting*, **28**(5), p. 387–404

Maih, J. (2019) ; « Rationality In Switching Environments (RISE) Toolbox » : URL https://github.com/jmaih/RISE_toolbox

Mandiefe Piabuo, S., Menjo Baye, F. and Julius, C. T. (2015) ; « Effects of credit constraints on the productivity of small and medium-sized enterprises in Cameroon » : *Journal of Economics and International Finance*, **7**(9), p. 204–212

Mbemba, A. (2011) ; « Fiscal Policy in Selected African Countries : The CFA Franc Zone » : *International Journal of Economics and Finance*, **3**(2), p. 101–110

Mishra, P. and Montiel, P. (2013) ; « How effective is monetary transmission in low-income countries ? A survey of the empirical evidence » : *Economic Systems*, **37**(2), p. 187–216

Mishra, P., Montiel, P., Pedroni, P. and Spilimbergo, A. (2014) ; « Monetary policy and bank lending rates in low-income countries : Heterogeneous panel estimates » : *Journal of Development Economics*, **111**, p. 117–131

Mundell, R. A. (1963) ; « Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates » : *The Canadian Journal of Economics and Political Science*, **29**(4), p. 475–485

Mvondo, E. T. (2018a) ; « A la recherche de l'amplitude optimale du corridor des facilités permanentes de la BEAC » : *BEAC Working Paper Series*, (BWP 11/18), p. 1–18

Mvondo, E. T. (2018b) ; « La pertinence du TIAO comme instrument de politique monétaire de la BEAC : Fondements théoriques et évaluation empirique » : *BEAC Working Paper Series*, (03/17)

Mvondo, E. T. (2019a) ; « Oil Shocks and Macroeconomic Effects of Occasionally Binding Constraint on External Reserves of CEMAC » : *International Journal of Business and Economic Research*, **8**(6), p. 422–438

Mvondo, E. T. (2019b) ; « Réformes financières et formation des taux d'intérêt en Afrique Centrale : une approche à travers le modèle DSGE » : *Revue Interventions Economiques*, (61)

Mvondo, E. T. (2020) ; « Stabilisation et relance macroéconomique post COVID-19 dans la CEMAC. Quels instruments pour quels effets dans un modèle DSGE ? » : *BEAC Working Paper Series*, (01/20)

Ngomba Bodi, F. G. (2022) ; « External Constraints and Procyclicality of the Monetary Policy of the Bank of Central African States » : *BEAC Working Paper Series*, (Forthcoming)

Obstfeld, M., Shambaugh, J. C. and Taylor, A. M. (2005) ; « The trilemma in history : tradeoffs among exchange rates, monetary policies, and capital mobility » : *Review of economics and statistics*, **87**(3), p. 423–438

Peiris, S. J. and Saxegaard, M. (2010) ; « An estimated dynamic stochastic general equilibrium model for monetary policy analysis in Mozambique » : *IMF Staff Papers*, **57**(1), p. 256–280

Poloz, S., Rose, D. and Tetlow, R. (1994) ; « The Bank of Canada's new Quarterly Projection Model (QPM) : An introduction » : *Bank of Canada Review*, **20**, p. 23–38

Rose, A. K. (2011) ; « Exchange rate regimes in the modern era : fixed, floating, and flaky » : *Journal of Economic Literature*, **49**(3), p. 652–672

Shaughnessy, T. O. (2011) ; « Hysteresis in unemployment » : *Oxford Review of Economic Policy*, **27**(2), p. 312–337

Smets, F. (2014) ; « Financial Stability and Monetary Policy : How Closely Interlinked ? » : *International Journal of Central Banking*, **10**(2)

Swoboda, A. K. (1973) ; « Monetary Policy under Fixed Exchange Rates : Effectiveness , the Speed of Adjustment and Proper Use » : *Economica*, **40**(158), p. 136–154

Talvi, E. and Végh, C. (2005) ; « Tax Base Variability and Procyclicality of Fiscal Policy » : *Journal of Development Economics*, **78**

The Growth Lab at Harvard University (2019) ; « International Trade Data (HS,92) » : *Harvard Dataverse*, **V2**

Thornton, J. (2008) ; « Explaining procyclical fiscal policy in African countries » : *Journal of African Economies*, **17**(3), p. 451–464

Wiegand, J. (2004) ; « Fiscal Surveillance in a Petro Zone : The Case of the CEMAC » : *IMF Working Papers*, **008**

Yuce, B., Packianather, M. S., Mastrocinque, E., Pham, D. T., Lambiase, A. and Parade, T. (2013) ; « Honey Bees Inspired Optimization Method : The Bees Algorithm » : *Insects*, **4**, p. 646–662

# Appendix

## Data

**Table 1** – *Description of Data*

| Observable | Variable name | Indicator | Source | Period | Observations |
|---|---|---|---|---|---|
| $\widehat{y}^{*}_{i,t}$ | Foreign output gap | Output gap USA | St. Louis Federal Reserve https://fred.stlouisfed.org/graph/?g=f1cZ | 2000Q1-2021Q2 | Cyclical component of the HP-filtered US real GDP |

*Continued on next page*

– Continued from previous page

| Observable | Variable name | Indicator | Source | Period | Observations |
|---|---|---|---|---|---|
| $p_t^{oil}$ | Oil prices | Log of Brend oil prices (current US dollars per barrel) | US Energy Information Administration, https://www.eia.gov/outlooks/steo/data.php?type=tables | 2000Q1-2021Q2 | |
| $i_t^*$ | Foreign interest rate | ECB main refinancing rate | European Central Bank | 2000Q1-2021Q2 | |
| $\pi_t^{eu}$ | Eurozone Q-o-Q inflation rate | Q-o-Q growth rate of the Eurozone consumer price index | International Monetary Fund, International Financial Statistics database | 2000Q2-2021Q2 | |

Continued on next page

– *Continued from previous page*

| **Observable** | **Variable name** | **Indicator** | **Source** | **Period** | **Observations** |
|---|---|---|---|---|---|
| $\pi_t^{us}$ | US Q-o-Q inflation rate | Q-o-Q growth rate of the US consumer price index | International Monetary Fund, International Financial Statistics database | 2000Q2-2021Q2 | |
| $s_t^{eur,usd}$ | Euro-USD exchange rate | Euro-USD exchange rate | International Monetary Fund, International Financial Statistics database | 2000Q1-2021Q2 | |
| $\pi_{i,t}^{food}$ | International Food prices | FAO Food Price Index | Food and Agriculture Organization of the United Nations | 2000Q1-2021Q2 | |

*Continued on next page*

– *Continued from previous page*

| **Observable** | **Variable name** | **Indicator** | **Source** | **Period** | **Observations** |
|---|---|---|---|---|---|
| $\Delta y_{it}$ | Headline real economic q-o-q growth of CEMAC country i | Q-o-Q Real GDP growth of country i | Bank of Central African States (BEAC) | 2000Q1-2021Q2 | Real GDP published in BEAC Monetary Policy Reports statistical appendix. Chow-Lin temporal disaggregation has been applied on the annual data using Quarterly data on broad money (M2) data published by the Bank of Central African States |
| $\Delta y_{it}^{oil}$ | Oil sector Q-o-Q real GDP of country i | Oil sector Q-o-Q real GDP of country i | Bank of Central African States (BEAC) | 2000Q1-2021Q2 | Q-o-Q growth rate of the real GDP published in BEAC Monetary Policy Reports statistical appendix. Chow-Lin temporal disaggregation has been applied on the annual data using Quarterly data on broad money (M2) data published by the Bank of Central African States |
| $\pi_{i,t}^4$ | Y-O-Y inflation of country i | Y-o-Y growth rate of the Harmonized Consumer Price index of country i | Bank of Central African States (BEAC) | 2002Q1-2021Q2 | Data published by the Bank of Central African States based on National Institutions in charge of Statistics of CEMAC countries. |

*Continued on next page*

– *Continued from previous page*

| Observable | Variable name | Indicator | Source | Period | Observations |
|---|---|---|---|---|---|
| $sh_{it}^{oil}$ | Share of oil GDP in headline real GDP of country i | Share of oil GDP in headline real GDP of country i | Bank of Central African States (BEAC) | 2000Q1-2021Q2 | Indicator computed by the author based on annual data on headline real GDP of country i. The Denton temporal disaggregation method has been used to obtain the quarterly indicator. |
| $\Delta g_{i,t}$ | Q-o-Q growth rate of nominal public expenses of country i | Q-o-Q growth rate of Current public expenses of country i | Bank of Central African States (BEAC) | 2000Q1-2021Q2 | Data published by the Bank of Central African States based on National Treasury data. The quarterly data is obtained by using the Denton temporal disaggregation method on the annual data. |
| $debt_{i,t}$ | Debt to GDP ratio of country i | External Debt to GDP Ratio used of country i | Bank of Central African States (BEAC) | 2000Q1-2021Q2 | Data published by the Bank of Central African States based on National Treasury data. The quarterly data is obtained by using the Denton temporal disaggregation method on the annual data. |
| $\Delta cr_{i,t}$ | Q-o-Q credit growth of country i | Q-o-Q credit to private sector of country i | Bank of Central African States (BEAC) | 2006Q1-2021Q2 | Author's calculations based on the monthly Data published by the Bank of Central African States (Monetary statistics) |

*Continued on next page*

– *Continued from previous page*

| **Observable** | **Variable name** | **Indicator** | **Source** | **Period** | **Observations** |
|---|---|---|---|---|---|
| $RESMIMP_t$ | International Reserves of CEMAC in months of imports | International reserves of CEMAC in months of exports | Bank of Central African States (BEAC) | 2000Q1-2021Q2 | Author's calculations based on international reserves stocks of CEMAC and quarterly data on current imports of CEMAC (obtained by temporal disaggregation of Annual imports data published by the Bank of Central African States). The indicator is the ratio of international reserves at time t and the imports at time t. |
| $IPOLICY_t$ | Central Bank Policy interest rate | Taux d'intérêt d'Appels d'Offres (TIAO) | Bank of Central African States (BEAC) | 2000Q1-2021Q2 | |

*Continued on next page*

– *Continued from previous page*

| **Observable** | **Variable name** | **Indicator** | **Source** | **Period** | **Observations** |
|---|---|---|---|---|---|
| $IINTERBANK_t$ | Interbank market interest rate | Taux d'intérêt moyen pondéré (TIMP) | Bank of Central African States (BEAC) | 2000Q1-2021Q2 | The data on the Interbank rate has been compiled from 2 main sources : (i) the BEAC annual reports published from 2001 to 2017 and (ii) the monthly interbank rates statistics of the 2018-2021 period published by the Bank of Central African States. The BEAC annual reports published from 2001 to 2017 present annual average interbank rates (except for the 2002Q1-2004Q4 period, where monthly data are reported). The Denton temporal disaggregation technique has been used to obtain quarterly interbank rates for the 2001Q1-2001Q4 and 2005Q1-2017Q4 periods. For the 2018Q1-2021Q2 period, the quarterly average of the unsecured interbank rate (Taux Interbancaire Moyen pondéré sur les opérations en blanc for the french denomination) has been considered. |

*Continued on next page*

*– Continued from previous page*

| **Observable** | **Variable name** | **Indicator** | **Source** | **Period** | **Observations** |
|---|---|---|---|---|---|
| $CBINJEC_t$ | Central Bank liquidity injection to real GDP ratio | Ratio between the net liquidity injections of the Bank of Central African States and the real GDP of CEMAC | Bank of Central African States (BEAC) | 2000Q1-2021Q2 | The net liquidity injections have been computed by substracting the liquidity punctions of the Central from the total liquidity injection of the Central Bank on the CEMAC money market. The data has been collected from the BEAC website. |

**Table 2** – *Descriptive statistics of observables data over the estimation period (2006Q1-2019Q4)*

| Observables | Mean | Std. | Min | 25th percentile | Median | 75th percentile | Max |
|---|---|---|---|---|---|---|---|
| Central Bank liquidity injections to GDP ratio | -0.0051 | 0.05 | -0.14 | -0.033 | 0.0012 | 0.029 | 0.071 |
| Credit growth (q-o-q) - Central African Republic | 0.021 | 0.075 | -0.13 | -0.028 | 0.014 | 0.055 | 0.26 |
| Credit growth (q-o-q) - Cameroon | 0.023 | 0.031 | -0.039 | -0.00011 | 0.016 | 0.043 | 0.12 |
| Credit growth (q-o-q) - Congo | 0.048 | 0.069 | -0.094 | 0.0038 | 0.045 | 0.074 | 0.34 |
| Credit growth (q-o-q) - Gabon | 0.019 | 0.063 | -0.1 | -0.025 | 0.004 | 0.06 | 0.24 |
| Credit growth (q-o-q) - Equatorial Guinea | 0.055 | 0.17 | -0.3 | -0.023 | 0.022 | 0.11 | 0.54 |
| Credit growth (q-o-q) - Chad | 0.031 | 0.069 | -0.13 | -0.0079 | 0.018 | 0.072 | 0.27 |
| Public debt level - Central African Republic | 0.35 | 0.2 | 0.15 | 0.22 | 0.26 | 0.32 | 0.86 |
| Public debt level - Cameroon | 0.14 | 0.076 | 0.065 | 0.077 | 0.1 | 0.2 | 0.29 |
| Public debt level - Congo | 0.53 | 0.27 | 0.15 | 0.23 | 0.56 | 0.77 | 0.99 |
| Public debt level - Gabon | 0.29 | 0.097 | 0.15 | 0.18 | 0.28 | 0.38 | 0.41 |
| Public debt level - Equatorial Guinea | 0.066 | 0.035 | 0.0014 | 0.039 | 0.078 | 0.096 | 0.11 |
| Public debt level - Chad | 0.066 | 0.035 | 0.0014 | 0.039 | 0.078 | 0.096 | 0.11 |
| Headline GDP growth - Central African Republic (q-o-q) | 0.001 | 0.039 | -0.17 | 0.0051 | 0.009 | 0.013 | 0.061 |
| Headline GDP growth - Cameroon (q-o-q) | 0.011 | 0.013 | -0.026 | 0.0055 | 0.01 | 0.013 | 0.056 |
| Headline GDP growth - Congo (q-o-q) | 0.0054 | 0.025 | -0.063 | -0.01 | 0.0072 | 0.026 | 0.062 |
| Headline GDP growth - Gabon (q-o-q) | 0.0077 | 0.012 | -0.017 | -0.0023 | 0.01 | 0.016 | 0.028 |

*Continued on next page*

*– Continued from previous page*

| Observables | Mean | Std. | Min | 25th percentile | Median | 75th percentile | Max |
|---|---|---|---|---|---|---|---|
| Headline GDP growth - Equatorial Guinea (q-o-q) | 0.0017 | 0.024 | -0.057 | -0.015 | 0.0012 | 0.022 | 0.048 |
| Headline GDP growth - Chad (q-o-q) | 0.0073 | 0.019 | -0.03 | -0.0053 | 0.0045 | 0.017 | 0.07 |
| Public expenses (log) - Central African Republic | 3.5 | 0.26 | 3.1 | 3.3 | 3.5 | 3.7 | 4.1 |
| Public expenses (log) - Cameroon | 6.5 | 0.39 | 5.6 | 6.2 | 6.5 | 6.8 | 7 |
| Public expenses (log) - Congo | 6 | 0.45 | 5.3 | 5.7 | 5.9 | 6.4 | 7 |
| Public expenses (log) - Gabon | 6 | 0.28 | 5.5 | 5.7 | 6 | 6.2 | 6.4 |
| Public expenses (log) - Equatorial Guinea | 6.2 | 0.47 | 5.3 | 5.8 | 6.4 | 6.7 | 6.9 |
| Public expenses (log) - Chad | 5.5 | 0.33 | 4.8 | 5.2 | 5.4 | 5.8 | 6 |
| Interbank rate - CEMAC | 0.039 | 0.0092 | 0.02 | 0.031 | 0.039 | 0.046 | 0.052 |
| Monetary Policy rate - CEMAC | 0.038 | 0.0096 | 0.025 | 0.03 | 0.04 | 0.043 | 0.055 |
| Foreign Interest rate | 0.013 | 0.017 | 0.00073 | 0.0012 | 0.0019 | 0.019 | 0.053 |
| International food prices variation (percent, q-o-q) | 0.0093 | 0.073 | -0.24 | -0.023 | 0.0035 | 0.03 | 0.19 |
| Inflation (y-o-y) - Central African Republic | 0.048 | 0.061 | -0.038 | 0.0027 | 0.035 | 0.062 | 0.3 |
| Inflation (y-o-y) - Cameroon | 0.023 | 0.017 | -0.0086 | 0.0099 | 0.023 | 0.029 | 0.068 |
| Inflation (y-o-y) - Congo | 0.03 | 0.024 | -0.008 | 0.013 | 0.022 | 0.046 | 0.11 |
| Inflation (y-o-y) - Gabon | 0.023 | 0.024 | -0.017 | 0.0037 | 0.024 | 0.042 | 0.074 |
| Inflation (y-o-y) - Equatorial Guinea | 0.032 | 0.019 | -0.007 | 0.018 | 0.029 | 0.049 | 0.06 |
| Inflation (y-o-y) - Chad | 0.024 | 0.054 | -0.1 | -0.019 | 0.016 | 0.057 | 0.19 |

*Continued on next page*

– *Continued from previous page*

| Observables | Mean | Std. | Min | 25th percentile | Median | 75th percentile | Max |
|---|---|---|---|---|---|---|---|
| Foreign Inflation - Eurozone | 0.0037 | 0.0046 | -0.0058 | 0.0007 | 0.0034 | 0.006 | 0.014 |
| Foreign Inflation - USA | 0.0048 | 0.0098 | -0.039 | 0 | 0.0047 | 0.012 | 0.025 |
| Oil prices (100*log) | 4.3 | 0.32 | 3.5 | 4.1 | 4.2 | 4.7 | 4.8 |
| International reserves - CEMAC (months of imports) | 4.3 | 1.2 | 2 | 3.3 | 4.8 | 5.3 | 6 |
| Nominal Exchange rate (log) | 2.8 | 0 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Nominal exchange rate EUR/USD (log) | -0.24 | 0.1 | -0.45 | -0.31 | -0.26 | -0.13 | -0.064 |
| Share of oil GDP in Total GDP - Central African Republic | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Share of oil GDP in Total GDP - Cameroon | 0.063 | 0.0089 | 0.05 | 0.055 | 0.061 | 0.07 | 0.08 |
| Share of oil GDP in Total GDP - Congo | 0.39 | 0.062 | 0.3 | 0.33 | 0.41 | 0.44 | 0.53 |
| Share of oil GDP in Total GDP - Gabon | 0.28 | 0.056 | 0.19 | 0.23 | 0.25 | 0.33 | 0.39 |
| Share of oil GDP in Total GDP - Equatorial Guinea | 0.57 | 0.083 | 0.43 | 0.52 | 0.56 | 0.64 | 0.71 |
| Share of oil GDP in Total GDP - Chad | 0.14 | 0.031 | 0.091 | 0.12 | 0.13 | 0.15 | 0.22 |
| Foreign Output gap (percent) | -0.019 | 0.018 | -0.053 | -0.033 | -0.019 | -0.0011 | 0.011 |
| Non oil sector Output gap - Central African Republic | 0.0014 | 0.091 | -0.25 | -0.019 | -0.0073 | 0.028 | 0.24 |
| Non oil sector Output gap - Cameroon | 0.0014 | 0.012 | -0.036 | -0.0054 | -0.0014 | 0.0074 | 0.037 |
| Non oil sector Output gap - Congo | 0.0014 | 0.091 | -0.25 | -0.019 | -0.0073 | 0.028 | 0.24 |
| Non oil sector Output gap - Gabon | 0.00074 | 0.041 | -0.19 | -0.012 | 0.0038 | 0.022 | 0.066 |
| Non oil sector Output gap - Equatorial Guinea | 0.0024 | 0.04 | -0.085 | -0.027 | 0.012 | 0.025 | 0.078 |

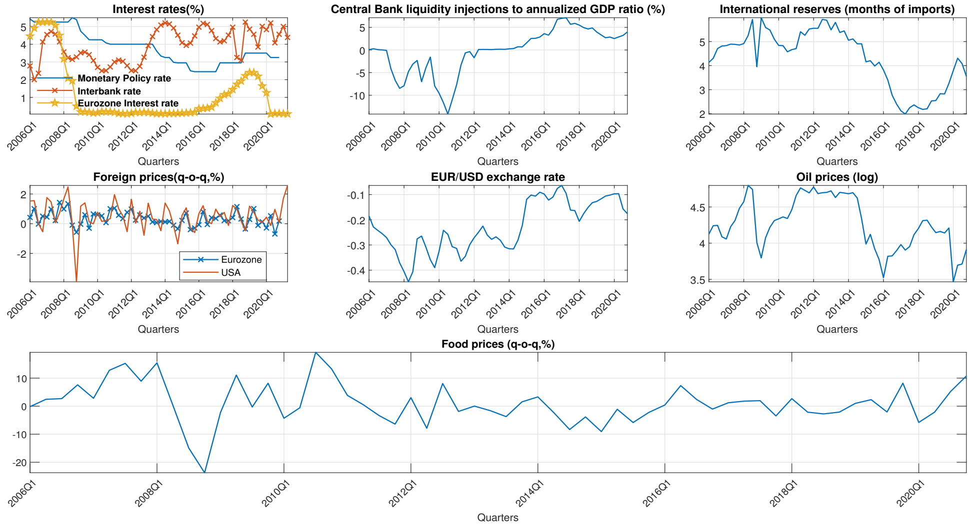
*Continued on next page*

– *Continued from previous page*

| Observables | Mean | Std. | Min | 25th percentile | Median | 75th percentile | Max |
|---|---|---|---|---|---|---|---|
| Non oil sector Output gap - Chad | -0.0018 | 0.027 | -0.083 | -0.016 | 0.00044 | 0.019 | 0.035 |

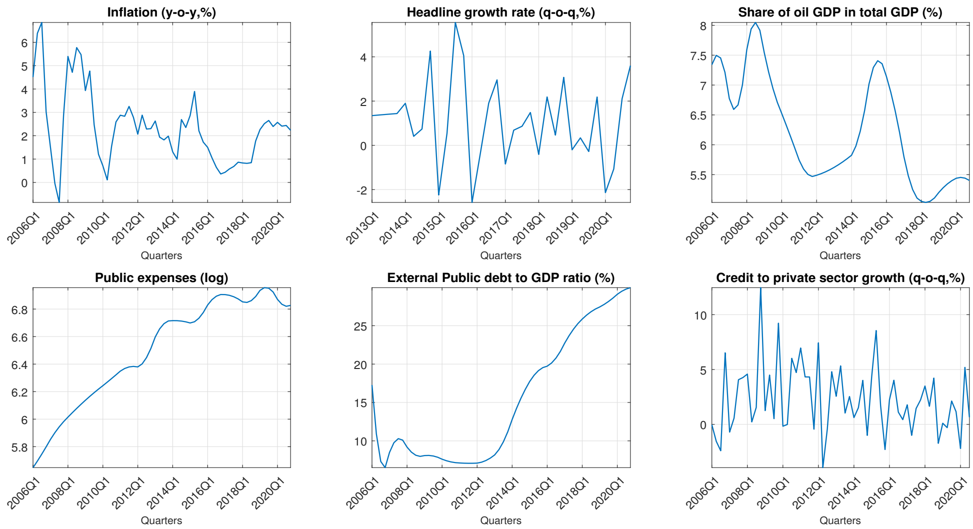
*Source : Author's calculations*

**Figure 17** – *Evolution of common data*



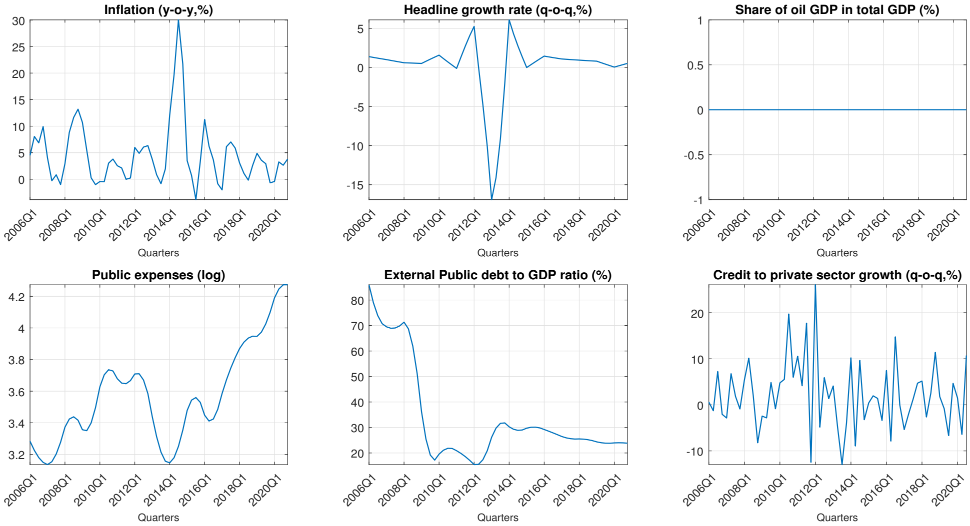

*Source : Bank of Central African States, International Monetary Fund, FAO, US Energy Information Administration, St. Louis Federal Reserve*

**Figure 18** – *Evolution of Cameroon's observables*



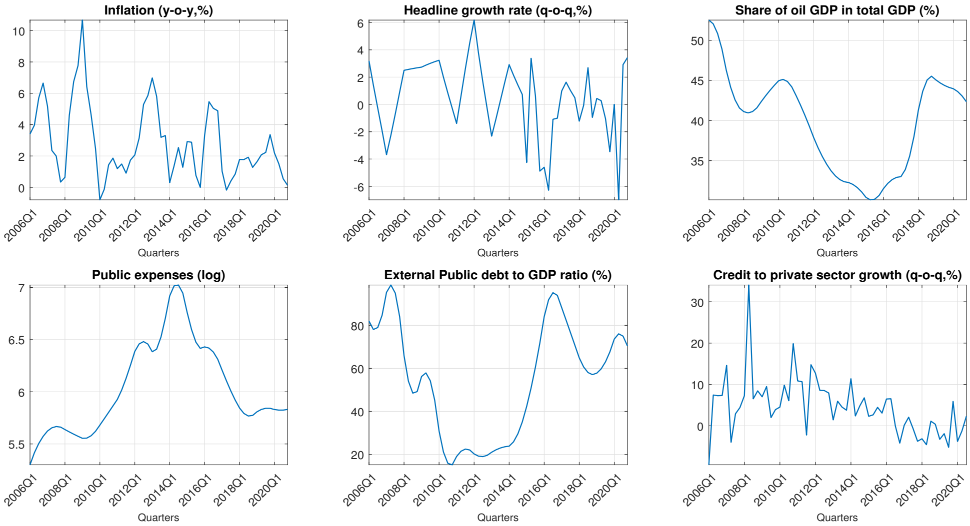

*Source : Author's calculations based on Bank of Central African States data*

**Figure 19** – *Evolution of Central African Republic's observables*



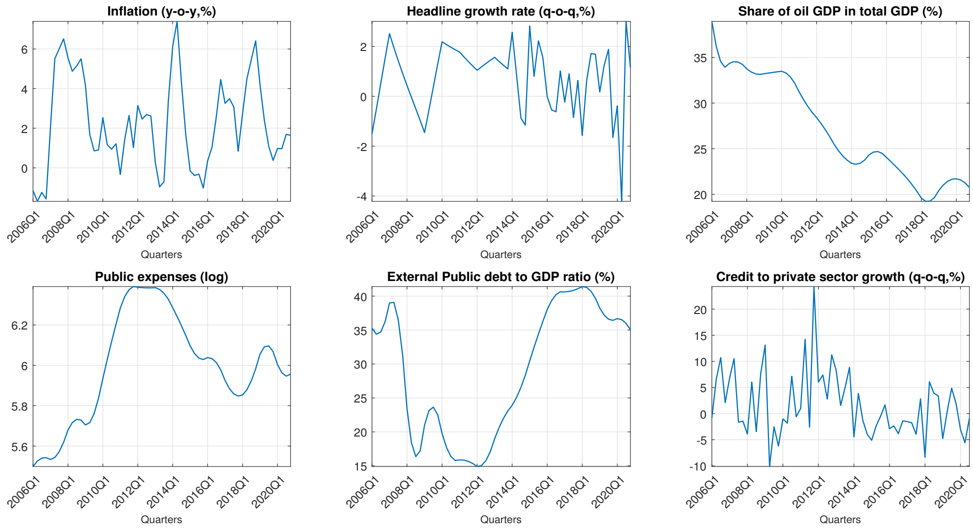

*Source : Author's calculations based on Bank of Central African States data*

**Figure 20** – *Evolution of Congo's observables*



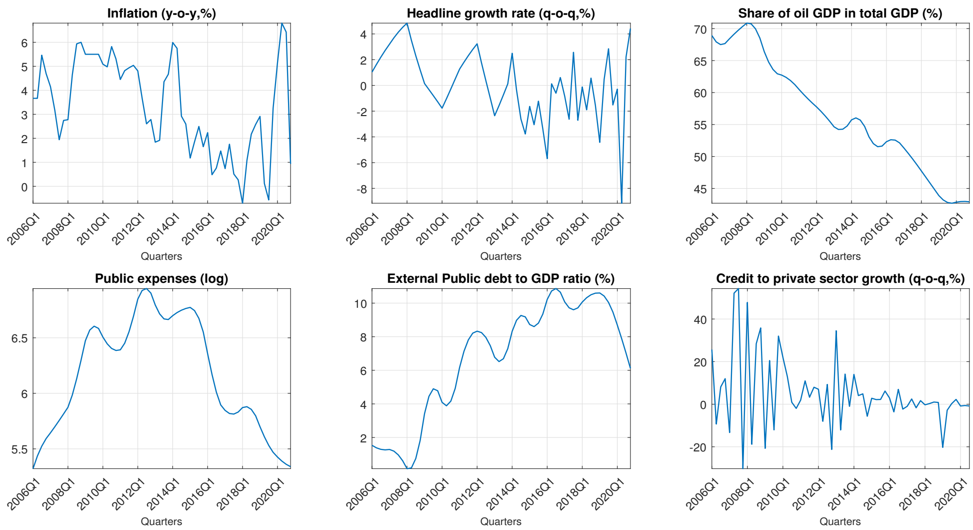

*Source : Author's calculations based on Bank of Central African States data*

**Figure 21** – *Evolution of Gabon's observables*



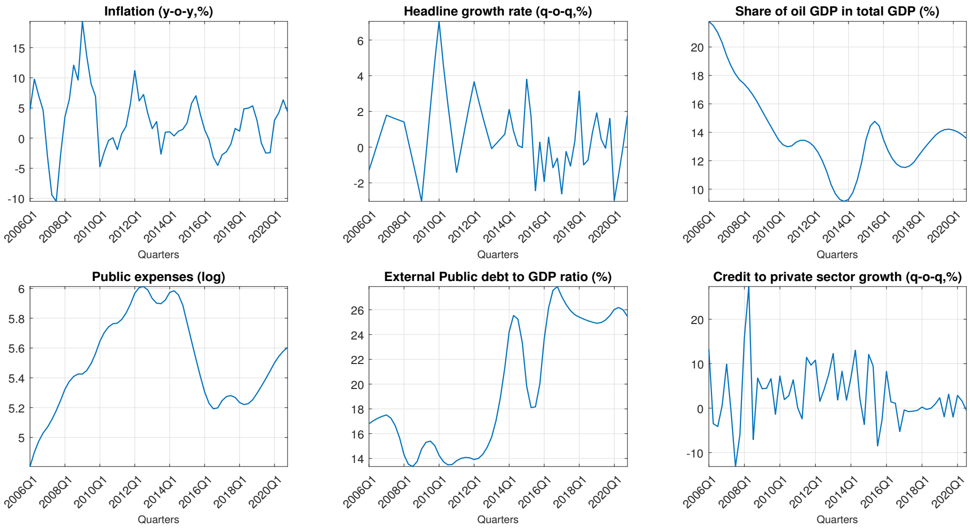

*Source : Author's calculations based on Bank of Central African States data*

**Figure 22** – *Evolution of Equatorial Guinea's observables*




*Source : Author's calculations based on Bank of Central African States data*

**Figure 23** – *Evolution of Chad's observables*




*Source : Author's calculations based on Bank of Central African States data*

# Parameter values

## Country parameters modes

**Table 3** – *Country parameters estimated modes*

| Parameter | Labels | CEMAC | CMR | CAR | CNG | GAB | GEQ | TCD |
|---|---|---|---|---|---|---|---|---|
| $a_0^1$ | Non oil Output gap inertia | 0.2 | 0.087 | 0.74 | 0.56 | 0.31 | 0.5 | 0.24 |
| $a_1^1$ | Non oil Output gap expectation | 0.085 | 0.078 | 0.091 | 0.11 | 0.085 | 0.09 | 0.095 |
| $a_2^1$ | Financial conditions output gap sensitiveness | 0.51 | 0.4 | 0.35 | 0.92 | 0.57 | 0.57 | 0.59 |
| $a_3^1$ | Non oil output gap sensitiveness to exchange rate | 0.21 | 0.22 | 0.31 | 0.31 | 0.19 | 0.25 | 0.19 |
| $a_4^1$ | Domestic non oil output gap sensitiveness to foreign output gap | 0.56 | 0.37 | 0.41 | 0.31 | 0.49 | 0.44 | 0.36 |
| $a_5^1$ | Non oil Output gap sensitiveness to public expenses gap | 0.11 | 0.089 | 0.11 | 0.13 | 0.088 | 0.08 | 0.091 |
| $a_0^3$ | Inertia of non oil gdp trend growth | 0.75 | 0.52 | 0.88 | 0.92 | 0.91 | 0.9 | 0.89 |
| $a_1^3$ | Non oil GDP reaction to structural public spending growth | 0.13 | 0.077 | 0.12 | 0.083 | 0.22 | 0.13 | 0.16 |
| $a_{0,o}^1$ | Inertia of oil production growth | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| $b_0^1$ | Weight of lag inflation | 0.64 | 0.66 | 0.59 | 0.62 | 0.6 | 0.61 | 0.57 |
| $b_1^1$ | Weight of prices expectations | 0.094 | 0.09 | 0.1 | 0.093 | 0.098 | 0.092 | 0.1 |
| $b_2^1$ | Demand price sensitiveness | 0.29 | 0.21 | 0.063 | 0.082 | 0.16 | 0.2 | 0.33 |
| $b_3^1$ | Exchange rate price sensitiveness | 0.046 | 0.043 | 0.063 | 0.064 | 0.083 | 0.068 | 0.086 |
| $b_4^1$ | Sensitiveness of local inflation to Imported Food prices | 0.12 | 0.12 | 0.3 | 0.15 | 0.17 | 0.16 | 0.21 |
| $c_0^1$ | Inertia of public spending gap | 0.52 | 0.52 | 0.51 | 0.53 | 0.52 | 0.51 | 0.52 |

*Continued on next page*

– *Continued from previous page*

| Parameter | Labels | CEMAC | CMR | CAR | CNG | GAB | GEQ | TCD |
|---|---|---|---|---|---|---|---|---|
| $c_1^1$ | Weight of output stabilization in fiscal policy rule | 0.53 | 0.35 | 0.3 | 0.42 | 0.52 | 0.41 | 0.55 |
| $c_2^1$ | Public spending gap response to public debt | 0.088 | 0.092 | 0.086 | 0.094 | 0.096 | 0.09 | 0.092 |
| $c_0^3$ | Inertia of the growth rate of structural public spending | 0.31 | 0.55 | 0.75 | 0.7 | 0.55 | 0.82 | 0.64 |
| $c_1^3$ | Structural public spending growth to non oil GDP growth | 1.1 | 0.49 | 0.37 | 0.55 | 0.65 | 1 | 0.59 |
| $c_2^1$ | Structural public spending growth to oil GDP growth | 0.29 | 0.39 | 0.94 | 0.28 | 0.23 | 0.26 | 0.18 |
| $cd_0^1$ | Public debt growth inertia | 0.77 | 0.79 | 0.72 | 0.67 | 0.74 | 0.77 | 0.79 |
| $cd_1^2$ | Sensitiveness of public debt to exchange rate | 0.12 | 0.071 | 0.099 | 0.25 | 0.15 | 0.19 | 0.13 |
| $d_0^3$ | Weight of eurozone trade in total trade | 0.28 | 0.36 | 0.39 | 0.21 | 0.31 | 0.31 | 0.16 |
| $d_0^4$ | Risk premium inertia | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| $d_1^4$ | Risk premium sensitiveness to oil price shocks | 0.0066 | 0.0066 | 0.0066 | 0.0066 | 0.0066 | 0.0066 | 0.0066 |
| $d_2^4$ | Risk premium sensitiveness to public debt variation | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| $d_3^4$ | Risk premium sensitiveness to public debt gap | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| debttar | Debt target | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| $e_0^1$ | Inertia of monetary policy rate | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| $e_1^1$ | Inflation in monetary policy rule | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| $e_2^1$ | Output gap in monetary policy rule | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| $e_3^1$ | International reserves in monetary policy rule | 0.0096 | 0.0096 | 0.0096 | 0.0096 | 0.0096 | 0.0096 | 0.0096 |
| $e_4^1$ | Inertia of structural real interest rate | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |

*Continued on next page*

– *Continued from previous page*

| Parameter | Labels | CEMAC | CMR | CAR | CNG | GAB | GEQ | TCD |
|---|---|---|---|---|---|---|---|---|
| $e_1^2$ | Financial openess | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| $f_1^1$ | International reserves sensitiveness to economic growth | 1.1 | 1.5 | 2.1 | 0.3 | 4.8 | 1.1 | 0.55 |
| $f_2^1$ | International reserves sensitiveness to oil GDP | 2.5 | 3 | 3 | 2 | 3.2 | 2.4 | 2.6 |
| $f_3^1$ | International reserves sensitiveness to debt dynamics | 3.3 | 1 | 0.41 | 4.3 | 3.9 | 1.8 | 1.6 |
| $g_0^1$ | Inertia of foreign interest rate | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 |
| $g_0^2$ | Inertia of foreign output gap | 0.63 | 0.63 | 0.63 | 0.63 | 0.63 | 0.63 | 0.63 |
| $g_0^3$ | Inertia of foreign inglation - Eurozone | 0.097 | 0.097 | 0.097 | 0.096 | 0.097 | 0.097 | 0.097 |
| $g_0^4$ | Inertia of foreign inglation - USA | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| $g_0^6$ | Inertia of international food prices variation | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| $gpr^{oil}$ | steady state value of oil production growth | -0.001 | -0.001 | 0 | -0.001 | -0.001 | -0.001 | -0.001 |
| $\bar{gy}$ | Long term value of gdp trend growth | 0.0086 | 0.01 | 0.0019 | 0.0019 | 0.0044 | 0.014 | 0.0091 |
| $h_0^1$ | Bank Lending Tightness inertia | 0.75 | 0.72 | 0.72 | 0.73 | 0.73 | 0.75 | 0.75 |
| $h_1^1$ | Output expectations effect on credit supply | 0.49 | 0.49 | 0.49 | 0.48 | 0.49 | 0.48 | 0.48 |
| $h_2^1$ | Output past dynamics effect on credit supply | 0.75 | 0.76 | 0.76 | 0.74 | 0.77 | 0.75 | 0.75 |
| $h_3^1$ | Interbank rate effect on credit supply | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 |
| $h_4^1$ | Central Bank liquidity effect on credit suply | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.19 | 0.17 |
| $h_0^2$ | Credit gap inertia | 0.56 | 0.53 | 0.9 | 0.83 | 0.57 | 0.53 | 0.49 |
| $h_1^2$ | Bank-lending tightness effect on credit gap | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

*Continued on next page*

– *Continued from previous page*

| Parameter | Labels | CEMAC | CMR | CAR | CNG | GAB | GEQ | TCD |
|---|---|---|---|---|---|---|---|---|
| $h_2^2$ | Interest rate effect on credit gap | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.06 | 0.059 |
| $h_0^3$ | Inertia of credit trend growth | 0.88 | 0.79 | 0.54 | 0.77 | 0.62 | 0.5 | 0.75 |
| $h_1^3$ | Nominal growth effect on credit trend | 0.42 | 0.39 | 0.43 | 0.37 | 0.45 | 0.42 | 0.44 |
| $h_0^4$ | Inertia of Bank Stability Index | 0.73 | 0.72 | 0.72 | 0.73 | 0.71 | 0.72 | 0.72 |
| $h_1^4$ | Debt importance in bank stability dynamics | 0.097 | 0.098 | 0.097 | 0.097 | 0.097 | 0.097 | 0.097 |
| $i_0^1$ | Inertia of Interbank rate | 0.93 | 0.94 | 0.99 | 0.98 | 0.96 | 0.96 | 0.97 |
| $i_1^1$ | Liquidity injection influence on Interbank rate | 0.49 | 0.39 | 0.17 | 0.43 | 0.32 | 0.38 | 0.32 |
| $i_2^1$ | Bank stability influence on interbank rate dynamics | 0.38 | 0.44 | 0.39 | 0.33 | 0.4 | 0.4 | 0.39 |
| $i_0^2$ | Central bank liquidity inertia | 0.95 | 0.95 | 0.89 | 0.86 | 0.88 | 0.87 | 0.83 |
| $i_1^2$ | Central bank liquidity reaction to interbank spread | 5.6 | 7 | 7.5 | 7.2 | 7 | 7.1 | 7.2 |
| $i_2^2$ | Central bank liquidity reaction to bank instability | 0.17 | 0.17 | 0.17 | 0.16 | 0.17 | 0.17 | 0.17 |
| $i^{n,*}$ | Foreign neutral interest rate | 0.035 | 0.035 | 0.035 | 0.035 | 0.035 | 0.035 | 0.035 |
| $\bar{\pi}$ | Inflation target | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| $\bar{\pi}^*$ | world long term foreign inflation (y-o-y) | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| $\bar{poil}$ | Oil prices median value | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 |
| $resmimp$ | Target of international reserves in months of imports | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| $rsh^{oil}$ | Share of oil revenue on headline fiscal revenues | 0.5 | 0.21 | 0 | 0.51 | 0.66 | 0.84 | 0.84 |
| $sh$ | share of country GDP in total GDP | 1 | 0.37 | 0.021 | 0.14 | 0.18 | 0.16 | 0.16 |

*Continued on next page*

– Continued from previous page

| Parameter | Labels | CEMAC | CMR | CAR | CNG | GAB | GEQ | TCD |
|---|---|---|---|---|---|---|---|---|
| $\sigma^{susd}$ | Size of EUR/USD exchange rate shock | 0.037 | 0.037 | 0.037 | 0.037 | 0.037 | 0.037 | 0.037 |
| $\sigma^{\hat{y}}$ | Size of Demand Shock | 0.0072 | 0.012 | 0.0058 | 0.0064 | 0.0069 | 0.006 | 0.0074 |
| $\sigma^{cbinjec}$ | Size of Central Bank liquidity injection | 0.006 | 0.012 | 0.16 | 0.029 | 0.024 | 0.023 | 0.033 |
| $\sigma^{\bar{cr}}$ | Size of permament credit supply shock | 0.024 | 0.03 | 0.074 | 0.039 | 0.061 | 0.12 | 0.046 |
| $\sigma^{blt}$ | Size of temporary credit supply shock | 0.0095 | 0.0075 | 0.0072 | 0.1 | 0.03 | 0.031 | 0.03 |
| $\sigma^{debt}$ | Size of debt level shock | 0.0058 | 0.0043 | 0.0059 | 0.0067 | 0.006 | 0.006 | 0.0059 |
| $\sigma^{\bar{g}}$ | Size of structural fiscal policy shock (level) | 0.03 | 0.006 | 0.0081 | 0.007 | 0.0067 | 0.0065 | 0.0063 |
| $\sigma^{\Delta debt}$ | Size of public debt growth shock | 0.016 | 0.0072 | 0.021 | 0.048 | 0.022 | 0.026 | 0.021 |
| $\sigma^{\hat{g}}$ | Size of short term fiscal policy shock | 0.007 | 0.0055 | 0.0062 | 0.0066 | 0.0062 | 0.0061 | 0.0059 |
| $\sigma^{G(\bar{g})}$ | Size of structural fiscal policy shock (growth) | 0.0081 | 0.019 | 0.04 | 0.049 | 0.031 | 0.034 | 0.029 |
| $\sigma^{G(pr)^{oil}}$ | size of oil production growth shock | 0.007 | 0.0096 | 0.019 | 0.0075 | 0.019 | 0.076 | 0.0079 |

Continued on next page

– *Continued from previous page*

| Parameter | Labels | CEMAC | CMR | CAR | CNG | GAB | GEQ | TCD |
|---|---|---|---|---|---|---|---|---|
| $\sigma^{G(\bar{y})}$ | Size of growth productivity shock | 0.0033 | 0.0031 | 0.0036 | 0.0037 | 0.0033 | 0.0034 | 0.0032 |
| $\sigma^{IPOLICY}$ | size of monetary policy shock | 0.003 | 0.0029 | 0.0039 | 0.0033 | 0.003 | 0.0031 | 0.0035 |
| $\sigma^{\pi}$ | Size of cost push shock | 0.0094 | 0.0071 | 0.032 | 0.015 | 0.012 | 0.013 | 0.031 |
| $\sigma^{\pi^{food}}$ | Size of International food prices shock | 0.064 | 0.064 | 0.064 | 0.064 | 0.064 | 0.064 | 0.064 |
| $\sigma^{poil}$ | Size of oil price shock | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| $\sigma^{prem}$ | Size of risk premium shock | 0.0072 | 0.0073 | 0.0073 | 0.19 | 0.0073 | 0.0073 | 0.0073 |
| $\sigma^{pr^{oil}}$ | Size of oil production shock | 0.051 | 0.0086 | 0.0059 | 0.16 | 0.0066 | 0.0074 | 0.042 |
| $\sigma^{\bar{r}}$ | Size of real interest rate trend shock | 0.0067 | 0.0098 | 0.014 | 0.0075 | 0.0072 | 0.019 | 0.013 |
| $\sigma^{resmimp}$ | Size of international reserves shock | 0.57 | 0.58 | 0.59 | 0.61 | 0.56 | 0.61 | 0.6 |
| $\sigma^{\bar{y}}$ | Size of level productivity shock | 0.003 | 0.0031 | 0.003 | 0.0031 | 0.003 | 0.003 | 0.003 |
| $\sigma^{y^{oil}}$ | Size of oil production shock | 0.0074 | 0.0087 | 0.0059 | 0.0073 | 0.0065 | 0.0097 | 0.0073 |
| $\sigma^{\bar{z}}$ | Size of Structural exchange rate shock | 0.022 | 0.013 | 0.079 | 0.0052 | 0.0085 | 0.0076 | 0.0074 |
| $\sigma^{\bar{cr}}$ | Size of credit trend growth shock | 0.007 | 0.011 | 0.0072 | 0.024 | 0.012 | 0.0072 | 0.014 |
| $\sigma^{IINTERBANK}$ | Size of interbank risk shock | 0.0059 | 0.0056 | 0.0058 | 0.0052 | 0.0059 | 0.0057 | 0.0057 |
| $\sigma^{i^{euro}}$ | Size of foreign interest rate shock | 0.0044 | 0.0044 | 0.0044 | 0.0044 | 0.0044 | 0.0044 | 0.0044 |
| $\sigma^{\pi^{euro}}$ | Size of foreign inflation - Eurozone | 0.0056 | 0.0056 | 0.0056 | 0.0056 | 0.0056 | 0.0056 | 0.0056 |
| $\sigma^{\pi^{us}}$ | Size of foreign inflation - USA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| $\sigma^{s^{euro}}$ | Size of nominal exchange rate shock | 0.0022 | 0.0022 | 0.0022 | 0.0022 | 0.0022 | 0.0022 | 0.0022 |
| $\sigma^{y^{*}}$ | Size of foreign output gap shock | 0.017 | 0.017 | 0.017 | 0.017 | 0.017 | 0.017 | 0.017 |

[a] Source : the author, based on CEMAC-GLOBAL estimates

[b] The CEMAC column reports the estimated modes of the parameters of the "country-specific" version of the model where CEMAC is considered as a single country (aggregated data).

## Estimation results

**Table 4** – *Estimation results - Cameroon*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $a_0^1$ | Non oil Output gap inertia | 0.081 | 0.25 | beta | 0.087 | 0.078 |
| $a_1^1$ | Non oil Output gap expectation | 0.18 | 0.03 | gamma | 0.078 | 0.023 |
| $a_2^1$ | Financial conditions output gap sensitiveness | 0.5 | 0.15 | gamma | 0.4 | 0.027 |
| $a_3^1$ | Non oil output gap sensitiveness to exchange rate | 0.3 | 0.1 | gamma | 0.22 | 0.1 |
| $a_4^1$ | Domestic non oil output gap sensitiveness to foreign output gap | 0.79 | 0.21 | gamma | 0.37 | 0.18 |
| $a_5^1$ | Non oil Output gap sensitiveness to public expenses gap | 0.16 | 0.05 | gamma | 0.089 | 0.098 |
| $a_0^3$ | Inertia of non oil gdp trend growth | 0.4 | 0.15 | beta | 0.52 | 0.074 |
| $a_1^3$ | Non oil GDP reaction to structural public spending growth | 0.77 | 0.12 | beta | 0.077 | 0.066 |
| $b_0^1$ | Weight of lag inflation | 0.79 | 0.06 | beta | 0.66 | 0.084 |
| $b_1^1$ | Weight of prices expectations | 1.1 | 0.075 | gamma | 0.09 | 0.21 |
| $b_2^1$ | Demand price sensitiveness | 3 | 0.36 | gamma | 0.21 | 0.28 |
| $b_3^1$ | Exchange rate price sensitiveness | 0.34 | 0.05 | gamma | 0.043 | 0.048 |
| $b_4^1$ | Sensitiveness of local inflation to Imported Food prices | 0.42 | 0.15 | gamma | 0.12 | 0.27 |
| $c_0^1$ | Inertia of public spending gap | 0.78 | 0.05 | beta | 0.52 | 0.025 |
| $c_1^1$ | Weight of output stabilization in fiscal policy rule | 2.3 | 0.21 | gamma | 0.35 | 0.29 |
| $c_2^1$ | Public spending gap response to public debt | 0.37 | 0.03 | gamma | 0.092 | 0.0037 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $c_0^3$ | Inertia of the growth rate of structural public spending | 0.13 | 0.1 | gamma | 0.55 | 0.14 |
| $c_1^3$ | Structural public spending growth to non oil GDP growth | 1.1 | 0.5 | gamma | 0.49 | 0.21 |
| $c_2^3$ | Structural public spending growth to oil GDP growth | 1.5 | 0.25 | gamma | 0.39 | 0.22 |
| $cd_0^1$ | Public debt growth inertia | 0.63 | 0.05 | beta | 0.79 | 0.097 |
| $cd_1^2$ | Sensitiveness of public debt to exchange rate | 3.4 | 0.25 | gamma | 0.071 | 0.53 |
| $f_1^1$ | International reserves sensitiveness to economic growth | 66 | 4 | gamma | 1.5 | 6.4 |
| $f_2^1$ | International reserves sensitiveness to oil GDP | 2.4 | 2 | gamma | 3 | 1.9 |
| $f_3^1$ | International reserves sensitiveness to debt dynamics | 5 | 2.4 | gamma | 1 | 4.9 |
| $g_0^1$ | Inertia of foreign interest rate | 0.78 | 0.08 | beta | 0.97 | 0.073 |
| $g_0^2$ | Inertia of foreign output gap | 0.44 | 0.08 | beta | 0.63 | 0.14 |
| $g_0^3$ | Inertia of foreign inglation - Eurozone | 0.26 | 0.04 | beta | 0.097 | 0.021 |
| $g_0^6$ | Inertia of international food prices variation | 0.16 | 0.02 | beta | 0.1 | 0.016 |
| $h_0^1$ | Bank Lending Tightness inertia | 0.63 | 0.07 | beta | 0.72 | 0.021 |
| $h_1^1$ | Output expectations effect on credit supply | 0.43 | 0.05 | gamma | 0.49 | 0.03 |
| $h_2^1$ | Output past dynamics effect on credit supply | 0.3 | 0.16 | gamma | 0.76 | 0.11 |
| $h_3^1$ | Interbank rate effect on credit supply | 0.03 | 0.006 | gamma | 0.059 | 0.0022 |
| $h_4^1$ | Central Bank liquidity effect on credit suply | 0.17 | 0.06 | gamma | 0.18 | 0.02 |
| $h_0^2$ | Credit gap inertia | 0.57 | 0.2 | beta | 0.53 | 0.068 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $h_2^2$ | Interest rate effect on credit gap | 0.069 | 0.006 | gamma | 0.059 | 0.0052 |
| $h_0^3$ | Inertia of credit trend growth | 0.11 | 0.1 | beta | 0.79 | 0.12 |
| $h_1^3$ | Nominal growth effect on credit trend | 1.4 | 0.1 | gamma | 0.39 | 0.072 |
| $h_0^4$ | Inertia of Bank Stability Index | 0.37 | 0.07 | beta | 0.72 | 0.039 |
| $h_1^4$ | Debt importance in bank stability dynamics | 0.064 | 0.02 | beta | 0.098 | 0.019 |
| $i_0^1$ | Inertia of Interbank rate | 0.62 | 0.045 | beta | 0.94 | 0.22 |
| $i_1^1$ | Liquidity injection influence on Interbank rate | 1.9 | 0.24 | gamma | 0.39 | 1.3 |
| $i_2^1$ | Bank stability influence on interbank rate dynamics | 1.2 | 0.2 | gamma | 0.44 | 0.42 |
| $i_0^2$ | Central bank liquidity inertia | 0.31 | 0.08 | beta | 0.95 | 0.2 |
| $i_1^2$ | Central bank liquidity reaction to interbank spread | 10 | 0.75 | gamma | 7 | 1.3 |
| $i_2^2$ | Central bank liquidity reaction to bank instability | 0.061 | 0.08 | gamma | 0.17 | 0.031 |
| $\sigma^{\hat{y}}$ | Size of Demand Shock | 1.1 | 0.005 | inv. Gamma | 0.012 | 0.35 |
| $\sigma^{\bar{y}}$ | Size of level productivity shock | 0.66 | 0.005 | inv. Gamma | 0.0031 | 0.084 |
| $\sigma^{G(\bar{y})}$ | Size of growth productivity shock | 1.2 | 0.005 | inv. Gamma | 0.0031 | 0.071 |
| $\sigma^{y^{oil}}$ | Size of oil production shock | 0.85 | 0.005 | inv. Gamma | 0.0087 | 0.16 |
| $\sigma^{pr^{oil}}$ | Size of oil production shock | 1.7 | 0.005 | inv. Gamma | 0.0086 | 0.38 |
| $\sigma^{G(pr)^{oil}}$ | size of oil production growth shock | 0.021 | 0.005 | inv. Gamma | 0.0096 | 0.079 |
| $\sigma^{\pi}$ | Size of cost push shock | 2.8 | 0.005 | inv. Gamma | 0.0071 | 0.059 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{\hat{g}}$ | Size of short term fiscal policy shock | 0.086 | 0.005 | inv. Gamma | 0.0055 | 0.29 |
| $\sigma^{G(\bar{y})}$ | Size of structural fiscal policy shock (level) | 1.6 | 0.005 | inv. Gamma | 0.006 | 0.21 |
| $\sigma^{G(\bar{g})}$ | Size of structural fiscal policy shock (growth) | 1.9 | 0.005 | inv. Gamma | 0.019 | 0.6 |
| $\sigma^{\Delta debt}$ | Size of public debt growth shock | 2.2 | 0.005 | inv. Gamma | 0.0072 | 0.41 |
| $\sigma^{debt}$ | Size of debt level shock | 0.67 | 0.005 | inv. Gamma | 0.0043 | 0.32 |
| $\sigma^{\bar{z}}$ | Size of Structural exchange rate shock | 0.66 | 0.005 | inv. Gamma | 0.013 | 0.24 |
| $\sigma^{prem}$ | Size of risk premium shock | 1.4 | 0.005 | inv. Gamma | 0.0073 | 0.046 |
| $\sigma^{s^{euro}}$ | Size of nominal exchange rate shock | 2.6 | 0.005 | inv. Gamma | 0.0022 | 0.37 |
| $\sigma^{IPOLICY}$ | size of monetary policy shock | 0.17 | 0.005 | inv. Gamma | 0.0029 | 0.08 |
| $\sigma^{\bar{r}}$ | Size of real interest rate trend shock | 0.06 | 0.005 | inv. Gamma | 0.0098 | 0.22 |
| $\sigma^{resmimp}$ | Size of international reserves shock | 1.3 | 0.005 | inv. Gamma | 0.58 | 0.19 |
| $\sigma^{i^{euro}}$ | Size of foreign interest rate shock | 0.24 | 0.003 | inv. Gamma | 0.0044 | 0.013 |
| $\sigma^{y^*}$ | Size of foreign output gap shock | 0.24 | 0.003 | inv. Gamma | 0.017 | 0.0095 |
| $\sigma^{\pi^{euro}}$ | Size of foreign inflation - Eurozone | 0.15 | 0.003 | inv. Gamma | 0.0056 | 0.014 |
| $\sigma^{poil}$ | Size of oil price shock | 2.8 | 0.005 | inv. Gamma | 0.19 | 0.33 |
| $\sigma^{s^{usd}}$ | Size of EUR/USD exchange rate shock | 1.5 | 0.005 | inv. Gamma | 0.037 | 0.13 |
| $\sigma^{\pi^{food}}$ | Size of International food prices shock | 2.6 | 0.005 | inv. Gamma | 0.064 | 0.19 |
| $\sigma^{blt}$ | Size of temporary credit supply shock | 2.6 | 0.005 | inv. Gamma | 0.0075 | 0.024 |

*Continued on next page*

*– Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{\bar{cr}}$ | Size of permament credit supply shock | 0.018 | 0.005 | inv. Gamma | 0.03 | 0.3 |
| $\sigma^{\bar{cr}}$ | Size of credit trend growth shock | 2.6 | 0.005 | inv. Gamma | 0.011 | 0.055 |
| $\sigma^{IINTERBANK}$ | Size of interbank risk shock | 2.6 | 0.005 | inv. Gamma | 0.0056 | 0.6 |
| $\sigma^{cbinjec}$ | Size of Central Bank liquidity injection | 2.6 | 0.005 | inv. Gamma | 0.012 | 0.28 |

*Source : Author's calculations*

**Table 5** – *Estimation results - Central African Republic*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $a_0^1$ | Non oil Output gap inertia | 0.34 | 0.25 | beta | 0.74 | 0.12 |
| $a_1^1$ | Non oil Output gap expectation | 0.25 | 0.03 | gamma | 0.091 | 0.042 |
| $a_2^1$ | Financial conditions output gap sensitiveness | 0.56 | 0.15 | gamma | 0.35 | 0.23 |
| $a_3^1$ | Non oil output gap sensitiveness to exchange rate | 0.95 | 0.1 | gamma | 0.31 | 0.069 |
| $a_4^1$ | Domestic non oil output gap sensitiveness to foreign output gap | 1.1 | 0.21 | gamma | 0.41 | 0.31 |
| $a_5^1$ | Non oil Output gap sensitiveness to public expenses gap | 0.22 | 0.05 | gamma | 0.11 | 0.15 |
| $a_0^3$ | Inertia of non oil gdp trend growth | 0.76 | 0.15 | beta | 0.88 | 0.14 |
| $a_1^3$ | Non oil GDP reaction to structural public spending growth | 0.77 | 0.12 | beta | 0.12 | 0.074 |
| $b_0^1$ | Weight of lag inflation | 0.35 | 0.06 | beta | 0.59 | 0.048 |
| $b_1^1$ | Weight of prices expectations | 0.81 | 0.075 | gamma | 0.1 | 0.095 |
| $b_2^1$ | Demand price sensitiveness | 1.9 | 0.36 | gamma | 0.063 | 0.65 |
| $b_3^1$ | Exchange rate price sensitiveness | 0.45 | 0.05 | gamma | 0.063 | 0.066 |
| $b_4^1$ | Sensitiveness of local inflation to Imported Food prices | 1.3 | 0.15 | gamma | 0.3 | 0.17 |
| $c_0^1$ | Inertia of public spending gap | 0.38 | 0.05 | beta | 0.51 | 0.029 |
| $c_1^1$ | Weight of output stabilization in fiscal policy rule | 2.7 | 0.21 | gamma | 0.3 | 0.3 |
| $c_2^1$ | Public spending gap response to public debt | 0.046 | 0.03 | gamma | 0.086 | 0.018 |
| $c_0^3$ | Inertia of the growth rate of structural public spending | 0.51 | 0.1 | gamma | 0.75 | 0.26 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $c_1^3$ | Structural public spending growth to non oil GDP growth | 0.48 | 0.5 | gamma | 0.37 | 0.18 |
| $c_2^3$ | Structural public spending growth to oil GDP growth | 1.1 | 0.25 | gamma | 0.94 | 0.3 |
| $cd_0^1$ | Public debt growth inertia | 0.65 | 0.05 | beta | 0.72 | 0.1 |
| $cd_1^2$ | Sensitiveness of public debt to exchange rate | 1.6 | 0.25 | gamma | 0.099 | 0.32 |
| $f_1^1$ | International reserves sensitiveness to economic growth | 33 | 4 | gamma | 2.1 | 4.2 |
| $f_2^1$ | International reserves sensitiveness to oil GDP | 21 | 2 | gamma | 3 | 3 |
| $f_3^1$ | International reserves sensitiveness to debt dynamics | 44 | 2.4 | gamma | 0.41 | 1.8 |
| $g_0^1$ | Inertia of foreign interest rate | 0.89 | 0.08 | beta | 0.97 | 0.14 |
| $g_0^2$ | Inertia of foreign output gap | 0.36 | 0.08 | beta | 0.63 | 0.057 |
| $g_0^3$ | Inertia of foreign inglation - Eurozone | 0.36 | 0.04 | beta | 0.097 | 0.07 |
| $g_0^6$ | Inertia of international food prices variation | 0.19 | 0.02 | beta | 0.1 | 0.01 |
| $h_0^1$ | Bank Lending Tightness inertia | 0.87 | 0.07 | beta | 0.72 | 0.05 |
| $h_1^1$ | Output expectations effect on credit supply | 0.75 | 0.05 | gamma | 0.49 | 0.049 |
| $h_2^1$ | Output past dynamics effect on credit supply | 2 | 0.16 | gamma | 0.76 | 0.26 |
| $h_3^1$ | Interbank rate effect on credit supply | 0.098 | 0.006 | gamma | 0.059 | 0.0031 |
| $h_4^1$ | Central Bank liquidity effect on credit suply | 0.16 | 0.06 | gamma | 0.18 | 0.03 |
| $h_0^2$ | Credit gap inertia | 0.49 | 0.2 | beta | 0.9 | 0.13 |
| $h_2^2$ | Interest rate effect on credit gap | 0.085 | 0.006 | gamma | 0.059 | 0.0039 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---:|---:|---:|---:|---:|---:|
| $h_0^3$ | Inertia of credit trend growth | 0.68 | 0.1 | beta | 0.54 | 0.12 |
| $h_1^3$ | Nominal growth effect on credit trend | 0.77 | 0.1 | gamma | 0.43 | 0.16 |
| $h_0^4$ | Inertia of Bank Stability Index | 0.4 | 0.07 | beta | 0.72 | 0.052 |
| $h_1^4$ | Debt importance in bank stability dynamics | 0.15 | 0.02 | beta | 0.097 | 0.029 |
| $i_0^1$ | Inertia of Interbank rate | 0.76 | 0.045 | beta | 0.99 | 0.12 |
| $i_1^1$ | Liquidity injection influence on Interbank rate | 0.71 | 0.24 | gamma | 0.17 | 0.9 |
| $i_2^1$ | Bank stability influence on interbank rate dynamics | 1.3 | 0.2 | gamma | 0.39 | 0.32 |
| $i_0^2$ | Central bank liquidity inertia | 0.63 | 0.08 | beta | 0.89 | 0.11 |
| $i_1^2$ | Central bank liquidity reaction to interbank spread | 4.2 | 0.75 | gamma | 7.5 | 1.4 |
| $i_2^2$ | Central bank liquidity reaction to bank instability | 0.77 | 0.08 | gamma | 0.17 | 0.063 |
| $\sigma^{\hat{y}}$ | Size of Demand Shock | 2.3 | 0.005 | inv. Gamma | 0.0058 | 0.21 |
| $\sigma^{\bar{y}}$ | Size of level productivity shock | 1.5 | 0.005 | inv. Gamma | 0.003 | 0.5 |
| $\sigma^{G(\bar{y})}$ | Size of growth productivity shock | 0.55 | 0.005 | inv. Gamma | 0.0036 | 0.02 |
| $\sigma^{y^{oil}}$ | Size of oil production shock | 1.8 | 0.005 | inv. Gamma | 0.0059 | 0.34 |
| $\sigma^{pr^{oil}}$ | Size of oil production shock | 1.2 | 0.005 | inv. Gamma | 0.0059 | 0.43 |
| $\sigma^{G(pr)^{oil}}$ | size of oil production growth shock | 0.65 | 0.005 | inv. Gamma | 0.019 | 0.43 |
| $\sigma^{\pi}$ | Size of cost push shock | 0.42 | 0.005 | inv. Gamma | 0.032 | 0.23 |
| $\sigma^{\hat{g}}$ | Size of short term fiscal policy shock | 2.1 | 0.005 | inv. Gamma | 0.0062 | 0.24 |

*Continued on next page*

*– Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{G(\bar{y})}$ | Size of structural fiscal policy shock (level) | 0.23 | 0.005 | inv. Gamma | 0.0081 | 0.41 |
| $\sigma^{G(\bar{g})}$ | Size of structural fiscal policy shock (growth) | 1.2 | 0.005 | inv. Gamma | 0.04 | 0.095 |
| $\sigma^{\Delta debt}$ | Size of public debt growth shock | 0.59 | 0.005 | inv. Gamma | 0.021 | 0.13 |
| $\sigma^{debt}$ | Size of debt level shock | 1.2 | 0.005 | inv. Gamma | 0.0059 | 0.64 |
| $\sigma^{\bar{z}}$ | Size of Structural exchange rate shock | 0.56 | 0.005 | inv. Gamma | 0.079 | 0.29 |
| $\sigma^{prem}$ | Size of risk premium shock | 2.2 | 0.005 | inv. Gamma | 0.0073 | 0.26 |
| $\sigma^{s^{euro}}$ | Size of nominal exchange rate shock | 0.76 | 0.005 | inv. Gamma | 0.0022 | 0.29 |
| $\sigma^{IPOLICY}$ | size of monetary policy shock | 1.2 | 0.005 | inv. Gamma | 0.0039 | 0.15 |
| $\sigma^{\bar{r}}$ | Size of real interest rate trend shock | 0.93 | 0.005 | inv. Gamma | 0.014 | 0.3 |
| $\sigma^{resmimp}$ | Size of international reserves shock | 0.77 | 0.005 | inv. Gamma | 0.59 | 0.35 |
| $\sigma^{i^{euro}}$ | Size of foreign interest rate shock | 0.14 | 0.003 | inv. Gamma | 0.0044 | 0.022 |
| stdystar | Size of foreign output gap shock | 0.25 | 0.003 | inv. Gamma | 0.017 | 0.014 |
| $\sigma^{\pi^{euro}}$ | Size of foreign inflation - Eurozone | 0.19 | 0.003 | inv. Gamma | 0.0056 | 0.014 |
| $\sigma^{poil}$ | Size of oil price shock | 2.3 | 0.005 | inv. Gamma | 0.19 | 0.32 |
| $\sigma^{s^{usd}}$ | Size of EUR/USD exchange rate shock | 1.1 | 0.005 | inv. Gamma | 0.037 | 0.28 |
| $\sigma^{\pi^{food}}$ | Size of International food prices shock | 1.7 | 0.005 | inv. Gamma | 0.064 | 0.23 |
| $\sigma^{blt}$ | Size of temporary credit supply shock | 2 | 0.005 | inv. Gamma | 0.0072 | 0.07 |
| $\sigma^{\bar{cr}}$ | Size of permament credit supply shock | 2.7 | 0.005 | inv. Gamma | 0.074 | 0.25 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{\bar{cr}}$ | Size of credit trend growth shock | 1 | 0.005 | inv. Gamma | 0.0072 | 0.15 |
| $\sigma^{IINTERBANK}$ | Size of interbank risk shock | 2.3 | 0.005 | inv. Gamma | 0.0058 | 0.38 |
| $\sigma^{cbinjec}$ | Size of Central Bank liquidity injection | 0.66 | 0.005 | inv. Gamma | 0.16 | 0.41 |

*Source : Author's calculations*

**Table 6** – *Estimation results - Congo*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $a_0^1$ | Non oil Output gap inertia | 0.87 | 0.25 | beta | 0.56 | 0.17 |
| $a_1^1$ | Non oil Output gap expectation | 0.32 | 0.03 | gamma | 0.11 | 0.097 |
| $a_2^1$ | Financial conditions output gap sensitiveness | 1.6 | 0.15 | gamma | 0.92 | 0.27 |
| $a_3^1$ | Non oil output gap sensitiveness to exchange rate | 1.2 | 0.1 | gamma | 0.31 | 0.17 |
| $a_4^1$ | Domestic non oil output gap sensitiveness to foreign output gap | 0.74 | 0.21 | gamma | 0.31 | 0.15 |
| $a_5^1$ | Non oil Output gap sensitiveness to public expenses gap | 0.27 | 0.05 | gamma | 0.13 | 0.13 |
| $a_0^3$ | Inertia of non oil gdp trend growth | 0.96 | 0.15 | beta | 0.92 | 0.17 |
| $a_1^3$ | Non oil GDP reaction to structural public spending growth | 0.14 | 0.12 | beta | 0.083 | 0.068 |
| $b_0^1$ | Weight of lag inflation | 0.3 | 0.06 | beta | 0.62 | 0.049 |
| $b_1^1$ | Weight of prices expectations | 1.1 | 0.075 | gamma | 0.093 | 0.003 |
| $b_2^1$ | Demand price sensitiveness | 0.73 | 0.36 | gamma | 0.082 | 1.2 |
| $b_3^1$ | Exchange rate price sensitiveness | 0.6 | 0.05 | gamma | 0.064 | 0.056 |
| $b_4^1$ | Sensitiveness of local inflation to Imported Food prices | 1.6 | 0.15 | gamma | 0.15 | 0.12 |
| $c_0^1$ | Inertia of public spending gap | 0.28 | 0.05 | beta | 0.53 | 0.054 |
| $c_1^1$ | Weight of output stabilization in fiscal policy rule | 3 | 0.21 | gamma | 0.42 | 0.87 |
| $c_2^1$ | Public spending gap response to public debt | 0.094 | 0.03 | gamma | 0.094 | 0.004 |
| $c_0^3$ | Inertia of the growth rate of structural public spending | 0.41 | 0.1 | gamma | 0.7 | 0.21 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $c_1^3$ | Structural public spending growth to non oil GDP growth | 3.9 | 0.5 | gamma | 0.55 | 0.097 |
| $c_2^3$ | Structural public spending growth to oil GDP growth | 1.1 | 0.25 | gamma | 0.28 | 0.58 |
| $cd_0^1$ | Public debt growth inertia | 0.63 | 0.05 | beta | 0.67 | 0.063 |
| $cd_1^2$ | Sensitiveness of public debt to exchange rate | 2.3 | 0.25 | gamma | 0.25 | 0.054 |
| $f_1^1$ | International reserves sensitiveness to economic growth | 58 | 4 | gamma | 0.3 | 0.17 |
| $f_2^1$ | International reserves sensitiveness to oil GDP | 4.6 | 2 | gamma | 2 | 3.6 |
| $f_3^1$ | International reserves sensitiveness to debt dynamics | 15 | 2.4 | gamma | 4.3 | 10 |
| $g_0^1$ | Inertia of foreign interest rate | 0.94 | 0.08 | beta | 0.97 | 0.091 |
| $g_0^2$ | Inertia of foreign output gap | 0.72 | 0.08 | beta | 0.63 | 0.04 |
| $g_0^3$ | Inertia of foreign inglation - Eurozone | 0.3 | 0.04 | beta | 0.096 | 0.082 |
| $g_0^6$ | Inertia of international food prices variation | 0.14 | 0.02 | beta | 0.1 | 0.02 |
| $h_0^1$ | Bank Lending Tightness inertia | 0.84 | 0.07 | beta | 0.73 | 0.026 |
| $h_1^1$ | Output expectations effect on credit supply | 0.77 | 0.05 | gamma | 0.48 | 0.036 |
| $h_2^1$ | Output past dynamics effect on credit supply | 0.45 | 0.16 | gamma | 0.74 | 0.2 |
| $h_3^1$ | Interbank rate effect on credit supply | 0.076 | 0.006 | gamma | 0.059 | 0.007 |
| $h_4^1$ | Central Bank liquidity effect on credit suply | 0.68 | 0.06 | gamma | 0.18 | 0.12 |
| $h_0^2$ | Credit gap inertia | 0.75 | 0.2 | beta | 0.83 | 0.049 |
| $h_2^2$ | Interest rate effect on credit gap | 0.03 | 0.006 | gamma | 0.059 | 0.0015 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $h_0^3$ | Inertia of credit trend growth | 0.22 | 0.1 | beta | 0.77 | 0.13 |
| $h_1^3$ | Nominal growth effect on credit trend | 0.61 | 0.1 | gamma | 0.37 | 0.31 |
| $h_0^4$ | Inertia of Bank Stability Index | 0.56 | 0.07 | beta | 0.73 | 0.076 |
| $h_1^4$ | Debt importance in bank stability dynamics | 0.25 | 0.02 | beta | 0.097 | 0.017 |
| $i_0^1$ | Inertia of Interbank rate | 0.96 | 0.045 | beta | 0.98 | 0.14 |
| $i_1^1$ | Liquidity injection influence on Interbank rate | 2.2 | 0.24 | gamma | 0.43 | 0.91 |
| $i_2^1$ | Bank stability influence on interbank rate dynamics | 2.2 | 0.2 | gamma | 0.33 | 0.21 |
| $i_0^2$ | Central bank liquidity inertia | 0.91 | 0.08 | beta | 0.86 | 0.16 |
| $i_1^2$ | Central bank liquidity reaction to interbank spread | 7.2 | 0.75 | gamma | 7.2 | 1.2 |
| $i_2^2$ | Central bank liquidity reaction to bank instability | 0.25 | 0.08 | gamma | 0.16 | 0.073 |
| $\sigma^{\hat{y}}$ | Size of Demand Shock | 1.5 | 0.005 | inv. Gamma | 0.0064 | 0.018 |
| $\sigma^{\bar{y}}$ | Size of level productivity shock | 2.6 | 0.005 | inv. Gamma | 0.0031 | 0.52 |
| $\sigma^{G(\bar{y})}$ | Size of growth productivity shock | 0.6 | 0.005 | inv. Gamma | 0.0037 | 0.24 |
| $\sigma^{y^{oil}}$ | Size of oil production shock | 2.8 | 0.005 | inv. Gamma | 0.0073 | 0.081 |
| $\sigma^{pr^{oil}}$ | Size of oil production shock | 1.2 | 0.005 | inv. Gamma | 0.16 | 0.64 |
| $\sigma^{G(pr)^{oil}}$ | size of oil production growth shock | 0.76 | 0.005 | inv. Gamma | 0.0075 | 0.43 |
| $\sigma^{\pi}$ | Size of cost push shock | 2.1 | 0.005 | inv. Gamma | 0.015 | 0.18 |
| $\sigma^{\hat{g}}$ | Size of short term fiscal policy shock | 1.5 | 0.005 | inv. Gamma | 0.0066 | 0.27 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{G(\bar{y})}$ | Size of structural fiscal policy shock (level) | 1.1 | 0.005 | inv. Gamma | 0.007 | 0.03 |
| $\sigma^{G(\bar{g})}$ | Size of structural fiscal policy shock (growth) | 1.1 | 0.005 | inv. Gamma | 0.049 | 0.038 |
| $\sigma^{\Delta debt}$ | Size of public debt growth shock | 0.62 | 0.005 | inv. Gamma | 0.048 | 0.39 |
| $\sigma^{debt}$ | Size of debt level shock | 2.4 | 0.005 | inv. Gamma | 0.0067 | 0.66 |
| $\sigma^{\bar{z}}$ | Size of Structural exchange rate shock | 0.21 | 0.005 | inv. Gamma | 0.0052 | 0.21 |
| $\sigma^{prem}$ | Size of risk premium shock | 1 | 0.005 | inv. Gamma | 0.19 | 0.79 |
| $\sigma^{s^{euro}}$ | Size of nominal exchange rate shock | 0.31 | 0.005 | inv. Gamma | 0.0022 | 0.074 |
| $\sigma^{IPOLICY}$ | size of monetary policy shock | 2.6 | 0.005 | inv. Gamma | 0.0033 | 0.035 |
| $\sigma^{\bar{r}}$ | Size of real interest rate trend shock | 0.12 | 0.005 | inv. Gamma | 0.0075 | 0.32 |
| $\sigma^{resmimp}$ | Size of international reserves shock | 0.65 | 0.005 | inv. Gamma | 0.61 | 0.59 |
| $\sigma^{i^{euro}}$ | Size of foreign interest rate shock | 0.091 | 0.003 | inv. Gamma | 0.0044 | 0.034 |
| stdystar | Size of foreign output gap shock | 0.23 | 0.003 | inv. Gamma | 0.017 | 0.0075 |
| $\sigma^{\pi^{euro}}$ | Size of foreign inflation - Eurozone | 0.12 | 0.003 | inv. Gamma | 0.0056 | 0.008 |
| $\sigma^{poil}$ | Size of oil price shock | 0.6 | 0.005 | inv. Gamma | 0.19 | 0.42 |
| $\sigma^{s^{usd}}$ | Size of EUR/USD exchange rate shock | 0.9 | 0.005 | inv. Gamma | 0.037 | 0.27 |
| $\sigma^{\pi^{food}}$ | Size of International food prices shock | 2.6 | 0.005 | inv. Gamma | 0.064 | 0.021 |
| $\sigma^{blt}$ | Size of temporary credit supply shock | 0.022 | 0.005 | inv. Gamma | 0.1 | 0.47 |
| $\sigma^{\bar{cr}}$ | Size of permament credit supply shock | 0.5 | 0.005 | inv. Gamma | 0.039 | 0.25 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{\bar{cr}}$ | Size of credit trend growth shock | 2.2 | 0.005 | inv. Gamma | 0.024 | 0.42 |
| $\sigma^{IINTERBANK}$ | Size of interbank risk shock | 0.5 | 0.005 | inv. Gamma | 0.0052 | 0.067 |
| $\sigma^{cbinjec}$ | Size of Central Bank liquidity injection | 1.4 | 0.005 | inv. Gamma | 0.029 | 0.67 |

*Source : the author*

**Table 7** – *Estimation results - Gabon*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $a_0^1$ | Non oil Output gap inertia | 0.86 | 0.25 | beta | 0.31 | 0.099 |
| $a_1^1$ | Non oil Output gap expectation | 0.23 | 0.03 | gamma | 0.085 | 0.014 |
| $a_2^1$ | Financial conditions output gap sensitiveness | 1.5 | 0.15 | gamma | 0.57 | 0.14 |
| $a_3^1$ | Non oil output gap sensitiveness to exchange rate | 0.097 | 0.1 | gamma | 0.19 | 0.18 |
| $a_4^1$ | Domestic non oil output gap sensitiveness to foreign output gap | 1.1 | 0.21 | gamma | 0.49 | 0.48 |
| $a_5^1$ | Non oil Output gap sensitiveness to public expenses gap | 0.7 | 0.05 | gamma | 0.088 | 0.16 |
| $a_0^3$ | Inertia of non oil gdp trend growth | 0.72 | 0.15 | beta | 0.91 | 0.12 |
| $a_1^3$ | Non oil GDP reaction to structural public spending growth | 0.16 | 0.12 | beta | 0.22 | 0.063 |
| $b_0^1$ | Weight of lag inflation | 0.52 | 0.06 | beta | 0.6 | 0.044 |
| $b_1^1$ | Weight of prices expectations | 1 | 0.075 | gamma | 0.098 | 0.049 |
| $b_2^1$ | Demand price sensitiveness | 1.7 | 0.36 | gamma | 0.16 | 0.43 |
| $b_3^1$ | Exchange rate price sensitiveness | 0.17 | 0.05 | gamma | 0.083 | 0.077 |
| $b_4^1$ | Sensitiveness of local inflation to Imported Food prices | 1.5 | 0.15 | gamma | 0.17 | 0.14 |
| $c_0^1$ | Inertia of public spending gap | 0.54 | 0.05 | beta | 0.52 | 0.021 |
| $c_1^1$ | Weight of output stabilization in fiscal policy rule | 2.7 | 0.21 | gamma | 0.52 | 0.41 |
| $c_2^1$ | Public spending gap response to public debt | 0.14 | 0.03 | gamma | 0.096 | 0.053 |
| $c_0^3$ | Inertia of the growth rate of structural public spending | 0.13 | 0.1 | gamma | 0.55 | 0.18 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $c_1^3$ | Structural public spending growth to non oil GDP growth | 2.1 | 0.5 | gamma | 0.65 | 0.25 |
| $c_2^3$ | Structural public spending growth to oil GDP growth | 0.9 | 0.25 | gamma | 0.23 | 0.5 |
| $cd_0^1$ | Public debt growth inertia | 0.73 | 0.05 | beta | 0.74 | 0.07 |
| $cd_1^2$ | Sensitiveness of public debt to exchange rate | 3.7 | 0.25 | gamma | 0.15 | 0.19 |
| $f_1^1$ | International reserves sensitiveness to economic growth | 32 | 4 | gamma | 4.8 | 8.6 |
| $f_2^1$ | International reserves sensitiveness to oil GDP | 16 | 2 | gamma | 3.2 | 3.2 |
| $f_3^1$ | International reserves sensitiveness to debt dynamics | 2.4 | 2.4 | gamma | 3.9 | 9.8 |
| $g_0^1$ | Inertia of foreign interest rate | 0.94 | 0.08 | beta | 0.97 | 0.086 |
| $g_0^2$ | Inertia of foreign output gap | 0.59 | 0.08 | beta | 0.63 | 0.15 |
| $g_0^3$ | Inertia of foreign inglation - Eurozone | 0.16 | 0.04 | beta | 0.097 | 0.1 |
| $g_0^6$ | Inertia of international food prices variation | 0.12 | 0.02 | beta | 0.1 | 0.035 |
| $h_0^1$ | Bank Lending Tightness inertia | 0.36 | 0.07 | beta | 0.73 | 0.035 |
| $h_1^1$ | Output expectations effect on credit supply | 0.53 | 0.05 | gamma | 0.49 | 0.029 |
| $h_2^1$ | Output past dynamics effect on credit supply | 0.18 | 0.16 | gamma | 0.77 | 0.33 |
| $h_3^1$ | Interbank rate effect on credit supply | 0.047 | 0.006 | gamma | 0.059 | 0.00073 |
| $h_4^1$ | Central Bank liquidity effect on credit suply | 0.58 | 0.06 | gamma | 0.18 | 0.094 |
| $h_0^2$ | Credit gap inertia | 0.3 | 0.2 | beta | 0.57 | 0.21 |
| $h_2^2$ | Interest rate effect on credit gap | 0.034 | 0.006 | gamma | 0.059 | 0.01 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $h_0^3$ | Inertia of credit trend growth | 0.5 | 0.1 | beta | 0.62 | 0.083 |
| $h_1^3$ | Nominal growth effect on credit trend | 0.2 | 0.1 | gamma | 0.45 | 0.16 |
| $h_0^4$ | Inertia of Bank Stability Index | 0.58 | 0.07 | beta | 0.71 | 0.05 |
| $h_1^4$ | Debt importance in bank stability dynamics | 0.068 | 0.02 | beta | 0.097 | 0.011 |
| $i_0^1$ | Inertia of Interbank rate | 0.66 | 0.045 | beta | 0.96 | 0.19 |
| $i_1^1$ | Liquidity injection influence on Interbank rate | 0.66 | 0.24 | gamma | 0.32 | 1.5 |
| $i_2^1$ | Bank stability influence on interbank rate dynamics | 1.4 | 0.2 | gamma | 0.4 | 0.51 |
| $i_0^2$ | Central bank liquidity inertia | 0.99 | 0.08 | beta | 0.88 | 0.18 |
| $i_1^2$ | Central bank liquidity reaction to interbank spread | 9 | 0.75 | gamma | 7 | 1.4 |
| $i_2^2$ | Central bank liquidity reaction to bank instability | 0.2 | 0.08 | gamma | 0.17 | 0.09 |
| $\sigma^{\hat{y}}$ | Size of Demand Shock | 2.1 | 0.005 | inv. Gamma | 0.0069 | 0.36 |
| $\sigma^{\bar{y}}$ | Size of level productivity shock | 2.5 | 0.005 | inv. Gamma | 0.003 | 0.019 |
| $\sigma^{G(\bar{y})}$ | Size of growth productivity shock | 1.5 | 0.005 | inv. Gamma | 0.0033 | 0.28 |
| $\sigma^{y^{oil}}$ | Size of oil production shock | 1.3 | 0.005 | inv. Gamma | 0.0065 | 0.32 |
| $\sigma^{pr^{oil}}$ | Size of oil production shock | 0.9 | 0.005 | inv. Gamma | 0.0066 | 0.35 |
| $\sigma^{G(pr)^{oil}}$ | size of oil production growth shock | 0.02 | 0.005 | inv. Gamma | 0.019 | 0.81 |
| $\sigma^{\pi}$ | Size of cost push shock | 0.19 | 0.005 | inv. Gamma | 0.012 | 0.5 |
| $\sigma^{\hat{g}}$ | Size of short term fiscal policy shock | 0.17 | 0.005 | inv. Gamma | 0.0062 | 0.44 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{G(\bar{y})}$ | Size of structural fiscal policy shock (level) | 2.1 | 0.005 | inv. Gamma | 0.0067 | 0.35 |
| $\sigma^{G(\bar{g})}$ | Size of structural fiscal policy shock (growth) | 1.5 | 0.005 | inv. Gamma | 0.031 | 0.34 |
| $\sigma^{\Delta debt}$ | Size of public debt growth shock | 0.86 | 0.005 | inv. Gamma | 0.022 | 0.33 |
| $\sigma^{debt}$ | Size of debt level shock | 2 | 0.005 | inv. Gamma | 0.006 | 0.55 |
| $\sigma^{\bar{z}}$ | Size of Structural exchange rate shock | 1.5 | 0.005 | inv. Gamma | 0.0085 | 0.15 |
| $\sigma^{prem}$ | Size of risk premium shock | 0.91 | 0.005 | inv. Gamma | 0.0073 | 0.24 |
| $\sigma^{s^{euro}}$ | Size of nominal exchange rate shock | 1.9 | 0.005 | inv. Gamma | 0.0022 | 0.25 |
| $\sigma^{IPOLICY}$ | size of monetary policy shock | 2.6 | 0.005 | inv. Gamma | 0.003 | 0.14 |
| $\sigma^{\bar{r}}$ | Size of real interest rate trend shock | 2.6 | 0.005 | inv. Gamma | 0.0072 | 0.54 |
| $\sigma^{resmimp}$ | Size of international reserves shock | 0.96 | 0.005 | inv. Gamma | 0.56 | 0.29 |
| $\sigma^{i^{euro}}$ | Size of foreign interest rate shock | 0.045 | 0.003 | inv. Gamma | 0.0044 | 0.016 |
| stdystar | Size of foreign output gap shock | 0.22 | 0.003 | inv. Gamma | 0.017 | 0.053 |
| $\sigma^{\pi^{euro}}$ | Size of foreign inflation - Eurozone | 0.098 | 0.003 | inv. Gamma | 0.0056 | 0.0015 |
| $\sigma^{poil}$ | Size of oil price shock | 0.27 | 0.005 | inv. Gamma | 0.19 | 0.11 |
| $\sigma^{s^{usd}}$ | Size of EUR/USD exchange rate shock | 0.11 | 0.005 | inv. Gamma | 0.037 | 0.46 |
| $\sigma^{\pi^{food}}$ | Size of International food prices shock | 1.4 | 0.005 | inv. Gamma | 0.064 | 0.46 |
| $\sigma^{blt}$ | Size of temporary credit supply shock | 0.15 | 0.005 | inv. Gamma | 0.03 | 0.26 |
| $\sigma^{\bar{cr}}$ | Size of permament credit supply shock | 2.1 | 0.005 | inv. Gamma | 0.061 | 0.4 |

*Continued on next page*

*– Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{\bar{cr}}$ | Size of credit trend growth shock | 0.61 | 0.005 | inv. Gamma | 0.012 | 0.47 |
| $\sigma^{IINTERBANK}$ | Size of interbank risk shock | 0.48 | 0.005 | inv. Gamma | 0.0059 | 0.24 |
| $\sigma^{cbinjec}$ | Size of Central Bank liquidity injection | 0.55 | 0.005 | inv. Gamma | 0.024 | 0.034 |

*Source : the author*

**Table 8** – *Estimation results - Equatorial Guinea*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $a_0^1$ | Non oil Output gap inertia | 0.45 | 0.25 | beta | 0.5 | 0.082 |
| $a_1^1$ | Non oil Output gap expectation | 0.16 | 0.03 | gamma | 0.09 | 0.064 |
| $a_2^1$ | Financial conditions output gap sensitiveness | 1.1 | 0.15 | gamma | 0.57 | 0.12 |
| $a_3^1$ | Non oil output gap sensitiveness to exchange rate | 0.38 | 0.1 | gamma | 0.25 | 0.11 |
| $a_4^1$ | Domestic non oil output gap sensitiveness to foreign output gap | 0.96 | 0.21 | gamma | 0.44 | 0.33 |
| $a_5^1$ | Non oil Output gap sensitiveness to public expenses gap | 0.077 | 0.05 | gamma | 0.08 | 0.17 |
| $a_0^3$ | Inertia of non oil gdp trend growth | 0.84 | 0.15 | beta | 0.9 | 0.18 |
| $a_1^3$ | Non oil GDP reaction to structural public spending growth | 0.94 | 0.12 | beta | 0.13 | 0.07 |
| $b_0^1$ | Weight of lag inflation | 0.83 | 0.06 | beta | 0.61 | 0.068 |
| $b_1^1$ | Weight of prices expectations | 0.93 | 0.075 | gamma | 0.092 | 0.2 |
| $b_2^1$ | Demand price sensitiveness | 0.0021 | 0.36 | gamma | 0.2 | 1.3 |
| $b_3^1$ | Exchange rate price sensitiveness | 0.8 | 0.05 | gamma | 0.068 | 0.033 |
| $b_4^1$ | Sensitiveness of local inflation to Imported Food prices | 1.8 | 0.15 | gamma | 0.16 | 0.32 |
| $c_0^1$ | Inertia of public spending gap | 0.64 | 0.05 | beta | 0.51 | 0.064 |
| $c_1^1$ | Weight of output stabilization in fiscal policy rule | 0.8 | 0.21 | gamma | 0.41 | 0.71 |
| $c_2^1$ | Public spending gap response to public debt | 0.029 | 0.03 | gamma | 0.09 | 0.069 |
| $c_0^3$ | Inertia of the growth rate of structural public spending | 0.43 | 0.1 | gamma | 0.82 | 0.3 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $c_1^3$ | Structural public spending growth to non oil GDP growth | 2.9 | 0.5 | gamma | 1 | 0.4 |
| $c_2^3$ | Structural public spending growth to oil GDP growth | 0.23 | 0.25 | gamma | 0.26 | 0.12 |
| $cd_0^1$ | Public debt growth inertia | 0.68 | 0.05 | beta | 0.77 | 0.14 |
| $cd_1^2$ | Sensitiveness of public debt to exchange rate | 0.41 | 0.25 | gamma | 0.19 | 0.61 |
| $f_1^1$ | International reserves sensitiveness to economic growth | 27 | 4 | gamma | 1.1 | 1.2 |
| $f_2^1$ | International reserves sensitiveness to oil GDP | 24 | 2 | gamma | 2.4 | 1.7 |
| $f_3^1$ | International reserves sensitiveness to debt dynamics | 40 | 2.4 | gamma | 1.8 | 3.9 |
| $g_0^1$ | Inertia of foreign interest rate | 0.34 | 0.08 | beta | 0.97 | 0.014 |
| $g_0^2$ | Inertia of foreign output gap | 0.31 | 0.08 | beta | 0.63 | 0.18 |
| $g_0^3$ | Inertia of foreign inglation - Eurozone | 0.19 | 0.04 | beta | 0.097 | 0.0047 |
| $g_0^6$ | Inertia of international food prices variation | 0.096 | 0.02 | beta | 0.1 | 0.011 |
| $h_0^1$ | Bank Lending Tightness inertia | 0.7 | 0.07 | beta | 0.75 | 0.041 |
| $h_1^1$ | Output expectations effect on credit supply | 0.56 | 0.05 | gamma | 0.48 | 0.034 |
| $h_2^1$ | Output past dynamics effect on credit supply | 1.8 | 0.16 | gamma | 0.75 | 0.058 |
| $h_3^1$ | Interbank rate effect on credit supply | 0.03 | 0.006 | gamma | 0.059 | 0.0062 |
| $h_4^1$ | Central Bank liquidity effect on credit suply | 0.83 | 0.06 | gamma | 0.19 | 0.11 |
| $h_0^2$ | Credit gap inertia | 0.26 | 0.2 | beta | 0.53 | 0.072 |
| $h_2^2$ | Interest rate effect on credit gap | 0.091 | 0.006 | gamma | 0.06 | 0.0039 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $h_0^3$ | Inertia of credit trend growth | 0.29 | 0.1 | beta | 0.5 | 0.089 |
| $h_1^3$ | Nominal growth effect on credit trend | 0.79 | 0.1 | gamma | 0.42 | 0.074 |
| $h_0^4$ | Inertia of Bank Stability Index | 0.49 | 0.07 | beta | 0.72 | 0.093 |
| $h_1^4$ | Debt importance in bank stability dynamics | 0.12 | 0.02 | beta | 0.097 | 0.011 |
| $i_0^1$ | Inertia of Interbank rate | 0.72 | 0.045 | beta | 0.96 | 0.21 |
| $i_1^1$ | Liquidity injection influence on Interbank rate | 0.85 | 0.24 | gamma | 0.38 | 1.2 |
| $i_2^1$ | Bank stability influence on interbank rate dynamics | 2.4 | 0.2 | gamma | 0.4 | 0.1 |
| $i_0^2$ | Central bank liquidity inertia | 0.27 | 0.08 | beta | 0.87 | 0.2 |
| $i_1^2$ | Central bank liquidity reaction to interbank spread | 11 | 0.75 | gamma | 7.1 | 1.5 |
| $i_2^2$ | Central bank liquidity reaction to bank instability | 0.22 | 0.08 | gamma | 0.17 | 0.22 |
| $\sigma^{\hat{y}}$ | Size of Demand Shock | 2.7 | 0.005 | inv. Gamma | 0.006 | 0.29 |
| $\sigma^{\bar{y}}$ | Size of level productivity shock | 2.2 | 0.005 | inv. Gamma | 0.003 | 0.45 |
| $\sigma^{G(\bar{y})}$ | Size of growth productivity shock | 1.2 | 0.005 | inv. Gamma | 0.0034 | 0.4 |
| $\sigma^{y^{oil}}$ | Size of oil production shock | 1.9 | 0.005 | inv. Gamma | 0.0097 | 0.049 |
| $\sigma^{pr^{oil}}$ | Size of oil production shock | 2.4 | 0.005 | inv. Gamma | 0.0074 | 0.4 |
| $\sigma^{G(pr)^{oil}}$ | size of oil production growth shock | 0.77 | 0.005 | inv. Gamma | 0.076 | 0.072 |
| $\sigma^{\pi}$ | Size of cost push shock | 1.4 | 0.005 | inv. Gamma | 0.013 | 0.23 |
| $\sigma^{\hat{g}}$ | Size of short term fiscal policy shock | 1.2 | 0.005 | inv. Gamma | 0.0061 | 0.052 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{G(\bar{y})}$ | Size of structural fiscal policy shock (level) | 1.2 | 0.005 | inv. Gamma | 0.0065 | 0.24 |
| $\sigma^{G(\bar{g})}$ | Size of structural fiscal policy shock (growth) | 0.016 | 0.005 | inv. Gamma | 0.034 | 0.087 |
| $\sigma^{\Delta debt}$ | Size of public debt growth shock | 0.26 | 0.005 | inv. Gamma | 0.026 | 0.034 |
| $\sigma^{debt}$ | Size of debt level shock | 1.2 | 0.005 | inv. Gamma | 0.006 | 0.0093 |
| $\sigma^{\bar{z}}$ | Size of Structural exchange rate shock | 1.6 | 0.005 | inv. Gamma | 0.0076 | 0.2 |
| $\sigma^{prem}$ | Size of risk premium shock | 2.6 | 0.005 | inv. Gamma | 0.0073 | 0.19 |
| $\sigma^{s^{euro}}$ | Size of nominal exchange rate shock | 2 | 0.005 | inv. Gamma | 0.0022 | 0.18 |
| $\sigma^{IPOLICY}$ | size of monetary policy shock | 0.21 | 0.005 | inv. Gamma | 0.0031 | 0.041 |
| $\sigma^{\bar{r}}$ | Size of real interest rate trend shock | 2.2 | 0.005 | inv. Gamma | 0.019 | 0.37 |
| $\sigma^{resmimp}$ | Size of international reserves shock | 0.97 | 0.005 | inv. Gamma | 0.61 | 0.32 |
| $\sigma^{i^{euro}}$ | Size of foreign interest rate shock | 0.092 | 0.003 | inv. Gamma | 0.0044 | 0.011 |
| stdystar | Size of foreign output gap shock | 0.21 | 0.003 | inv. Gamma | 0.017 | 0.048 |
| $\sigma^{\pi^{euro}}$ | Size of foreign inflation - Eurozone | 0.056 | 0.003 | inv. Gamma | 0.0056 | 0.021 |
| $\sigma^{poil}$ | Size of oil price shock | 2 | 0.005 | inv. Gamma | 0.19 | 0.2 |
| $\sigma^{s^{usd}}$ | Size of EUR/USD exchange rate shock | 2.7 | 0.005 | inv. Gamma | 0.037 | 0.084 |
| $\sigma^{\pi^{food}}$ | Size of International food prices shock | 0.36 | 0.005 | inv. Gamma | 0.064 | 0.1 |
| $\sigma^{blt}$ | Size of temporary credit supply shock | 1.6 | 0.005 | inv. Gamma | 0.031 | 0.097 |
| $\sigma^{\bar{cr}}$ | Size of permament credit supply shock | 0.93 | 0.005 | inv. Gamma | 0.12 | 0.54 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{\bar{cr}}$ | Size of credit trend growth shock | 1.6 | 0.005 | inv. Gamma | 0.0072 | 0.2 |
| $\sigma^{IINTERBANK}$ | Size of interbank risk shock | 0.093 | 0.005 | inv. Gamma | 0.0057 | 0.36 |
| $\sigma^{cbinjec}$ | Size of Central Bank liquidity injection | 1.2 | 0.005 | inv. Gamma | 0.023 | 0.17 |

*Source : the author*

**Table 9** – *Estimation results - Chad*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $a_0^1$ | Non oil Output gap inertia | 0.043 | 0.25 | beta | 0.24 | 0.094 |
| $a_1^1$ | Non oil Output gap expectation | 0.38 | 0.03 | gamma | 0.095 | 0.084 |
| $a_2^1$ | Financial conditions output gap sensitiveness | 0.46 | 0.15 | gamma | 0.59 | 0.12 |
| $a_3^1$ | Non oil output gap sensitiveness to exchange rate | 0.32 | 0.1 | gamma | 0.19 | 0.056 |
| $a_4^1$ | Domestic non oil output gap sensitiveness to foreign output gap | 1.4 | 0.21 | gamma | 0.36 | 0.29 |
| $a_5^1$ | Non oil Output gap sensitiveness to public expenses gap | 0.74 | 0.05 | gamma | 0.091 | 0.054 |
| $a_0^3$ | Inertia of non oil gdp trend growth | 0.29 | 0.15 | beta | 0.89 | 0.23 |
| $a_1^3$ | Non oil GDP reaction to structural public spending growth | 0.13 | 0.12 | beta | 0.16 | 0.073 |
| $b_0^1$ | Weight of lag inflation | 0.79 | 0.06 | beta | 0.57 | 0.08 |
| $b_1^1$ | Weight of prices expectations | 1 | 0.075 | gamma | 0.1 | 0.18 |
| $b_2^1$ | Demand price sensitiveness | 0.053 | 0.36 | gamma | 0.33 | 1 |
| $b_3^1$ | Exchange rate price sensitiveness | 0.79 | 0.05 | gamma | 0.086 | 0.097 |
| $b_4^1$ | Sensitiveness of local inflation to Imported Food prices | 2 | 0.15 | gamma | 0.21 | 0.16 |
| $c_0^1$ | Inertia of public spending gap | 0.67 | 0.05 | beta | 0.52 | 0.045 |
| $c_1^1$ | Weight of output stabilization in fiscal policy rule | 1.2 | 0.21 | gamma | 0.55 | 0.39 |
| $c_2^1$ | Public spending gap response to public debt | 0.26 | 0.03 | gamma | 0.092 | 0.034 |
| $c_0^3$ | Inertia of the growth rate of structural public spending | 0.89 | 0.1 | gamma | 0.64 | 0.23 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $c_1^3$ | Structural public spending growth to non oil GDP growth | 4.7 | 0.5 | gamma | 0.59 | 1 |
| $c_2^3$ | Structural public spending growth to oil GDP growth | 2.5 | 0.25 | gamma | 0.18 | 0.26 |
| $cd_0^1$ | Public debt growth inertia | 0.33 | 0.05 | beta | 0.79 | 0.13 |
| $cd_1^2$ | Sensitiveness of public debt to exchange rate | 1.5 | 0.25 | gamma | 0.13 | 0.81 |
| $f_1^1$ | International reserves sensitiveness to economic growth | 0.68 | 4 | gamma | 0.55 | 6.3 |
| $f_2^1$ | International reserves sensitiveness to oil GDP | 21 | 2 | gamma | 2.6 | 3.7 |
| $f_3^1$ | International reserves sensitiveness to debt dynamics | 31 | 2.4 | gamma | 1.6 | 3.7 |
| $g_0^1$ | Inertia of foreign interest rate | 0.84 | 0.08 | beta | 0.97 | 0.13 |
| $g_0^2$ | Inertia of foreign output gap | 0.57 | 0.08 | beta | 0.63 | 0.16 |
| $g_0^3$ | Inertia of foreign inglation - Eurozone | 0.24 | 0.04 | beta | 0.097 | 0.029 |
| $g_0^6$ | Inertia of international food prices variation | 0.12 | 0.02 | beta | 0.1 | 0.028 |
| $h_0^1$ | Bank Lending Tightness inertia | 0.6 | 0.07 | beta | 0.75 | 0.033 |
| $h_1^1$ | Output expectations effect on credit supply | 0.57 | 0.05 | gamma | 0.48 | 0.045 |
| $h_2^1$ | Output past dynamics effect on credit supply | 2.3 | 0.16 | gamma | 0.75 | 0.079 |
| $h_3^1$ | Interbank rate effect on credit supply | 0.05 | 0.006 | gamma | 0.059 | 0.005 |
| $h_4^1$ | Central Bank liquidity effect on credit suply | 0.35 | 0.06 | gamma | 0.17 | 0.023 |
| $h_0^2$ | Credit gap inertia | 0.74 | 0.2 | beta | 0.49 | 0.16 |
| $h_2^2$ | Interest rate effect on credit gap | 0.1 | 0.006 | gamma | 0.059 | 0.0099 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---:|---:|---:|---:|---:|---:|
| $h_0^3$ | Inertia of credit trend growth | 0.64 | 0.1 | beta | 0.75 | 0.13 |
| $h_1^3$ | Nominal growth effect on credit trend | 0.75 | 0.1 | gamma | 0.44 | 0.096 |
| $h_0^4$ | Inertia of Bank Stability Index | 0.9 | 0.07 | beta | 0.72 | 0.093 |
| $h_1^4$ | Debt importance in bank stability dynamics | 0.19 | 0.02 | beta | 0.097 | 0.019 |
| $i_0^1$ | Inertia of Interbank rate | 0.98 | 0.045 | beta | 0.97 | 0.033 |
| $i_1^1$ | Liquidity injection influence on Interbank rate | 3.6 | 0.24 | gamma | 0.32 | 0.28 |
| $i_2^1$ | Bank stability influence on interbank rate dynamics | 0.49 | 0.2 | gamma | 0.39 | 0.34 |
| $i_0^2$ | Central bank liquidity inertia | 0.62 | 0.08 | beta | 0.83 | 0.054 |
| $i_1^2$ | Central bank liquidity reaction to interbank spread | 4.1 | 0.75 | gamma | 7.2 | 0.94 |
| $i_2^2$ | Central bank liquidity reaction to bank instability | 0.53 | 0.08 | gamma | 0.17 | 0.2 |
| $\sigma^{\hat{y}}$ | Size of Demand Shock | 1.1 | 0.005 | inv. Gamma | 0.0074 | 0.35 |
| $\sigma^{\bar{y}}$ | Size of level productivity shock | 1.7 | 0.005 | inv. Gamma | 0.003 | 0.53 |
| $\sigma^{G(\bar{y})}$ | Size of growth productivity shock | 1.5 | 0.005 | inv. Gamma | 0.0032 | 0.26 |
| $\sigma^{y^{oil}}$ | Size of oil production shock | 2.3 | 0.005 | inv. Gamma | 0.0073 | 0.24 |
| $\sigma^{pr^{oil}}$ | Size of oil production shock | 2.6 | 0.005 | inv. Gamma | 0.042 | 0.19 |
| $\sigma^{G(pr)^{oil}}$ | size of oil production growth shock | 1.3 | 0.005 | inv. Gamma | 0.0079 | 0.39 |
| $\sigma^{\pi}$ | Size of cost push shock | 2.1 | 0.005 | inv. Gamma | 0.031 | 0.091 |
| $\sigma^{\hat{g}}$ | Size of short term fiscal policy shock | 2 | 0.005 | inv. Gamma | 0.0059 | 0.49 |

*Continued on next page*

– *Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{G(\bar{y})}$ | Size of structural fiscal policy shock (level) | 2.5 | 0.005 | inv. Gamma | 0.0063 | 0.074 |
| $\sigma^{G(\bar{g})}$ | Size of structural fiscal policy shock (growth) | 0.056 | 0.005 | inv. Gamma | 0.029 | 0.3 |
| $\sigma^{\Delta debt}$ | Size of public debt growth shock | 0.44 | 0.005 | inv. Gamma | 0.021 | 0.2 |
| $\sigma^{debt}$ | Size of debt level shock | 0.35 | 0.005 | inv. Gamma | 0.0059 | 0.58 |
| $\sigma^{\bar{z}}$ | Size of Structural exchange rate shock | 2 | 0.005 | inv. Gamma | 0.0074 | 0.59 |
| $\sigma^{prem}$ | Size of risk premium shock | 0.055 | 0.005 | inv. Gamma | 0.0073 | 0.7 |
| $\sigma^{s^{euro}}$ | Size of nominal exchange rate shock | 0.56 | 0.005 | inv. Gamma | 0.0022 | 0.022 |
| $\sigma^{IPOLICY}$ | size of monetary policy shock | 0.67 | 0.005 | inv. Gamma | 0.0035 | 0.52 |
| $\sigma^{\bar{r}}$ | Size of real interest rate trend shock | 1.8 | 0.005 | inv. Gamma | 0.013 | 0.41 |
| $\sigma^{resmimp}$ | Size of international reserves shock | 1.6 | 0.005 | inv. Gamma | 0.6 | 0.28 |
| $\sigma^{i^{euro}}$ | Size of foreign interest rate shock | 0.13 | 0.003 | inv. Gamma | 0.0044 | 0.022 |
| stdystar | Size of foreign output gap shock | 0.062 | 0.003 | inv. Gamma | 0.017 | 0.036 |
| $\sigma^{\pi^{euro}}$ | Size of foreign inflation - Eurozone | 0.18 | 0.003 | inv. Gamma | 0.0056 | 0.01 |
| $\sigma^{poil}$ | Size of oil price shock | 1.8 | 0.005 | inv. Gamma | 0.19 | 0.18 |
| $\sigma^{s^{usd}}$ | Size of EUR/USD exchange rate shock | 0.2 | 0.005 | inv. Gamma | 0.037 | 0.46 |
| $\sigma^{\pi^{food}}$ | Size of International food prices shock | 1.4 | 0.005 | inv. Gamma | 0.064 | 0.33 |
| $\sigma^{blt}$ | Size of temporary credit supply shock | 0.12 | 0.005 | inv. Gamma | 0.03 | 0.55 |
| $\sigma^{\bar{cr}}$ | Size of permament credit supply shock | 2.7 | 0.005 | inv. Gamma | 0.046 | 0.37 |

*Continued on next page*

*– Continued from previous page*

| Param name | Labels | Prior mean | Prior std | Prior Dist. | Estim. Mode | Estim. std. |
|---|---|---|---|---|---|---|
| $\sigma^{\bar{cr}}$ | Size of credit trend growth shock | 2.6 | 0.005 | inv. Gamma | 0.014 | 0.47 |
| $\sigma^{IINTERBANK}$ | Size of interbank risk shock | 1.6 | 0.005 | inv. Gamma | 0.0057 | 0.37 |
| $\sigma^{cbinjec}$ | Size of Central Bank liquidity injection | 0.93 | 0.005 | inv. Gamma | 0.033 | 0.1 |

*Source : the author*

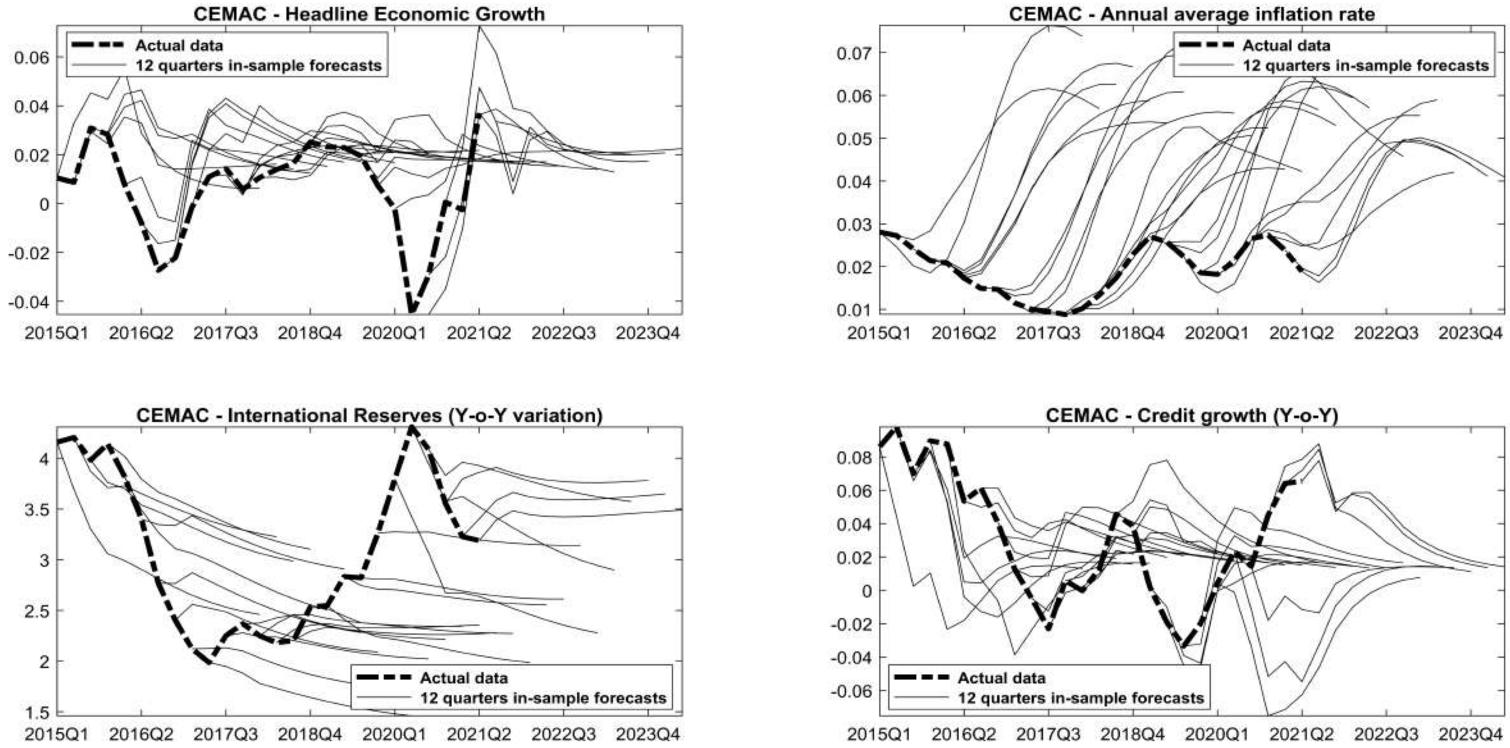
**Table 10** – *Intra-CEMAC trade parameters*

| | Cameroon | Central African Republic | Congo | Gabon | Eq.Guinea | Chad |
|---|---|---|---|---|---|---|
| **Cameroon** | - | 0,11696 | 0,00010 | 0,00792 | 0,00818 | 0,03990 |
| **Central African Republic** | 0,00449 | - | 0,00003 | 0,00001 | 0,00001 | 0,00009 |
| **Congo** | 0,00995 | 0,00853 | - | 0,02583 | 0,03080 | 0,00010 |
| **Gabon** | 0,00573 | 0,00012 | 0,00002 | - | 0,00000 | 0,00000 |
| **Eq.Guinea** | 0,00463 | 0,00009 | 0,00002 | 0,00000 | - | 0,00000 |
| **Chad** | 0,00702 | 0,00039 | 0,00002 | 0,00000 | 0,00000 | - |

*Source : the author*

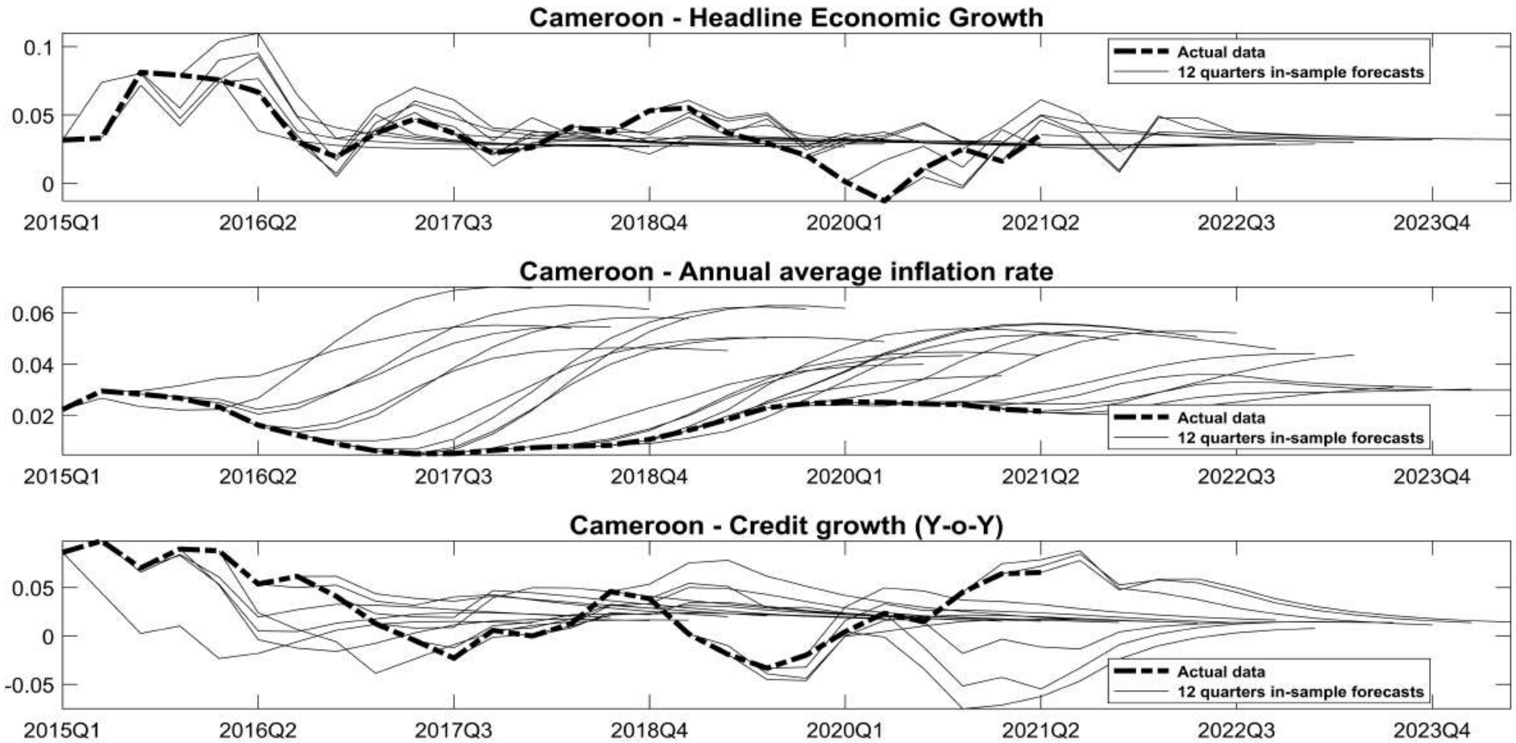
## In-sample forecasts

**Figure 24** – *In-sample unconditional forecasts of some CEMAC variables*



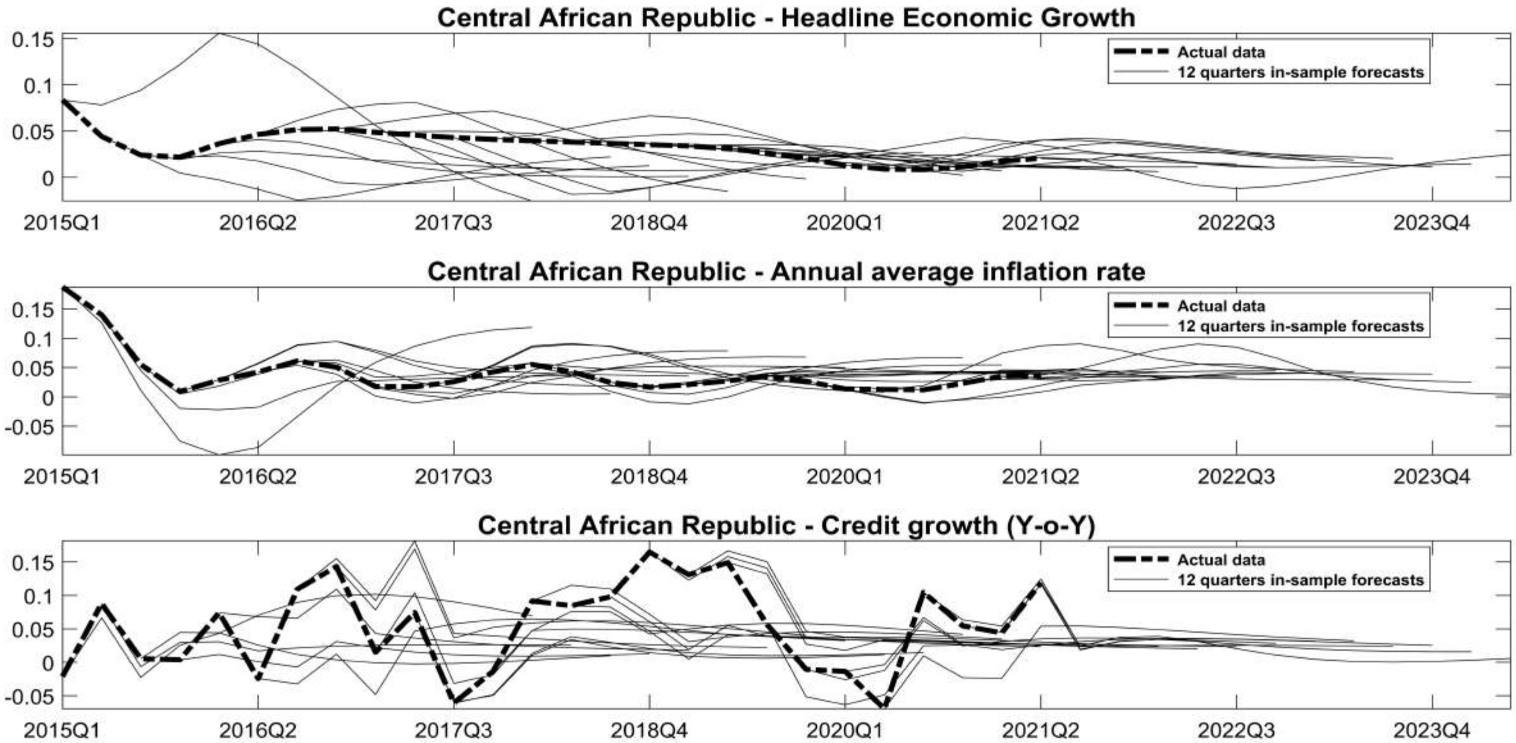

*Source : Author*

**Figure 25** – *In-sample unconditional forecasts of some Cameroon's variables*



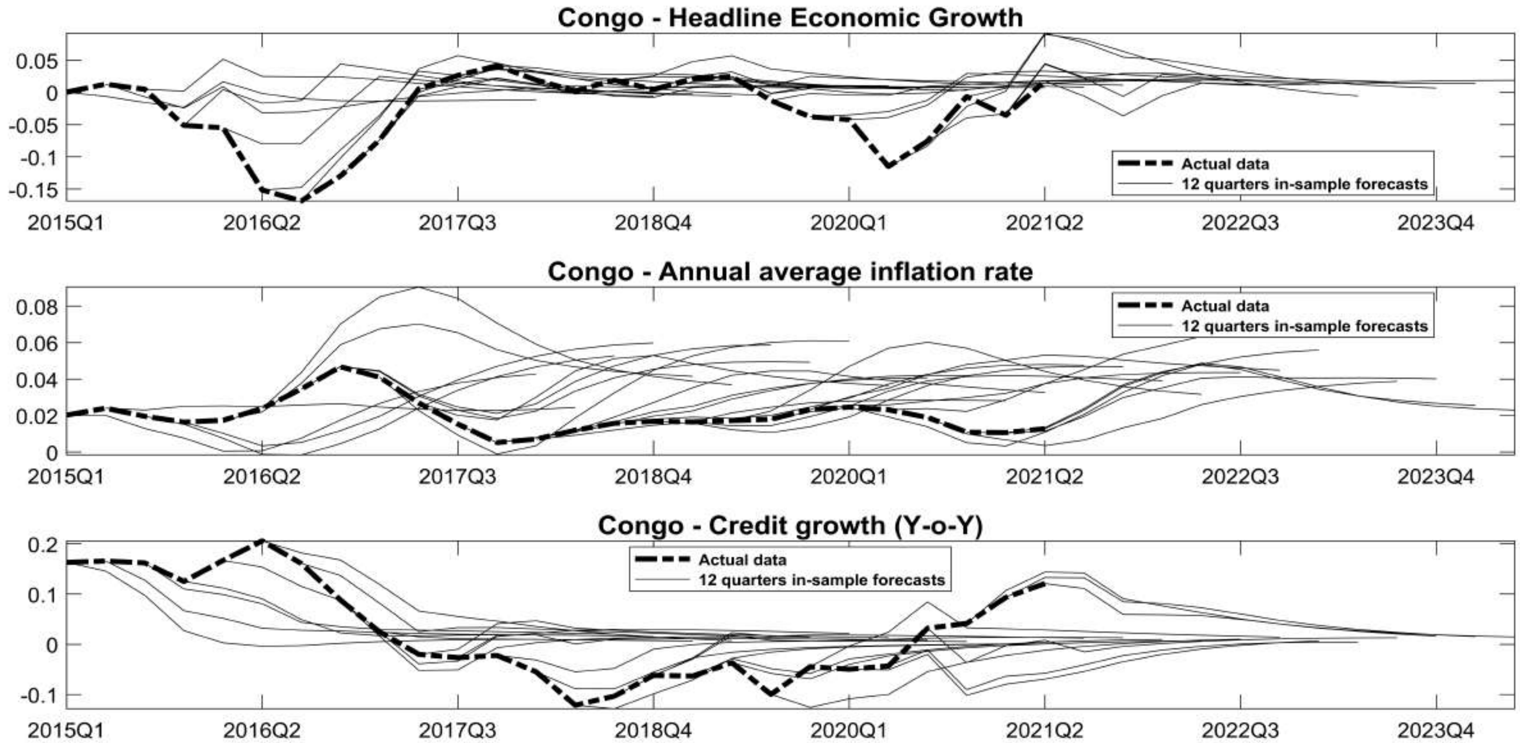

*Source : Author*

**Figure 26** – *In-sample unconditional forecasts of some Central African Republic's variables*



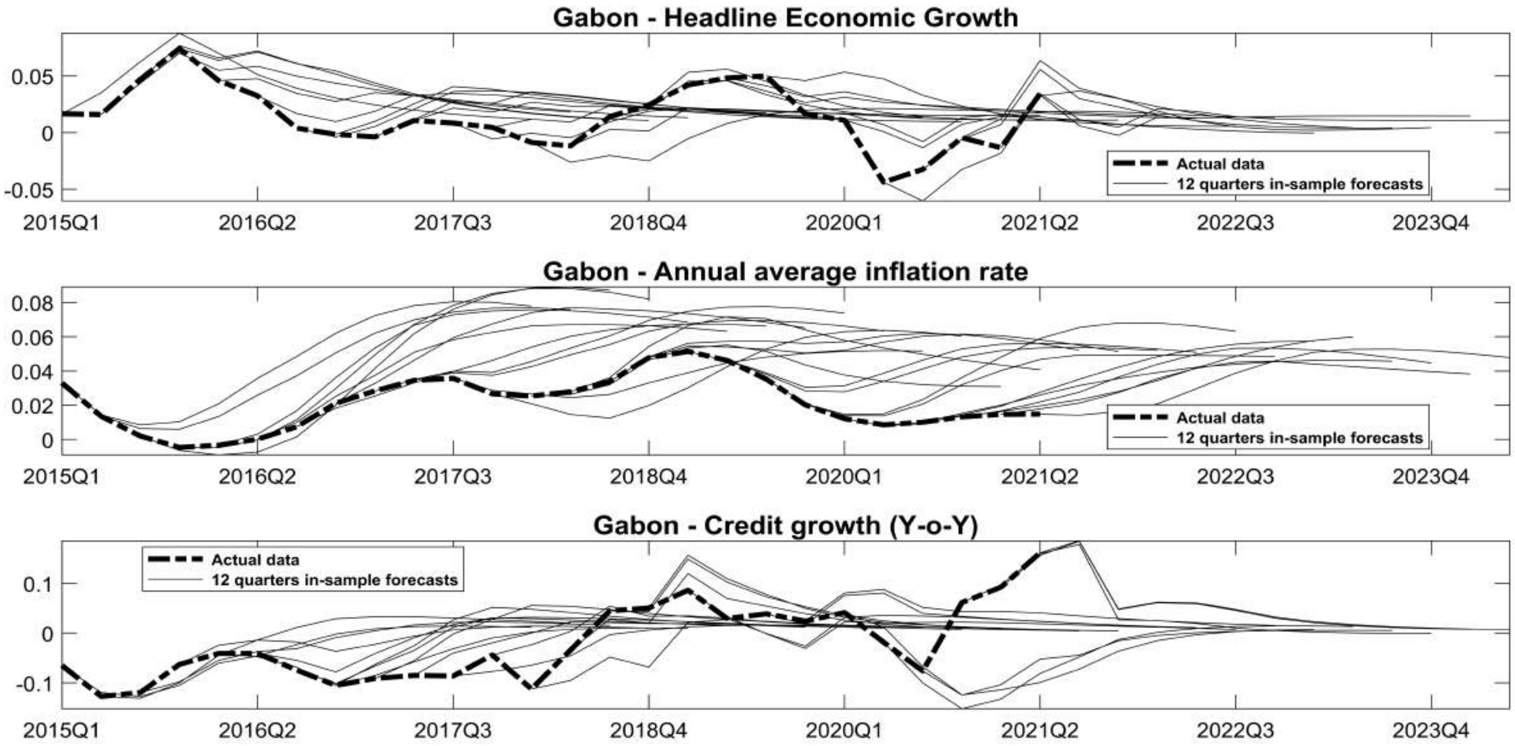

*Source : Author*

**Figure 27** – *In-sample unconditional forecasts of some Congo's variables*



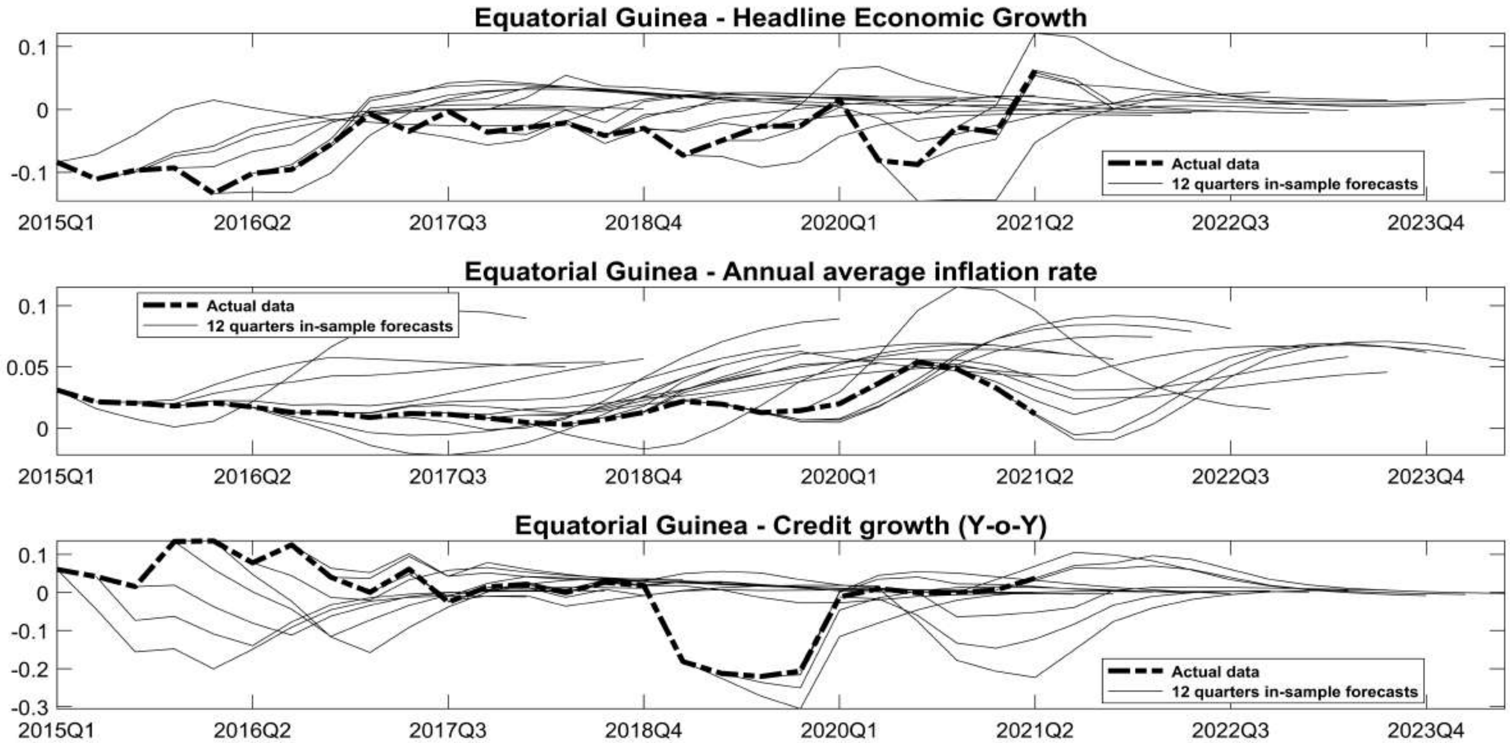

*Source : Author*

**Figure 28** – *In-sample unconditional forecasts of some Gabon's variables*



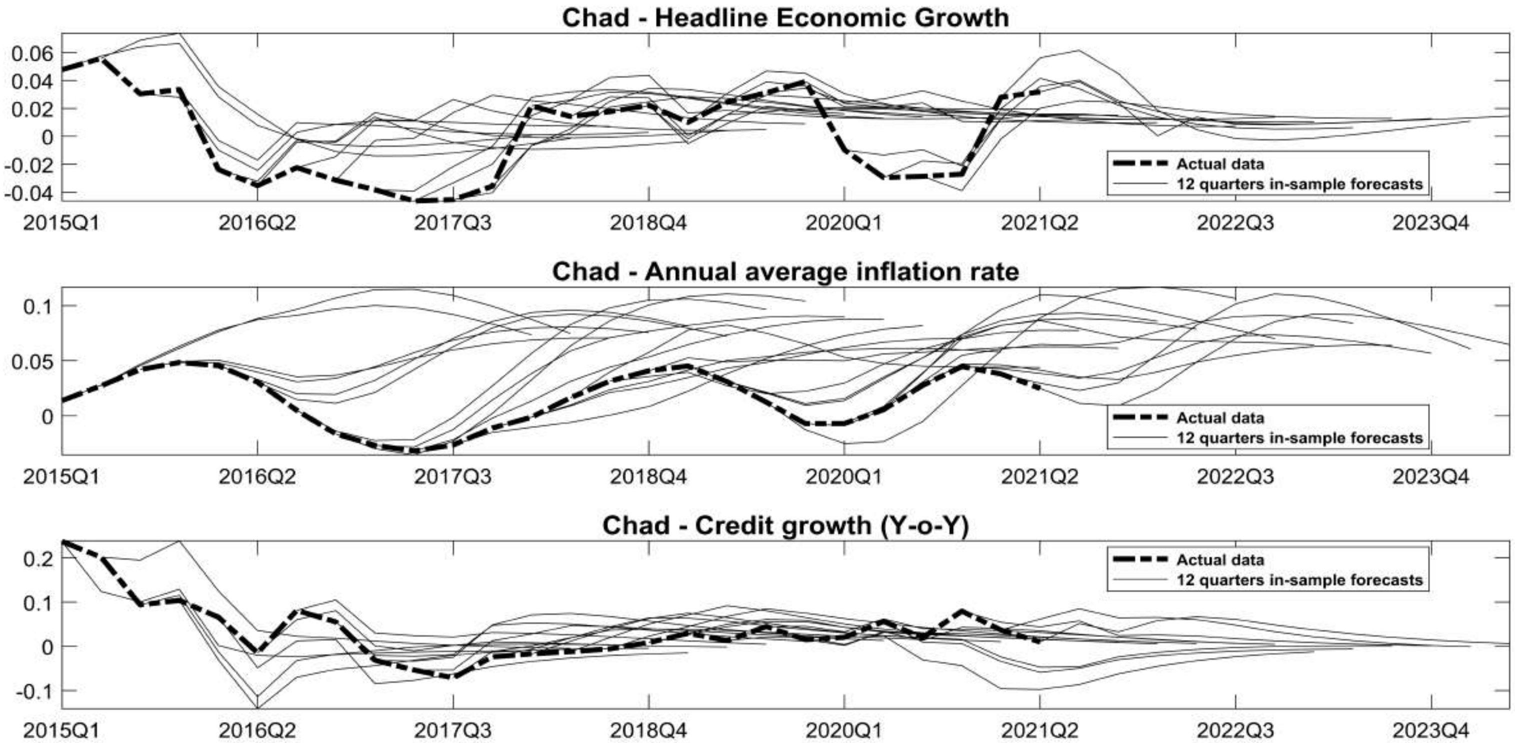

*Source : Author*

**Figure 29** – *In-sample unconditional forecasts of some Equatorial Guinea's variables*




*Source : Author*

**Figure 30** – *In-sample unconditional forecasts of some Chad's variables*



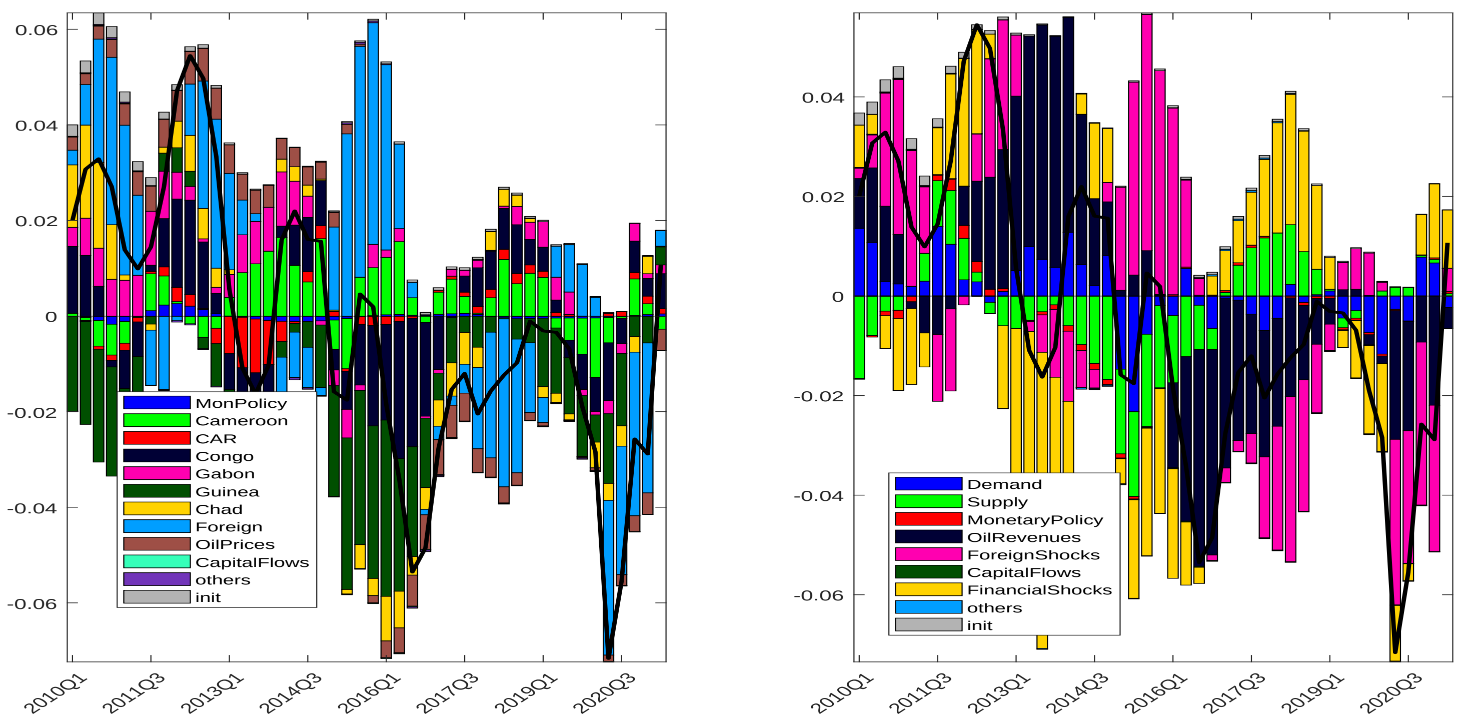

*Source : Author*

# Historical decompositions

## Shocks grouping

## Economic Growth

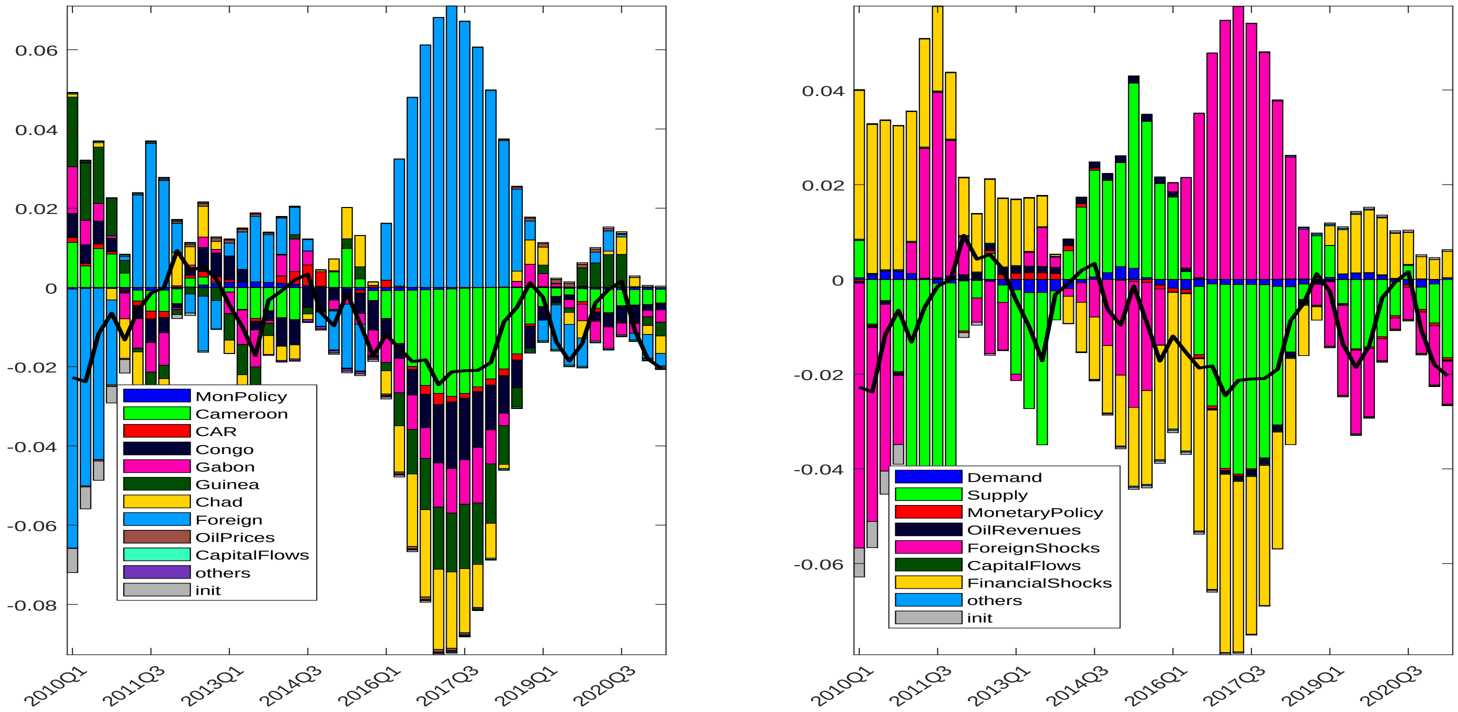
**Figure 31** – *Historical decomposition of CEMAC economic growth*




*Source : Author*

## Inflation

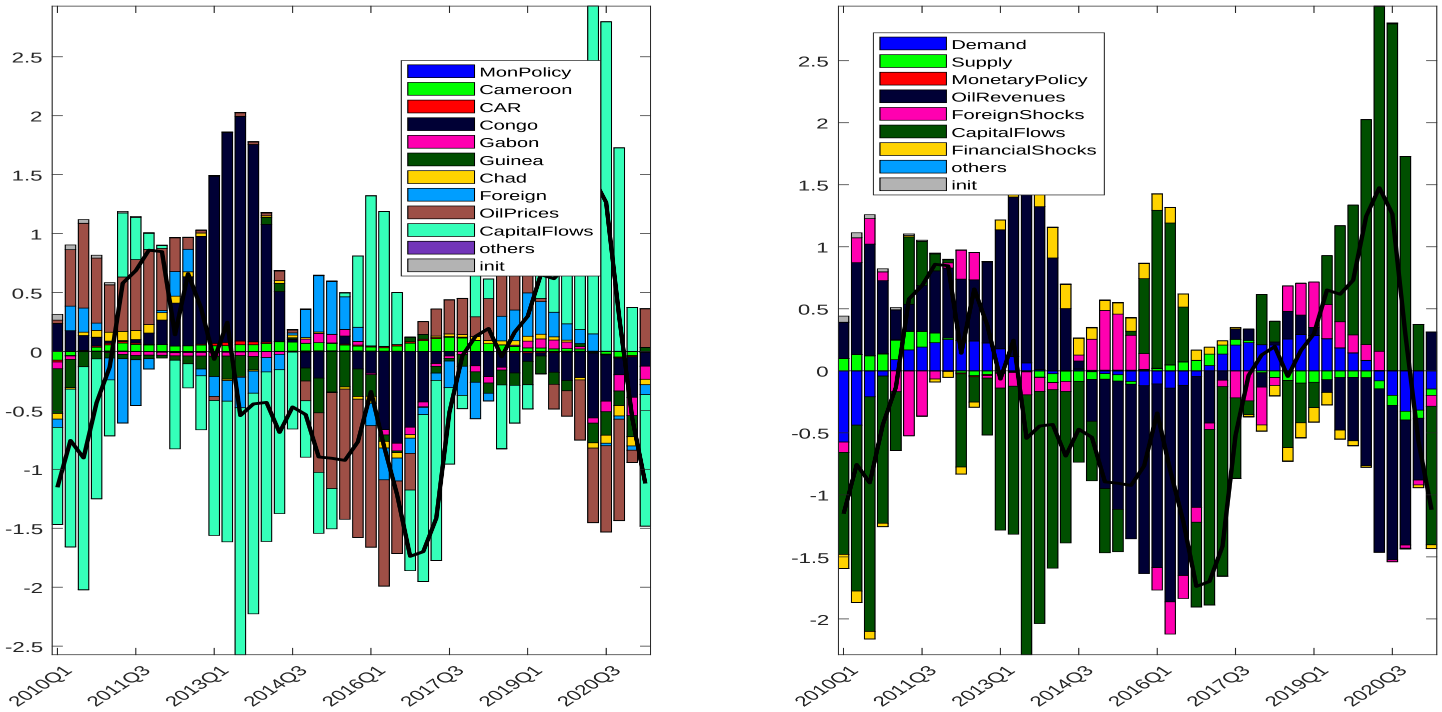
**Figure 32** – *Historical decomposition of CEMAC annual average inflation rate*




*Source : Author*

## International Reserves

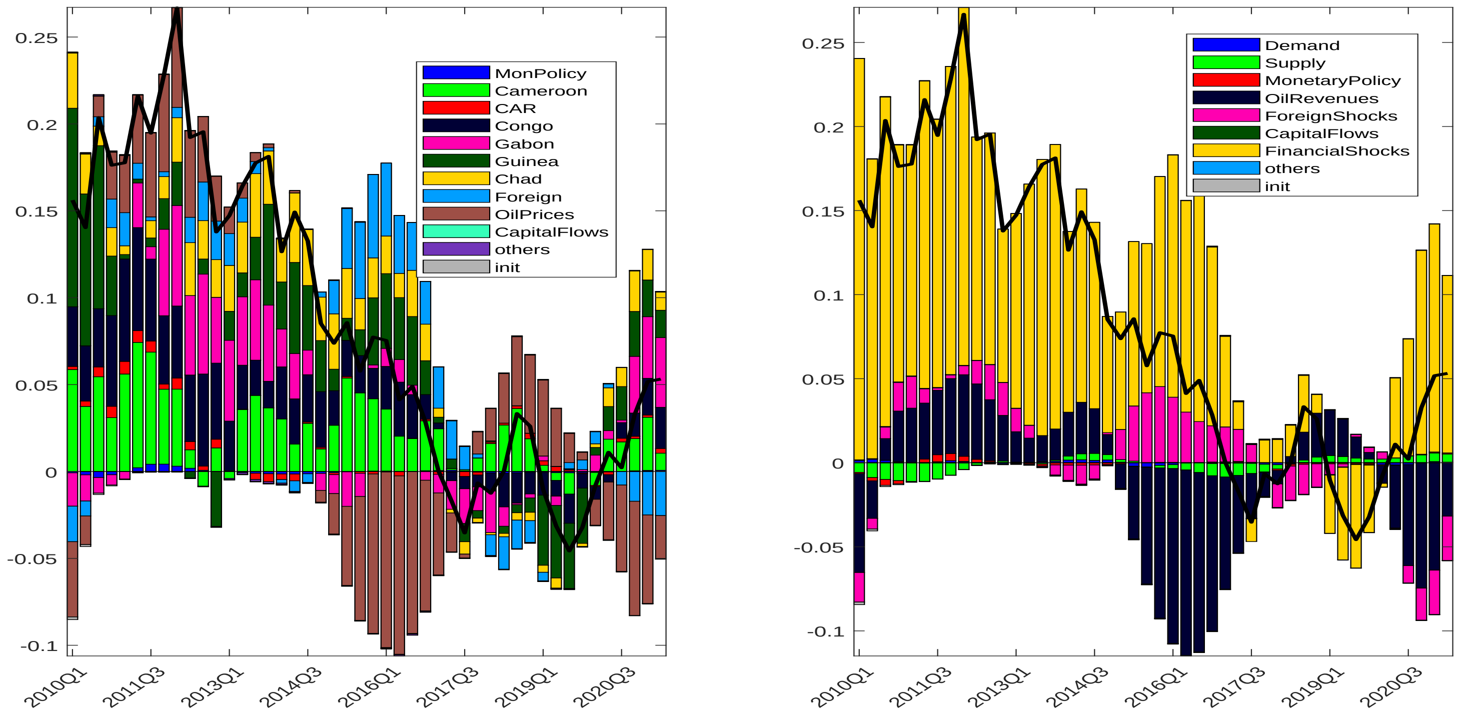
**Figure 33** – *Historical decomposition of CEMAC international reserves (absolute y-o-y variation)*




*Source : Author*

## Credit to private sector

**Figure 34** – *Historical decomposition of CEMAC credit growth rate (y-o-y)*




*Source : Author*