Title

Exchange Rate Policies and Monetary Union Effectiveness in the East Africa Community (EAC): a two-open country DSGE model with financial micro-foundation approach

ABSTRACT

The effectiveness of the monetary union closely depends on the appropriate monetary policy framework. Theoretical evidences suggest that, for low-income countries, fixed exchange rate policy offers more attractive macroeconomic stabilization properties than further exchange rate policies. However, the last decade saw a radical change of exchange rate policies in LICs. In Africa, the foreign exchange controls policy and the managed exchange rate policy are progressively giving place to policies built around floating exchange rates. Hence understanding the exchange rate policy efficient in achieving price stability without compromising economic growth for development is relevant for the effectiveness of the East Africa Monetary Union. The aim of this paper is thus to assess the effectiveness of the East Africa Monetary Union under the pure fixed exchange rate policy, the managed floating exchange rate policy, the target rate exchange rate policy and the pure floating exchange rate policy. We develop a two-open economy Dynamic Stochastic General Equilibrium model with financial micro-foundations for the East Africa Monetary Union. The counterfactual simulations reveal the preeminence of the pure floating exchange rate policy for the effectiveness of the East Africa Monetary Union. The partner states case study shows that the peg exchange rate policy is less preferable than the floating exchange rate policy for Rwanda and Burundi, whereas the managed floating exchange rate policy is less preferable that the floating exchange rate for Kenya, Uganda and Tanzania. However, the welfare analysis reveals that in the EAMU the pure floating exchange rate policy is a better policy in term of welfare stability facing demand shock and foreign shock, whereas, the managed exchanged rate performs well to cushion supply shock and domestic shock. As for policy implication, we can say that, for the effectiveness of EAMU in term of economic stability, shocks resilience and balanced development of all the partners states, floating exchange rate policy should be serve as benchmark for policymakers when harmonizing partner states monetary policy frameworks.

Key words: Exchange Rate Policies, Monetary Union Effectiveness, Financial Micro-foundation, DSGE model, Bayesian Method, Welfare analysis.

JEL Classification: C61, D60, E52, E44, F33, F41, O11

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1. Introduction

Exchange rate policies lie at the heart of the macroeconomics policymaking and matters fundamentally for the effectiveness of monetary union. In all open economies, exchange rate represents a key relative price and appears as one of a main channels of transmission of macroeconomics shocks to the home economy. The recent global financial crisis has emphasized the EAC vulnerability to large economic shocks. Furthermore, the commitment of EAC partner states towards the path of a Monetary Union raises concern about the appropriate exchange rate policy for the effectiveness of East Africa Monetary Union (Berg and Borensztein 2000; Rogoff et al. 2003; Drummond and Ramirez 2009; Davoodi 2012; Adam 2012; Adam et al. 2012).

Basically, with the adoption of the EAMU, partner states are in the process of adapting their exchange rate policies. Theoretical evidences reveal that, in the long run, stable and predictable inflation contributes to efficient financial sector, low real interest rates, and good investment environnent. However, in the short run, there are trade-offs between price, output, and exchange rate stability. Consequently, monetary policy must try to minimize macroeconomic volatility while keeping inflation low by identifying and responding to domestic and external shocks. Transitioning toward such a modern monetary policy framework is an important challenge for policymakers in the EAC (Honohan and O'Connell 2008; Adam et al. 2012).

Specifically, exchange rate policy operates at two levels. The first is determining the overall exchange rate policy[1]. The second is concerned with discretionary choices over the path of the nominal exchange rate, given the policy. Three majors types of exchange rate policy can thus been identified, such as, fixed exchange rate policy (also include pegs, target, bands, currency boards and full dollarization), pure floating exchange rate policy and managed floating exchange rate policy (Ghosh et al. 2003; Rogoff et al. 2003; Masson and Patillo 2005; Klein et Shambaugh 2010; Adam 2012).

The fixed exchange rate policy is a policy where the monetary authority' intervention in the foreign exchange market is entirely focused on hitting a specific target or level

[1] The basic rule by which the central bank intervenes in the foreign exchange market to influence the external price of the domestic currency

for the exchange rate. One of the main feature of the fixed exchange rate policy is that exchange rate is the nominal anchor of the monetary policy. The discipline of fixed exchange rate policy leads to two alternatives policies. First, the currency board policy in which the credibility of the exchange rate peg is enforced by curtailing central bank discretion altogether, through statute or practice. Second, the monetary union which represents an institutional framework where the domestic currency is abandoned in favor of the external anchor currency or a supranational currency. The main advantage of the fixed exchange rate policy is the protection of the economy against policy errors arising from time-inconsistent problem. Three main examples of the adoption of fixed exchange rate policy are the CFA Franc Zone (CEMAC and WAEMU) where the CFA franc is pegged to French franc since 1945 until 1999 and to euro thereafter[2]. In addition, the ECCU where the Eastern Caribbean dollar is pegged to British Pound since 1950 until 1976 and to US dollar thereafter[3]. However, the shortcoming of the fixed exchange rate policy is the complete lack of policy flexibility to protect the economy against short-run volatility in the face of shocks. Importantly, the main limit is its difficulty to deal with the problem of impossible trinity. In fact, policymakers seek to achieve three objectives: to target the exchange rate so as to stabilize relative prices, to stabilize domestic output in the face of shocks, and to allow for the free flow of capital across international borders. Beyond the short run, however, it is not possible to simultaneously satisfy all three (Berg et al. 2010; Ravenna 2011; Adam 2012; Davoodi 2012; Morales 2012).

The pure floating exchange rate policy is a strict non-intervention policy where the exchange rate is determine by the market forces of demand and supply. The responsibility of nominal anchor is allocated to a domestic variable, such as, money supply, nominal income, or directly to inflation targeting strategy or inflation expectations. The key benefit of the pure floating exchange rate policy is the resolution of the impossible trinity. Thus, for a small open economy with a larger traded goods share in expenditure, a floating exchange rate policy may be better suited to ensuring the efficient adjustment of the real economy to the external shocks arising from commodity price movements or shocks to global inflation, thereby

[2] CEMAC denotes Economic and Monetary Community of Central Africa. WAEMU denotes West Africa Economic and Monetary Union.
[3] ECCU denotes Eastern Caribbean Currency Union.

avoiding prolonged, growth-retarding real exchange rate misalignment. Similarly, when domestic markets are thin or absent, flexible exchange rate may be better to foster financial market development. Hence, the CMA, the ERM, the Euro Zone can been considered as typical floating exchange policy monetary unions[4]. Nevertheless, the floating exchange rate policy raises the concerns of capital flows. In fact, under floating exchange rate policy, surging private capital flows expose weaknesses in small domestic financial markets and produce sharply intensification of exchange rate and interest rate volatility (Berger 2006; Adam 2012**;** Davoodi 2012; Morales 2012)**.**

Managed floating exchange rate has long been the key element of monetary policy framework of many African countries outside the CFA and the Rand Zones (Nigeria, Mozambique and Zambia among others). It represents a framework that contributes significantly to achieving disinflation and macroeconomic stabilization. Hence, under the managed floating exchange rate policy, while the main objective is price stability, the stability of the exchange rate also appears as a policy objective, through either its effect on external competitiveness or the desirability of exchange rate smoothing. However, dependence on managed floating exchange rate policy has becoming much less useful, because it has be found as a highly distorted and fundamentally non-credible policy, which expose related economy to large foreign exchange inflows. Hence, many African countries have becoming to look elsewhere for exchange rate policy better suited to their needs, namely the EAC partner states (Calderon and Schmidt-Hebbel 2008;Berg et al. 2010;Adam 2012;Morales 2012;Andrle et al. 2013).

The purpose of this paper is thus to bring response to this exchange rate policy challenge by focusing on East Africa Monetary Union. The paper aims to develop a Two-open country DSGE model with financial micro-foundation to assess the EAMU effectiveness under alternatives exchange rate policies. Unlike to previous DSGE models in monetary union and in LICs, our model feature the monetary union as a composite of many countries and capture financial transaction between the union and the rest of the world. This a first attempt to develop a DSGE model for EAMU effectiveness. The next section will examine the monetary policy framework in EAC.

[4] CMA denotes Common Monetary Area formed by South Africa, Lesotho and Swaziland where the South Africa Rand serve as anchor of monetary policy. ERM denotes European Exchange Rate mechanism where the German deutschmark serve as anchor of monetary policy.

2. Monetary Policy Framework in East Africa Monetary Union

The East African Monetary Union is a supranational institution, which aims to issue a single currency for all the EAC partner states and remove the cost of transactions in different currencies and the risk of adverse exchange rate movements for intra-EAC trade. The seminal attempt of EAMU began in 1922 when Kenya Uganda and Tanganyika launched the East African Shilling area. In 1936 the process of monetary union evolves with the introduction of Zanzibar into the union. The monetary policy framework of the union was the peg exchange rate policy where the domestic currencies were pegged to the UK pound sterling. However the depreciation of the UK pound sterling against US dollar in the second half of the 1960-decade and the differences in monetary frameworks within the area in the first half of the 1970-decade lead in 1977 to the collapse of the East Africa Shilling area. But in 2000, Burundi, Kenya, Rwanda, Tanzania and Uganda re-launched the common area under the East Africa Community with an ambitious to form a monetary union in 2012. Although the great achievement made by the EAC during the period, the community didn't fulfill its monetary union commitment in 2012. Fortunately, in November 2013, a protocol establishing the East Africa Monetary Union has been officially signed by the five partners states[5] (ECB 2010; Davoodi 2012; Morales 2012).

The main policy goal of the new East African Central Bank (EACB) is to achieve and maintain price stability, and without prejudice to this primary objective, the EACB will contribute to financial stability, economic growth and economic development for the states partners. The main instrument of monetary policy of the common Central Bank is the open market operations. The operating target of the monetary policy is the reserve of money. The intermediate target to achieve the main policy goal is the broad money (Berg et al. 2010; Davoodi 2012; Davoodi et al. 2013).

Beyond this common framework the challenges is to pull over the specificities of each partner states Central Bank in term of monetary policy framework. In fact, whereas all the national Central Banks pursuit the same main policy goal as the EAMU, divergences appears when looking to main instrument, operating target and intermediate target of monetary policy in Burundi, Kenya, Rwanda, Tanzania and Uganda.

[5] The EAMU emphasizes that the EAC single currency is expected by 2024.

The monetary policy framework of Burundi is based on the managed exchange rate policy. The Bank of the Republic of Burundi (BoRB) sets the policy rate as the main instrument of monetary policy. The operating target of the BoRB is the reserve of money. The broad money represents the intermediate target of monetary policy. The foremost challenges faces by the BoRB are the issue of the degree of exchange rate flexibility as well as the large foreign inflows coming from foreign exchange receipts and fiscal revenue (Gupta and McHugh 2012; Davoodi 2012; Morales 2012).

In Kenya, the monetary policy framework is represented by the floating exchange rate policy. Similarly to Burundi, the Central Bank of Kenya (CBK) emphasizes the policy rate as the main instrument of monetary policy. The operating target of the CBK is represented by the Net Domestic Assets (NDS) managed through the interbank rates. The intermediate target of the monetary policy is the 5% medium-term inflation target. The core advantage of the conduct of monetary policy is the financial depth, with Kenya encountered the highest degree of financial development among the EAMU partner states (Sichei and Kamau 2010; Misati et al. 2011; Andrle et al. 2012).

In Rwanda, the monetary policy framework is based on managed floating exchange rate policy. The National Bank of Rwanda (NBR) sets the policy rate as main instrument of monetary policy. The operating target of the NBR is the reserve of money. The NBR relies on exchange rate as intermediate target of monetary policy. Dependence to external inflows is the main challenge (Slavov 2011; Davoodi 2012).

In Tanzania, the monetary policy framework is classified as floating exchange rate policy. The main instrument of the Bank of Tanzania (BOT) is the policy rate. But sometimes, the BOT makes also use of reserves requirements and the net open foreign exchange positions. The operating target of the BOT is the reserve of money. The intermediate target of monetary policy target is the broad money. Tanzania faces a challenge of financial and fiscal risks (Adam and Kessy 2010; Adam et al. 2010).

In Uganda, inflation targeting 'lite' policy represents the monetary policy framework. The Bank of Uganda (BoU) sets the policy rate as the key instrument of the monetary policy. The operating target of the BoU is a short-term interest rate centered on the seven-day interbank rate. The intermediate target of the BoU is the inflation forecast. The key advantage of Uganda is its greater financial development relatively to others EAMU partner states (Henstridge and Kasekende 2001; Atingi-Ego and Egesa 2008).

3. A two-open country DSGE model with financial micro-foundation in EAMU

This paper develops a two-open country DSGE model with financial micro-foundations to address the issue of Monetary Union effectiveness relative to alternatives exchanges rate policies in East Africa Monetary Union. The model is an extension of the basic New-Keynesian approach. The model consist of the home economy denoted (H), the rest of the EAC economy (RE henceforth). We make a realistic assumption that the EAMU is open to the rest of the world (RW henceforth), which is fully exogenous, since the union encompasses small countries. Households, entrepreneurs, capital producers, retailers, and government populate each country of the union. The monetary authority would be common to the union or not depending of the type of exchange rate policy involved.

3.1. Optimal allocation between domestic and foreign goods

In each economy of the monetary union, household consume goods produced in the home economy, the rest of EAC economy and the rest of the world. The aggregate consumption is a composite consumption index defined by:

- **Home economy**

$$C_t^H = \left[(1-\mu_1^H-\mu_2^H)^{\frac{1}{\theta}}\left(C_{H,t}^H\right)^{\frac{\theta-1}{\theta}} + (\mu_1^H)^{\frac{1}{\theta}}\left(C_{RE,t}^H\right)^{\frac{\theta-1}{\theta}} + (\mu_2^H)^{\frac{1}{\theta}}\left(C_{RW,t}^H\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \quad (1)$$

Here $C_{H,t}^H$ represents an index of consumption in the home economy of goods produced domestically, $C_{RE,t}^H$ is an index of consumption in the home economy of goods produced in the rest of the EAC, and $C_{RW,t}^H$ an index of consumption in the home economy of goods produced in the rest of the world. $\theta > 1$ represents the elasticity of substitution between the three type of goods, $\mu_1^H$is the share of imported goods from RE, and μ_2^H is the share of imported goods from RW. In fact, $\mu^H \epsilon [0,1]$ can been interpreted as a measure of openness. Equivalently, $(1-\mu_1^H-\mu_2^H)$ represents the measure of the degree of home bias in consumption. Because in an absence of some home bias, the households in the small open economy would attach an infinitesimally small weight to domestic goods, and consumption expenditures would be allocated to imported goods.

- **Rest of the EAC economy**

$$C_t^{RE} = \left[(1-\mu_1^{RE}-\mu_2^{RE})^{\frac{1}{\theta}}\left(C_{RE,t}^{RE}\right)^{\frac{\theta-1}{\theta}} + (\mu_1^{RE})^{\frac{1}{\theta}}\left(C_{H,t}^{RE}\right)^{\frac{\theta-1}{\theta}} + (\mu_2^{RE})^{\frac{1}{\theta}}\left(C_{RW,t}^{RE}\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \quad (2)$$

Here $C_{RE,t}^{RE}$represents an index of consumption in the RE economy of goods produced domestically, $C_{H,t}^{RE}$ is an index of consumption in the RE economy of goods produced in the home economy, and $C_{RW,t}^{RE}$ is an index of consumption in the RE economy of goods produced in the rest of the RW[6]. μ_1^{RE}represents the share of imported goods from home, and μ_2^{RE} is the share of imported goods from RW. These share are identical reciprocally between each economy of EAMU (home and RE) and the RW. $(1-\mu_1^{RE}-\mu_2^{RE})$ represents the measure of the degree of home bias in consumption.

Similarly, in each economy of the monetary union, each type of the three consumption index is the composite aggregates of differentiated variety produced domestically, in the RE and the RW, and defined by the constant elasticity of substation (CES) as follow:

- **Home economy**

$$C_{H,t}^{H} = \left(\int_0^1 C_{H,t}^{H}(j)^{\frac{\chi-1}{\chi}}\,dj\right)^{\frac{\chi}{\chi-1}} \quad ; \quad C_{RE,t}^{H} = \left(\int_0^1 C_{RE,t}^{H}(j)^{\frac{\chi-1}{\chi}}\,dj\right)^{\frac{\chi}{\chi-1}} \quad ; \quad C_{RW,t}^{H} = \left(\int_0^1 C_{RW,t}^{H}(j)^{\frac{\chi-1}{\chi}}\,dj\right)^{\frac{\chi}{\chi-1}} \quad (3)$$

Here $C_{H,t}^{H}(j)$ is a variety j of domestic goods, $C_{RE,t}^{H}(j)$ is a variety j of imported goods from the RE, and $C_{RW,t}^{H}(j)$ is variety j of imported goods from the RW. $\chi > 1$ denotes the elastic of substitution between varieties originating within any given economy.

[6] In the rest of EAC economy, the rest of EAC becomes the home economy and the previous home economy becomes the rest of EAC economy.

- **Rest of the EAC economy**

$$C_{RE,t}^{RE} = \left(\int_0^1 C_{RE,t}^{RE}(j)^{\frac{\chi-1}{\chi}} dj\right)^{\frac{\chi}{\chi-1}} \quad ; \quad C_{H,t}^{RE} = \left(\int_0^1 C_{H,t}^{RE}(j)^{\frac{\chi-1}{\chi}} dj\right)^{\frac{\chi}{\chi-1}} \quad ; \quad C_{RW,t}^{RE} = \left(\int_0^1 C_{RW,t}^{RE}(j)^{\frac{\chi-1}{\chi}} dj\right)^{\frac{\chi}{\chi-1}} \tag{4}$$

Here $C_{RE,t}^{RE}(j)$ is a variety j of domestic goods, $C_{H,t}^{RE}(j)$ is a variety j of imported goods from the home economy, and $C_{RW,t}^{RE}(j)$ is variety j of imported goods from the RW.

In each economy of EAC, the consumer price index (CPI) associated to (1) P_t^H and (2) P_t^{RE} are given by:

- **Home economy**

$$P_t^H = \left[(1-\mu_1^H-\mu_2^H)^{\frac{1}{\theta}}\left(P_{H,t}^H\right)^{\frac{\theta-1}{\theta}} + (\mu_1^H)^{\frac{1}{\theta}}\left(P_{RE,t}^H\right)^{\frac{\theta-1}{\theta}} + (\mu_2^H)^{\frac{1}{\theta}}\left(P_{RW,t}^H\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{5}$$

Here $P_{H,t}^H$ represents the domestic price of domestic goods or Domestic Price Index (DPI), $P_{RE,t}^H$ is the domestic price of imported goods from the RE, and $P_{RW,t}^H$ is domestic price of imported goods from the RW.

- **Rest of EAC economy**

$$P_t^{RE} = \left[(1-\mu_1^{RE}-\mu_2^{RE})^{\frac{1}{\theta}}\left(P_{RE,t}^{RE}\right)^{\frac{\theta-1}{\theta}} + (\mu_1^{RE})^{\frac{1}{\theta}}\left(P_{H,t}^{RE}\right)^{\frac{\theta-1}{\theta}} + (\mu_2^{RE})^{\frac{1}{\theta}}\left(P_{RW,t}^{RE}\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{6}$$

Here $P_{RE,t}^{RE}$ represents the domestic price of domestic goods or Domestic Price Index (DPI), $P_{H,t}^{RE}$ is the domestic price of imported goods from the home economy, and $P_{RW,t}^H$ is domestic price of imported goods from the RW.

Likewise, in each economy of the monetary union, each type of the three prices index is the composite aggregates of the prices of differentiated variety of good produced domestically, in the RE and the RW, and defined by the constant elasticity of substation (CES) as follow:

- **Home economy**

$$P_{H,t}^{H} = \left(\int_0^1 P_{H,t}^{H}(j)^{1-\chi}\, dj\right)^{\frac{1}{\chi-1}} \quad ; \quad P_{RE,t}^{H} = \left(\int_0^1 P_{RE,t}^{H}(j)^{1-\chi}\, dj\right)^{\frac{1}{\chi-1}} \quad ; \quad P_{RW,t}^{H} = \left(\int_0^1 P_{RW,t}^{H}(j)^{1-\chi}\, dj\right)^{\frac{1}{\chi-1}} \tag{7}$$

Here $P_{H,t}^{H}(j)$ is the price of a variety j domestically produced, $P_{RE,t}^{H}(j)$ is imported prices from the RE of a variety j, and $C_{RW,t}^{H}(j)$ is imported prices from the RW of a variety j.

- **Rest of the EAC economy**

$$P_{RE,t}^{RE} = \left(\int_0^1 P_{RE,t}^{RE}(j)^{1-\chi}\, dj\right)^{\frac{1}{\chi-1}} \quad ; \quad P_{H,t}^{RE} = \left(\int_0^1 P_{H,t}^{RE}(j)^{1-\chi}\, dj\right)^{\frac{1}{\chi-1}} \quad ; \quad P_{RW,t}^{RE} = \left(\int_0^1 P_{RW,t}^{RE}(j)^{1-\chi}\, dj\right)^{\frac{1}{\chi-1}} \tag{8}$$

Here $P_{RE,t}^{RE}(j)$ is the price of a variety j domestically produced, $P_{H,t}^{RE}(j)$ is imported prices from the RE of a variety j, and $C_{RW,t}^{RE}(j)$ is imported prices from the RW of a variety j.

The optimal allocation of expenditures between domestic, RE and RW can been expresses as:

- **Home economy**

$$\min_{C_{H,t}^{H}, C_{RE,t}^{H}, C_{RW,t}^{H}} P_{H,t}^{H} C_{H,t}^{H} + P_{RE,t}^{H} C_{RE,t}^{H} + P_{RW}^{H} C_{RW}^{H} = P_t^H C_t^H \tag{9}$$

Subject to

$$C_t^H = \left[(1-\mu_1^H-\mu_2^H)^{\frac{1}{\theta}}\left(C_{H,t}^{H}\right)^{\frac{\theta-1}{\theta}} + (\mu_1^H)^{\frac{1}{\theta}}\left(C_{RE,t}^{H}\right)^{\frac{\theta-1}{\theta}} + (\mu_2^H)^{\frac{1}{\theta}}\left(C_{RW,t}^{H}\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{10}$$

- **The rest of EAC**

$$\min_{C_{RE,t}^{RE}, C_{H,t}^{RE}, C_{RW,t}^{RE}} P_{RE,t}^{RE} C_{RE,t}^{RE} + P_{H,t}^{RE} C_{H,t}^{RE} + P_{RW}^{RE} C_{RW}^{RE} = P_t^{RE} C_t^{RE} \tag{11}$$

Subject to

$$C_t^{RE} = \left[(1-\mu_1^{RE}-\mu_2^{RE})^{\frac{1}{\theta}}\left(C_{RE,t}^{RE}\right)^{\frac{\theta-1}{\theta}} + (\mu_1^{RE})^{\frac{1}{\theta}}\left(C_{H,t}^{RE}\right)^{\frac{\theta-1}{\theta}} + (\mu_2^{RE})^{\frac{1}{\theta}}\left(C_{RW,t}^{RE}\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \quad (12)$$

The optimal demand for domestically produced goods, for imported goods from the RE and imported goods from the RW is defined in each economy of the union:

- **Home economy**

$$C_{H,t}^{H} = (1-\mu_1^{H}-\mu_2^{H})\left(\frac{P_{H,t}^{H}}{P_t^{H}}\right)^{-\theta} C_t^{H} \quad (13)$$

$$C_{RE,t}^{H} = \mu_1^{H}\left(\frac{P_{RE,t}^{H}}{P_t^{H}}\right)^{-\theta} C_t^{H} \quad (14)$$

$$C_{RW,t}^{H} = \mu_2^{H}\left(\frac{P_{RW,t}^{H}}{P_t^{H}}\right)^{-\theta} C_t^{H} \quad (15)$$

- **The rest of EAC economy**

$$C_{RE,t}^{RE} = (1-\mu_1^{RE}-\mu_2^{RE})\left(\frac{P_{RE,t}^{RE}}{P_t^{RE}}\right)^{-\theta} C_t^{RE} \quad (16)$$

$$C_{H,t}^{RE} = \mu_1^{RE}\left(\frac{P_{H,t}^{RE}}{P_t^{RE}}\right)^{-\theta} C_t^{RE} \quad (17)$$

$$C_{RW,t}^{RE} = \mu_2^{RE}\left(\frac{P_{RW,t}^{RE}}{P_t^{RE}}\right)^{-\theta} C_t^{RE} \quad (18)$$

3.2. International financial transactions and term of trade

Since EAC economies are involved in the international financial transaction, even if it is incompletely, they are exposed to a risk premium. In fact, the risk premium is function of the economy's real aggregate level of net-foreign assets (NFA) position in percentage of steady-state output, as follow:

- Home economy

$$\Psi_{d,t}^{H}(d_t^{H}, \Phi_t^{H}) = exp\left[-\psi_d^{H}\left(\frac{Z_{2,t}^{H} D_t^{H}}{YP_t^{H}}\right) + \Phi_t^{H}\right] \quad (19)$$

- Rest of the EAC economy

$$\Psi_{d,t}^{RE}(d_t^{RE}, \Phi_t^{RE}) = exp\left[-\psi_d^{RE}\left(\frac{Z_{2,t}^{RE} D_t^{RE}}{YP_t^{RE}}\right) + \Phi_t^{RE}\right] \quad (20)$$

This expression of risk premium encompasses:

- The real aggregate net foreign asset (NFA) position in percentage of steady-state output:

$$d_t^H \equiv \frac{Z_{2,t}^H D_t^H}{YP_t^H} \qquad d_t^{RE} \equiv \frac{Z_{2,t}^{RE} D_t^{RE}}{YP_t^{RE}} \quad (21)$$

- The total debt of each country of the union which is the sum of the nominal debt denominated in the RW currency $D_{h,t}$ and the entrepreneurs borrowing$D_{E,t}$, given as :

$$D_t^H \equiv D_{h,t}^H + D_{E,t}^H \qquad D_t^{RE} \equiv D_{h,t}^{RE} + D_{E,t}^{RE} \quad (22)$$

- The exogenous shocks on risk premium Φ_t is defined by:

$$\Phi_t^H = \rho_\Phi \Phi_{t-1}^H + e_{\Phi,t} \qquad \Phi_t^{RE} = \rho_\Phi \Phi_{t-1}^{RE} + e_{\Phi,t} \quad (22)$$

Where $e_{\Phi,t}$ is the i.i.d. zero mean normal random variable with standard deviation equals to σ_{e_Φ}.

- ψ_d represents the elasticity of the risk premium with respect to NFA position.

The risk premium is supposed to be strictly decreasing in the NFA and satisfies:

$$\Psi_{d,t}^H(0,0) = 1 \qquad \Psi_{d,t}^{RE}(0,0) = 1 \quad (23)$$

The risk premium is introduced in the model to feature imperfect integration in the international financial market and ensures a well-defined steady state of the model. However, we assume a perfect integration in EAC regional financial markets. Thus there is not a risk premium between the home economy and the Rest of EAC. Consequently, the uncovered interest parity holds within the EAC but didn't holds between the economies (home and RE) of EAC and the rest of the world.

Basically we define:

- The bilateral nominal exchange rate between the home economy and the rest of EAC economy as

$$Z_{1,t}^{H} \tag{24}$$

- The bilateral nominal exchange rate between the rest of EAC economy and the home economy as:

$$Z_{1,t}^{RE} = \frac{1}{Z_{1,t}^{H}} \tag{25}$$

- As result, the effectiveness of the EAC as a monetary union equalizes the two bilateral nominal exchange rate and implies that:

$$Z_{1,t}^{H} = Z_{1,t}^{RE} = 1 \tag{26}$$

However we can define;

- The bilateral nominal exchange rate between the home economy and the rest of the world as

$$Z_{2,t}^{H} \tag{27}$$

- The bilateral nominal exchange rate between the rest of EAC economy and the rest of the world as:

$$Z_{1,t}^{RE} = \frac{Z_{2,t}^{H}}{Z_{1,t}^{H}} \tag{28}$$

Similarly, bilateral term of trade can define both in home and rest of EAC economy:

- **Home economy**
  - The bilateral term of trade between the home economy and the rest of EAC (that is the price of rest of EAC's goods in term of home goods):

$$TOT_{RE,t}^{H} = \frac{P_{RE,t}^{H}}{P_{H,t}^{H}} \tag{29}$$

- The bilateral term of trade between the home economy and the rest of world (that is the price of rest of RW's goods in term of home goods):

$$TOT^{H}_{RW,t} = \frac{P^{H}_{RW,t}}{P^{H}_{H,t}} \tag{30}$$

Where $P^{H}_{H,t}$is the domestic price in the home economy or Domestic Price Index.

- **Rest of EAC economy**
  - The bilateral term of trade between the rest of EAC and the home economy (that is the price home economy goods in term of the rest of EAC's goods):

$$TOT^{RE}_{H,t} = \frac{P^{RE}_{H,t}}{P^{RE}_{RE,t}} \tag{31}$$

  - The bilateral term of trade between the rest of EAC and the rest of the world:

$$TOT^{RE}_{RW,t} = \frac{P^{RE}_{RW,t}}{P^{RE}_{RE,t}} \tag{32}$$

Where $P^{RE}_{RE,t}$ is the domestic price in the rest of the EAC economy.

From (5) and (6), the term of trade can be related to ratio of the consumer price index (CPI) and domestic price index (DPI) as follow:

- **Home economy**

$$\frac{P^{H}_{t}}{P^{H}_{H,t}} = \left[(1-\mu^{H}_{1}-\mu^{H}_{2}) + \mu^{H}_{1}\left(TOT^{H}_{RE,t}\right)^{1-\theta} + \mu^{H}_{2}\left(TOT^{H}_{RW,t}\right)^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{33}$$

Here $P^{H}_{t}$is the CPI in the home economy and $P^{H}_{H,t}$is the DPI in the home economy

- **Rest of the EAC economy**

$$\frac{P^{RE}_{t}}{P^{RE}_{RE,t}} = \left[(1-\mu^{RE}_{1}-\mu^{RE}_{2}) + \mu^{RE}_{1}\left(TOT^{RE}_{H,t}\right)^{1-\theta} + \mu^{RE}_{2}\left(TOT^{RE}_{RW,t}\right)^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{34}$$

Here $P^{RE}_{t}$is the CPI in the rest of the EAC economy and $P^{RE}_{H,t}$is the DPI in the rest of the EAC economy.

We suppose that the law of one price (LOP) holds for the export sector, but incomplete pass-trough involved in the import sector. This assumption is motivated by the existence of monopolistic domestic importers in the region that practice local currency pricing. Consequently, the price of foreign goods in the domestic market is temporarily deviate from the producer price level in the country origin. The wedge between these two prices is called the law of one price gap (LOPG) and is given by, bilaterally:

- **Home economy**
  - The LOPG between the home economy and the rest of EAC:

$$LOPG_{RE,t}^{H} = \frac{Z_{1,t}^{H} P_{RE,t}^{RE}}{P_{RE,t}^{H}} \quad (35)$$

  - The LOPG between the home economy and the rest of world:

$$LOPG_{RW,t}^{H} = \frac{Z_{2,t}^{H} P_{RW,t}^{RW}}{P_{RW,t}^{H}} \quad (36)$$

Where $P_{RW,t}^{RW}$is the domestic price in the rest of the world or DPI.

- **Rest of EAC economy**
  - The LOPG between the rest of EAC and the home economy:

$$LOPG_{H,t}^{RE} = \frac{Z_{1,t}^{RE} P_{H,t}^{H}}{P_{H,t}^{RE}} \quad (37)$$

  - The LOPG between the rest of EAC and the rest of world:

$$LOPG_{RW,t}^{RE} = \frac{Z_{2,t}^{RE} P_{RW,t}^{RW}}{P_{RW,t}^{RE}} \quad (38)$$

Similarly, we can define the bilateral real exchange rates as follows:

- **Home economy**
  - The bilateral real exchange rates between the home economy and the rest of EAC:

$$RER_{RE,t}^{H} = \frac{Z_{1,t}^{H} P_{t}^{RE}}{P_{t}^{H}} \quad (39)$$

- The bilateral real exchange rates between the home economy and the rest of world:

$$RER_{RW,t}^{H} = \frac{Z_{2,t}^{H} P_t^{RW}}{P_t^{H}} \quad (40)$$

Where P_t^{RW} is the CPI in the rest of the world.

- **Rest of EAC economy**
  - The bilateral real exchange rates between the rest of EAC and the home economy:

$$RER_{H,t}^{RE} = \frac{Z_{1,t}^{RE} P_t^{H}}{P_t^{RE}} \quad (41)$$

  - The bilateral real exchange rates between the rest of EAC and the rest of world:

$$RER_{RW,t}^{RE} = \frac{Z_{2,t}^{RE} P_t^{RW}}{P_t^{RE}} \quad (42)$$

all the previous development help us to determine the effective values for each economy (home economy and the rest of EAC) and for the whole monetary union (EAC) as follow:

- **Home economy**

  - **The effective term of trade**

$$TOT_t^{H} = \left(TOT_{RE,t}^{H}\right)^{\mu_1^{H}} \left(TOT_{RW,t}^{H}\right)^{\mu_2^{H}} \quad (43)$$

  - **The effective law of one price gap**

$$LOPG_t^{H} = \left(LOPG_{RE,t}^{H}\right)^{\mu_1^{H}} \left(LOPG_{RW,t}^{H}\right)^{\mu_2^{H}} \quad (44)$$

  - **The nominal effective exchange rate**

$$Z_t^{H} = \left(Z_{1,t}^{H}\right)^{\mu_1^{H}} \left(Z_{2,t}^{H}\right)^{\mu_2^{H}} \quad (45)$$

➢ **The real effective exchange rate**

$$RER_t^H = \left(RER_{RE,t}^H\right)^{\mu_1^H}\left(RER_{RW,t}^H\right)^{\mu_2^H} \quad (46)$$

- **Rest of the EAC economy**

➢ **The effective term of trade**

$$TOT_t^{RE} = \left(TOT_{H,t}^{RE}\right)^{\mu_1^{RE}}\left(TOT_{RW,t}^{RE}\right)^{\mu_2^{RE}} \quad (47)$$

➢ **The effective law of one price gap**

$$LOPG_t^{RE} = \left(LOPG_{H,t}^{RE}\right)^{\mu_1^{RE}}\left(LOPG_{RW,t}^{RE}\right)^{\mu_2^{RE}} \quad (48)$$

➢ **The nominal effective exchange rate**

$$Z_t^{RE} = \left(Z_{1,t}^{RE}\right)^{\mu_1^{RE}}\left(Z_{2,t}^{RE}\right)^{\mu_2^{RE}} \quad (49)$$

➢ **The real effective exchange rate**

$$RER_t^{RE} = \left(RER_{H,t}^{RE}\right)^{\mu_1^{RE}}\left(RER_{RW,t}^{RE}\right)^{\mu_2^{RE}} \quad (50)$$

- **Monetary Union effectiveness**

In case of the effectiveness of the East Africa Community Monetary Union, both the home and the rest of the EAC economies would have the same size in the union. Consequently the unique real effective exchange rate of the monetary union RER_t^U is defined as:

$$RER_t^U = (RER_t^H)^{\frac{1}{2}}(RER_t^{RE})^{\frac{1}{2}} = \left(RER_{RW,t}^H\right)^{\frac{\mu_2^H}{2}}\left(RER_{RW,t}^{RE}\right)^{\frac{\mu_2^H}{2}} \quad (51)$$

The real effective exchange rate of the monetary union can also be expressed in term of the nominal exchange rate of the monetary union, as follow:

$$RER_t^U = \frac{Z_t P_t^{RW}}{P_t^U} \quad (52)$$

Here P_t^U is the CPI of the monetary union, which is the average of the home economy CPI and the rest of EAC's CPI.

3.3. Households

A continuum of infinitely lived households populates each economy of the union and gains their utility from consumption (C_t), and hour of labor supply (H_t). The intertemporal optimization problem of the representative household is to maximize lifetime utility function:

$$\mathrm{E_t}\sum_{t=0}^{\infty}\beta^t\frac{\left(C_t^H\right)^{1-\sigma}}{1-\sigma}-\frac{\left(N_t^H\right)^{1+\varphi}}{1+\varphi};\qquad \mathrm{E_t}\sum_{t=0}^{\infty}\beta^t\frac{\left(C_t^{RE}\right)^{1-\sigma}}{1-\sigma}-\frac{\left(N_t^{RE}\right)^{1+\varphi}}{1+\varphi}; \quad (53)$$

$\mathrm{E_t}$ represents the conditional expectation operator, $0<\beta<1$ is the subjective discount factor, $0<\sigma<1$ the inverse intertemporal elasticity of substitution, and $\varphi>0$ is the inverse of elasticity of labor supply.

The households face the following intertemporal budget constraint:

- Home economy

$$P_t^H C_t^H + R_{t-1}^H B_{t-1}^H + R_{RW,t-1}\Psi_{d,t-1}^H(d_{t-1}^H,\Phi_{t-1}^H)Z_{2,t}^H D_{h,t-1}^H = W_t^H N_t^H + B_t^H + Z_{2,t}^H D_{h,t}^H + \Pi_t^H - T_t^H \quad (54)$$

- Rest of the EAC economy

$$P_t^{RE} C_t^{RE} + R_{t-1}^{RE} B_{t-1}^{RE} + R_{RW,t-1}\Psi_{d,t-1}^{RE}(d_{t-1}^{RE},\Phi_{t-1}^{RE})Z_{2,t}^{RE} D_{h,t-1}^{RE} = W_t^{RE} N_t^{RE} + B_t^{RE} + Z_{2,t}^{RE} D_{h,t}^{RE} + \Pi_t^{RE} - T_t^{RE} \quad (55)$$

Where P_t is the consumer price index, $W_t$is the nominal wage, $B_t$is the nominal stock of debt denominated in domestic currency with a domestic nominal gross interest rate R_t, $D_{h,t}$is the nominal stock of debt denominated in foreign currency with the RW gross nominal interest rate $R_{w,t}$. $Z_{2,t}$ is the bilateral nominal exchnage rate between EAC countries (home and rest of the union) and the rest of the world (expressed in term of units of domestic currency per unit of RW currency). T_t denotes lump-sum taxes paid to government and π_t is the real profit from the monopolistic sector. Finally, $\Psi_{d,t-1}$ reprsents a risk premium.

The Lagrangian for the household optimization problem can been written as follow:

$$L = E_o\left[\sum_{t=0}^{\infty}\beta^t u\left(C_t,N_t\right) + \sum_{t=0}^{\infty}\beta^t\lambda_t\left(W_t N_t + B_t + Z_{2,t}D_{h,t} + \Pi_t - T_t - P_t C_t - R_{t-1}B_{t-1} - R_{RW,t-1}\Psi_{d,t-1}(d_{t-1},\Phi_{t-1})Z_{2,t}D_{h,t-1} - T_t\right)\right] \quad (56)$$

In the Home economy, the representative household optimizes over C_t^H, N_t^H, B_t^H, and D_t^H, taking prices and the initial values of the price level P_0 and debt D_0 as given. The first order conditions of this optimization problem is given as[7]:

$$\frac{(N_t^H)^{\varphi}}{(C_t^H)^{-\sigma}} = \frac{W_t^H}{P_t^H} \tag{57}$$

$$(C_t^H)^{-\sigma} = \beta R_t^H E_t\left[(C_{t+1}^H)^{-\sigma}\frac{P_t^H}{P_{t+1}^H}\right] \tag{58}$$

$$(C_t^H)^{-\sigma} = \beta R_{RW,t-1}\Psi_{d,t-1}^H(d_{t-1}^H, \Phi_{t-1}^H)E_t\left[(C_{t+1}^H)^{-\sigma}\frac{P_t^H}{P_{t+1}^H}\frac{z_{2,t+1}^H}{z_{2,t}^H}\right] \tag{59}$$

In the rest of the EAC economy, the representative household optimizes over $C_t^{RE}, N_t^{RE}, B_t^{RE}$, and D_t^{RE}, taking prices and the initial values of the price level P_0 and debt D_0 as given. The first order conditions of this optimization problem is given as:

$$\frac{(N_t^{RE})^{\varphi}}{(C_t^{RE})^{-\sigma}} = \frac{W_t^{RE}}{P_t^{RE}} \tag{60}$$

$$(C_t^{RE})^{-\sigma} = \beta R_t^{RE} E_t\left[(C_{t+1}^{RE})^{-\sigma}\frac{P_t^{RE}}{P_{t+1}^{RE}}\right] \tag{61}$$

$$(C_t^{RE})^{-\sigma} = \beta R_{RW,t-1}\Psi_{d,t-1}^{RE}(d_{t-1}^{RE}, \Phi_{t-1}^{RE})E_t\left[(C_{t+1}^{RE})^{-\sigma}\frac{P_t^{RE}}{P_{t+1}^{RE}}\frac{z_{2,t+1}^{RE}}{z_{2,t}^{RE}}\right] \tag{62}$$

3.4. Production sector and international financial transaction

In each economy of the monetary Union, entrepreneurs manage a continuum of firms $j \in [0,1]$that produces wholesale goods in a perfectly competitive market according to the following technology:

$$Y_t^H(j) = A_t^H K_t^H(j)^{\alpha} N_t^H(j)^{\alpha-1}\ ; \qquad Y_t^{RE}(j) = A_t^{RE} K_t^{RE}(j)^{\alpha} N_t^{RE}(j)^{\alpha-1} \tag{63}$$

Where $\alpha \in [0,1]$ is the share of capital in the production technology. A_t^H and A_t^{RE} are technological shock that is common to all firms and follows a stationary first-order autoregressive process:

$$A_t^H = \rho_A A_{t-1}^H + e_{A,t}\ ; \qquad A_t^{RE} = \rho_A A_{t-1}^{RE} + e_{A,t} \tag{64}$$

[7] Here small variables indicates real quantities, for example $w_t^H = \frac{W_t^H}{P_t^H}$.

Where $e_{A,t}$ is the i.i.d. zero mean normal random variable with standard deviation equals to σ_{e_A}.

The representative firm maximizes the profit by choosing K and N subject to the production function (11). The first-order conditions for its optimization problem are:

$$w_t^H = (1-\alpha)mc_t^H \frac{Y_t^H}{N_t^H}\frac{P_{H,t}^H}{P_t^H}; \qquad w_t^{RE} = (1-\alpha)mc_t^{RE} \frac{Y_t^{RE}}{N_t^{RE}}\frac{P_{RE,t}^{RE}}{P_t^{RE}} \tag{65}$$

$$mpc_t^H = \alpha mc_t^H \frac{Y_t^H}{K_t^H}\frac{P_{H,t}^H}{P_t^H}; \qquad mpc_t^{RE} = \alpha mc_t^{RE} \frac{Y_t^{RE}}{K_t^{RE}}\frac{P_{RE,t}^{RE}}{P_t^{RE}} \tag{66}$$

Here w_t represents the real wage, mc_t is the real marginal cost and $mpc_t$is the real marginal productivity.

In both economies of EAC, entrepreneurs' are risk neutral and borrow from the rest of the world to finance a share of capital used in the production process. Entrepreneurs are assumed to have a finite expected horizon. Hence, entrepreneurs never accumulate enough funds to fully self-finance their own activity entirely. In each period t, entrepreneurs face a constant probability $(1-\nu)$of leaving the economy. In order to ensure that new entrepreneurs start out with a positive net worth, we assumed that newly entering entrepreneurs to inherit a fraction of the net worth of those firms which exit from the business.

At the end of each period, in each economy of the monetary union, entrepreneurs purchase capital K_{t+1}that will be used in the next period at real price q_t. Thus the total funding needed by entrepreneurs to purchase capital is $q_t K_{t+1}$. The capital acquisition is also partly financed by their net worth NK_{t+1}, and by borrowing from the RW, defined as:

$$D_{E,t+1}^H = q_t^H K_{t+1}^H - NW_{t+1}^H; \qquad D_{E,t+1}^{RE} = q_t^{RE} K_{t+1}^{RE} - NW_{t+1}^{RE} \tag{67}$$

The optimal financial contract between borrower and lender implies an external finance premium[8] $\left(\Psi_{E,t}\right)$. This external finance premium (EFP) depends on the entrepreneurs leverage ratio[9].

[8] An external finance premium represents the difference between the cost of external and internal finance.

[9] The leverage ratio is defined as the ratio of capital to net worth.

At the optimum, the entrepreneurs demand for capital satisfies the equality between expected real return on capital and the expected marginal finance cost[10]:

- **Home economy**

$$E_t\left(R^H_{K,t+1}\right) = E_t\left[R_{RW,t}\Psi^H_{d,t}\left(d^H_t, \Phi^H_t\right)\Psi^H_{E,t+1}(.)\frac{Z^H_{2,t+1}}{Z^H_{2,t}}\frac{P^H_t}{P^H_{t+1}}\right] \quad (68)$$

- **Rest of the EAC economy**

$$E_t\left(R^{RE}_{K,t+1}\right) = E_t\left[R_{RW,t}\Psi^{RE}_{d,t}\left(d^{RE}_t, \Phi^{RE}_t\right)\Psi^{RE}_{E,t+1}(.)\frac{Z^{RE}_{2,t+1}}{Z^{RE}_{2,t}}\frac{P^{RE}_t}{P^{RE}_{t+1}}\right] \quad (69)$$

$\Psi_{E,t+1}(.)$ is the function that describe how the EFP depends on the financial position of the firm or the specific risk premium.

The specific risk premium is defined as:

$$\Psi^H_{E,t+1}(.) = \left(\frac{NW^H_{t+1}}{q^H_t K^H_{t+1}}\right)^{-\gamma}; \qquad \Psi^{RE}_{E,t+1}(.) = \left(\frac{NW^{RE}_{t+1}}{q^{RE}_t K^{RE}_{t+1}}\right)^{-\gamma} \quad (70)$$

γ is the elasticity of the EFP with respect to firm's leverage ratio. $\left(\Psi_{E,t+1}(.)\right)' < 0$, $\Psi_E(1) = 1$.

At the equilibrium the EFP is an inverse function of the aggregate financial position in the economy, expressed by the leverage ratio.

In each economy, the capital demand must satisfy the following differentiation between the ex post marginal return on capital, $E_t\left(R_{H,t+1}\right)$, and the marginal productivity of capital at t+1, mpc^H_t, which is the rental rate of capital:

$$E_t\left(R^H_{K,t+1}\right) = E_t\left[\frac{mpc^H_{t+1}+(1-\delta)q^H_{t+1}}{q^H_t}\right]; \quad \text{and} \quad E_t\left(R^{RE}_{K,t+1}\right) = E_t\left[\frac{mpc^{RE}_{t+1}+(1-\delta)q^{RE}_{t+1}}{q^{RE}_t}\right] \quad (71)$$

Where δ is the capital depreciation rate and $(1-\delta)q_{t+1}$is the value of one unit of capital used in t+1.

Aggregate entrepreneurial net worth accumulation of each economy depends on profits earned in previous periods plus the bequest, Ω_t, that newly entering entrepreneurs receive from entrepreneurs who leave the economy, and evolves according to:

[10] The external marginal financing cost is the sum of the gross premium for external finance and the gross real interest rate on the borrowing.

- **Home economy**

$$NW_{t+1}^{H} = \nu\left[R_{K,t}^{H} q_{t-1}^{H} K_t^{H} - R_{RW,t}\Psi_{d,t}^{H}\left(d_t^{H}, \Phi_t^{H}\right)\left(\frac{NW_t^{H}}{q_{t-1}^{H} K_t^{H}}\right)^{-\gamma} \frac{Z_{2,t+1}^{H}}{Z_{2,t}^{H}} \frac{P_t^{H}}{P_{t+1}^{H}} (q_{t-1}^{H} K_t^{H} - NW_t^{H})\right] - (1-\nu)\Omega_t^{H} \quad (72)$$

- **Rest of the EAC economy**

$$NW_{t+1}^{RE} = \nu\left[R_{K,t}^{RE} q_{t-1}^{RE} K_t^{RE} - R_{RW,t}\Psi_{d,t}^{RE}\left(d_t^{RE}, \Phi_t^{RE}\right)\left(\frac{NW_t^{RE}}{q_{t-1}^{RE} K_t^{RE}}\right)^{-\gamma} \frac{Z_{2,t+1}^{RE}}{Z_{2,t}^{RE}} \frac{P_t^{RE}}{P_{t+1}^{RE}} (q_{t-1}^{RE} K_t^{RE} - NW_t^{RE})\right] - (1-\nu)\Omega_t^{RE} \quad (73)$$

3.5. Capital producers

Competitive capital producers use a linear technology to produce new capital from final investment goods and existing capital stock leasing from the entrepreneurs without costs. When producing capital, they are subject to quadratic capital adjustment cost specified as:

$$\frac{\psi_I}{2}\left(\frac{I_t^{H}}{K_t^{H}} - \delta\right)^2 K_t^{H} \;; \quad \text{and} \quad \frac{\psi_I}{2}\left(\frac{I_t^{RE}}{K_t^{RE}} - \delta\right)^2 K_t^{RE} \quad (74)$$

$\psi_I > 0$ is the parameter that measures the adjustment costs elasticity.

The aggregate capital stock used by producers in each economy of the monetary union evolves as follow:

- **Home economy**

$$K_{t+1}^{H} = \left[\frac{I_t^{H}}{K_t^{H}} - \frac{\psi_I}{2}\left(\frac{I_t^{H}}{K_t^{H}} - \delta\right)^2\right] K_t^{H} + (1-\delta) K_t^{H} \quad (75)$$

- **Rest of EAC economy**

$$K_{t+1}^{RE} = \left[\frac{I_t^{RE}}{K_t^{RE}} - \frac{\psi_I}{2}\left(\frac{I_t^{RE}}{K_t^{RE}} - \delta\right)^2\right] K_t^{RE} + (1-\delta) K_t^{RE} \quad (76)$$

Capital producers face an optimizing problem, which consists, in real terms, in choosing the level of investment that maximizes their profits:

- **Home economy**

$$\max_{I_t}\left[q_t^H I_t^H - I_t^H - \frac{\psi_I}{2}\left(\frac{I_t^H}{K_t^H} - \delta\right)^2 K_t^H\right] \quad (77)$$

- **Rest of EAC economy**

$$\max_{I_t}\left[q_t^{RE} I_t^{RE} - I_t^{RE} - \frac{\psi_I}{2}\left(\frac{I_t^{RE}}{K_t^{RE}} - \delta\right)^2 K_t^{RE}\right] \quad (78)$$

The following equilibrium condition holds;

$$q_t^H - \psi_I\left(\frac{I_t^H}{K_t^H} - \delta\right) = 1\,; \qquad \text{and} \qquad q_t^{RE} - \psi_I\left(\frac{I_t^{RE}}{K_t^{RE}} - \delta\right) = 1 \quad (79)$$

These relations represent the standard Tobin's Q equation that links the price of capital to the marginal adjustment costs. The major implication is that, capital adjustment costs lead necessarily to the capital price variation and hence contribute to the volatility of entrepreneurial net worth.

3.6.Retailers

In each economy of the monetary union, domestic goods retailers and imported goods retailers purchase wholesale goods, repackage them costlessly, and sell them in a monopolistically competitive market. At each period, a fraction $(1-\eta^H)$ of retailers are randomly selected to set new prices while the remaining fraction η^H of retailers keep their prices unchanged. For simplicity, these fractions are assumed to be equals within the two groups retailers[11]. All domestic goods retailers purchase the wholesale goods from entrepreneurs at a price equal to the entrepreneurs' nominal marginal cost. Each retailer j of them which sets price at t will choose the optimal price,, that maximizes the expected profits for s periods, expressed by :

- **Home economy**

$$\max_{\tilde{P}_{H,t}^H(j)} E_t\left[\sum_{s=0}^{\infty}(\beta\eta^H)^s \frac{\lambda_{t+s}^H}{\lambda_t^H}\left[Y_{H,t+s}^H(j)\left(\tilde{P}_{H,t}^H(j) - P_{H,t+s}^H mc_{t+s}^H\right)\right]\right] \quad (80)$$

[11] For simplicy, this fraction is assumed to be equal between the two groups of retailers.

Subject to the demand function

$$Y_{H,t+s}^{H}(j) = \left(\frac{\tilde{P}_{H,t+s}^{H}(j)}{\tilde{P}_{H,t+s}^{H}}\right)^{-\chi} Y_{H,t+s}^{H}(j) \tag{81}$$

- **Rest of the EAC economy**

$$\max_{\tilde{P}_{RE,t}^{RE}(j)} E_t\left[\sum_{s=0}^{\infty}(\beta\eta^{RE})^s \frac{\lambda_{t+s}^{RE}}{\lambda_t^{RE}}\left[Y_{RE,t+s}^{RE}(j)\left(\tilde{P}_{RE,t}^{RE}(j) - P_{RE,t+s}^{RE} mc_{t+s}^{RE}\right)\right]\right] \tag{82}$$

Subject to the demand function

$$Y_{RE,t+s}^{RE}(j) = \left(\frac{\tilde{P}_{RE,t+s}^{RE}(j)}{\tilde{P}_{RE,t+s}^{RE}}\right)^{-\chi} Y_{RE,t+s}^{RE}(j) \tag{83}$$

Where $\frac{\lambda_{t+s}}{\lambda_t}$ is the households' marginal utilities ratio between t+s and t.

The first order conditions for this problem in each economy of the monetary union is expressed by:

- **Home economy**

$$\tilde{P}_{H,t}^{H}(j) = \frac{\chi}{\chi-1}\frac{E_t\left[\sum_{s=0}^{\infty}(\beta\eta^{H})^s \lambda_{t+s}^{H} Y_{H,t+s}^{H}(j) P_{H,t+s}^{H} mc_{t+s}^{H}\right]}{E_t\left[\sum_{s=0}^{\infty}(\beta\eta^{H})^s \lambda_{t+s}^{H} Y_{H,t+s}^{H}(j)\right]} \tag{84}$$

- **Rest of the EAC economy**

$$\tilde{P}_{RE,t}^{RE}(j) = \frac{\chi}{\chi-1}\frac{E_t\left[\sum_{s=0}^{\infty}(\beta\eta^{RE})^s \lambda_{t+s}^{RE} Y_{RE,t+s}^{RE}(j) P_{RE,t+s}^{RE} mc_{t+s}^{RE}\right]}{E_t\left[\sum_{s=0}^{\infty}(\beta\eta^{RE})^s \lambda_{t+s}^{RE} Y_{RE,t+s}^{RE}(j)\right]} \tag{85}$$

Aggregating across all retailers, the DPI are given in each economy of the union by:

- **Home economy**

$$P_{H,t}^{H} = \left[(1-\eta^{H})\left(\tilde{P}_{H,t}^{H}\right)^{1-\chi} + \eta^{H}\left(\tilde{P}_{H,t}^{H}\right)^{1-\chi}\right]^{\frac{1}{1-\chi}} \tag{86}$$

- **Rest of the EAC economy**

$$P_{RE,t}^{RE} = \left[(1-\eta^{RE})\left(\tilde{P}_{RE,t}^{RE}\right)^{1-\chi} + \eta^{RE}\left(\tilde{P}_{RE,t}^{RE}\right)^{1-\chi}\right]^{\frac{1}{1-\chi}} \tag{87}$$

Combining the log-linearized version of the first order conditions and the DPIs yields an expression of inflation rate for domestically produced goods, defined by the following new Keynesian Phillips curve in each economy:

- **Home economy**

$$\hat{\pi}_{H,t}^{H} = \frac{P_{H,t}^{H}}{P_{H,t-1}^{H}} = \beta E_t \hat{\pi}_{H,t+1}^{H} + \frac{(1-\eta^{H})(1-\beta\eta^{H})}{\eta^{H}} \widehat{mc}_t^{H} \quad (88)$$

- **Rest of the EAC economy**

$$\hat{\pi}_{RE,t}^{RE} = \frac{P_{RE,t}^{RE}}{P_{RE,t-1}^{RE}} = \beta E_t \hat{\pi}_{RE,t+1}^{RE} + \frac{(1-\eta^{RE})(1-\beta\eta^{RE})}{\eta^{RE}} \widehat{mc}_t^{RE} \quad (89)$$

Where $\widehat{mc}_t$ is the log deviation of the real marginal state from its steady-state value and $\hat{\pi}_{H,t+1}$is the log deviation of the domestic inflation from its steady-state value.

Likewise, imported goods retailers purchase the products from foreign producers at the wholesale prices, $P_{RE,t}^{H}$and $P_{RW,t}^{H}$. At the wholesale level, the law of one price (LOP) holds. Thus, the wholesale prices (nominal marginal costs) for goods coming from the rest of EAC and the rest of the world are respectively:

- **Home economy**

$$P_{RE,t}^{H} = Z_{1,t}^{H} P_{RE,t}^{RE} \quad \text{and} \quad P_{RW,t}^{H} = Z_{2,t}^{H} P_{RW,t}^{RW} \quad (90)$$

- **The rest of EAC**

$$P_{H,t}^{RE} = Z_{1,t}^{RE} P_{H,t}^{H} \quad \text{and} \quad P_{H,t}^{RE} = Z_{2,t}^{RE} P_{RW,t}^{RW} \quad (91)$$

But at the retail level, we are assume that the law of one price does not hold, such as:

- **Home economy**

$$P_{RE,t}^{H} \neq Z_{1,t}^{H} P_{RE,t}^{RE} \quad \text{and} \quad P_{RW,t}^{H} \neq Z_{2,t}^{H} P_{RW,t}^{RW} \quad (92)$$

- **The rest of EAC**

$$P_{H,t}^{RE} \neq Z_{1,t}^{RE} P_{H,t}^{H} \quad \text{and} \quad P_{H,t}^{RE} \neq Z_{2,t}^{RE} P_{RW,t}^{RW} \quad (93)$$

There is thus incomplete exchange rate pass-through in the model. Similar to the home good retailers, imported goods retailers optimization problem is identical except for real marginal costs, which are in each economy:

- **Home economy**

$$\left(\frac{Z_{1,t}^{H} P_{RE,t}^{RE}}{P_{RE,t}^{H}}\right) \equiv LOPG_{RE,t}^{H} \quad \text{and} \quad \left(\frac{Z_{1,t}^{H} P_{RW,t}^{RW}}{P_{RW,t}^{H}}\right) \equiv LOPG_{RW,t}^{H} \tag{94}$$

- **The rest of EAC**

$$\left(\frac{Z_{1,t}^{RE} P_{H,t}^{H}}{P_{H,t}^{RE}}\right) \equiv LOPG_{H,t}^{RE} \quad \text{and} \quad \left(\frac{Z_{1,t}^{RE} P_{RW,t}^{RW}}{P_{RW,t}^{RE}}\right) \equiv LOPG_{RW,t}^{RE} \tag{95}$$

The inflation rates for imported goods then satisfy these following New Keynesian Phillips Curves:

- **Home economy**

$$\hat{\pi}_{RE,t}^{H} = \beta E_t \hat{\pi}_{RE,t+1}^{H} + \frac{(1-\eta^{H})(1-\beta\eta^{H})}{\eta^{H}} \widehat{lopg}_{RE,t}^{H} \tag{96}$$

$$\hat{\pi}_{RW,t}^{H} = \beta E_t \hat{\pi}_{RW,t+1}^{H} + \frac{(1-\eta^{H})(1-\beta\eta^{H})}{\eta^{H}} \widehat{lopg}_{RW,t}^{H} \tag{97}$$

Where $\pi_{RE,t}^{H}$ and $\pi_{RW,t}^{H}$are imported inflation prices from the RE and the RW.

- **Rest of the EAC economy**

$$\hat{\pi}_{H,t}^{RE} = \beta E_t \hat{\pi}_{H,t+1}^{RE} + \frac{(1-\eta^{RE})(1-\beta\eta^{RE})}{\eta^{RE}} \widehat{lopg}_{H,t}^{RE} \tag{98}$$

$$\hat{\pi}_{RW,t}^{RE} = \beta E_t \hat{\pi}_{RW,t+1}^{RE} + \frac{(1-\eta^{RE})(1-\beta\eta^{RE})}{\eta^{RE}} \widehat{lopg}_{RW,t}^{RE} \tag{99}$$

Where $\pi_{H,t}^{RE}$ and $\pi_{RW,t}^{RE}$are imported inflation prices from the RE and the RW.

Finally, from equation 5 and 6, CPI inflation, $\hat{\pi}_t^{H}$ and $\hat{\pi}_t^{RE}$ are a composite of domestic, RE and RW goods prices inflation, such that:

- **Home economy**

$$\hat{\pi}_t^{H} = (1 - \mu_1^{H} - \mu_2^{H})\hat{\pi}_{H,t}^{H} + \mu_1^{H}\hat{\pi}_{RE,t}^{H} + \mu_2^{H}\hat{\pi}_{RW,t}^{H} \tag{100}$$

- **The rest of EAC**

$$\hat{\pi}_t^{RE} = (1 - \mu_1^{RE} - \mu_2^{RE})\hat{\pi}_{RE,t}^{RE} + \mu_1^{H}\hat{\pi}_{H,t}^{RE} + \mu_2^{RE}\hat{\pi}_{RW,t}^{RE} \tag{101}$$

2.7. Monetary Authority and exchange rate policies in EAMU

The aim of this research is to assess the effectiveness of EAMU under alternative exchange rate policies. The standard Taylor-type rule would move thus from simple to modified framework in order to feature the exchange rate policies in the monetary authorities behavior. We consider four exchange rate policies, namely, pure fixed exchange rate policy, managed floating exchange rate policy, target zone exchange rate policy and pure floating exchange rate policy. Depending of the type of exchange rate policy involved, the monetary authority would try to stabilize inflation, output and sometimes exchange rate.

2.7.1. Pure fixed exchange rate policy in EAMU

The monetary union is assumed to be effective and the common central bank of all the economies (Home and the rest of the EAC) of the union sets the nominal exchange rate pegged at a predetermined level, expressed by:

$$Z_t = \bar{Z}_t \tag{102}$$

The central bank of the union sets the nominal interest rate according to the following Taylor-type rule

$$\hat{R}_t = \beta_0 \hat{R}_{t-1} + (1-\beta_0)[\beta_1 \hat{\pi}_t^{mu} + \beta_2 \hat{y}_t^{mu}] + e_{R,t} \tag{103}$$

Where $e_{\mathrm{R},t}$ is the i.i.d. zero mean normal random variable with standard deviation equals to $\sigma_{e_{\mathrm{R}}}$. $\hat{r}_t$, $\hat{\pi}_t^{mu}$ and $\hat{y}_t^{mu}$ are respectively, the log-deviation from their steady-state values of the nominal interest rate, the inflation and the output of the monetary union. $\hat{\pi}_t^{mu}$ and $\hat{y}_t^{mu}$ are the average values of inflation and output of the home economy and the rest of EAC economy expressed as :

$$\pi_t^{mu} = \frac{1}{2}(\pi_t^H + \pi_t^{RE}) \quad \text{and} \quad y_t^{mu} = \frac{1}{2}(y_t^H + y_t^{RE}) \tag{104}$$

$0 < \beta_0 < 1$ captures the degree of interest rate smoothing, $\beta_1 > 1$ and $\beta_2 < 1$ are coefficients that measures central bank responses to expected inflation and output deviations.

2.7.2. Managed floating exchanges rate policy in EAMU

It is well known that some of EAC countries target the stability of exchange rate in their monetary policy framework. We assumed thus that the economies of the EAC monetary union opt for the managed floating exchange rate policy.

In this second case, each economy has its monetary autonomy and the monetary authority practices the managed floating exchange rate policy according to the following augmented Taylor-type rule:

- **Home economy**

$$\hat{R}_t^H = \beta_0^H \hat{R}_{t-1}^H + (1-\beta_0^H)\left[\beta_1^H \hat{\pi}_t^H + \beta_2^H \hat{y}_t^H + \beta_3^H \hat{Z}_t^H\right] + e_{R,t} \quad (105)$$

$\hat{R}_t^H$, $\hat{\pi}_t^H$, $\hat{y}_t^H$and $\hat{Z}_t^H$ are respectively, the log-deviation from their steady-state values of the nominal interest rate, the inflation , the output and the nominal effective exchange rate (NEER) of the home economy.

- **Rest of EAC economy**

$$\hat{R}_t^{RE} = \beta_0^{RE} \hat{R}_{t-1}^{RE} + (1-\beta_0^{RE})\left[\beta_1^{RE} \hat{\pi}_t^{RE} + \beta_2^{RE} \hat{y}_t^{RE} + \beta_3^{RE} \hat{Z}_t^{RE}\right] + e_{R,t} \quad (106)$$

$\hat{R}_t^{RE}$, $\hat{\pi}_t^{RE}$, $\hat{y}_t^{RE}$and $\hat{Z}_t^{RE}$ are respectively, the log-deviation from their steady-state values of the nominal interest rate, the inflation , the output and the nominal effective exchange rate (NEER) of the rest of EAC economy.

2.7.3. The target zone exchanges rate policy in EAMU

We assumed that in the economies of the EAC opt for the target zone exchange rate policy. The target zone exchange rate policy is a type of policy where the monetary authority seeks to maintain within an implicit boundary the ideal range of exchange rates. In this case, each economy of the union has its monetary autonomy and the monetary authority adopts an exchange rate peg while allowing it to float around a central parity within a target band.

The NEER is decomposed as follow in each economy of the union:

$$\hat{Z}_t^H = \hat{Z}_{H,t}^c + \hat{Z}_{Ht}^D \; ; \qquad \text{and} \qquad \hat{Z}_t^{RE} = \hat{Z}_{RE,t}^c + \hat{Z}_{RE,t}^D \qquad (107)$$

Where $\hat{Z}_t^c$ stands for the central parity of the exchange rate and $\hat{Z}_t^D$ represents the deviations of the exchange rate from the central parity.

The monetary authority sets thus the nominal interest rate according to the following modified Taylor-type rule:

- **Home economy**

$$\hat{R}_t^H = \beta_0^H \hat{R}_{t-1}^H + (1-\beta_0^H)\left[\beta_1^H \hat{\pi}_t^H + \beta_2^H \hat{y}_t^H + \beta_3^H \hat{Z}_{H,t}^D\right] + e_{R,t} \qquad (108)$$

- **Rest of EAC economy**

$$\hat{R}_t^{RE} = \beta_0^{RE} \hat{R}_{t-1}^{RE} + (1-\beta_0^{RE})\left[\beta_1^{RE} \hat{\pi}_t^{RE} + \beta_2^{RE} \hat{y}_t^{RE} + \beta_3^{RE} \hat{Z}_{RE,t}^D\right] + e_{R,t} \qquad (109)$$

2.7.4. The pure floating exchanges rate policy in EAMU

We assumed thus that the economies of the EAC monetary union opt for a pure floating exchange rate policy. In this last case, each economy has its monetary autonomy and the monetary authority practices the floating exchange rate policy according to the following augmented Taylor-type rule:

- **Home economy**

$$\hat{R}_t^H = \beta_0^H \hat{R}_{t-1}^H + (1-\beta_0^H)\left[\beta_1^H \hat{\pi}_t^H + \beta_2^H \hat{y}_t^H + \beta_3^H \Delta\hat{Z}_t^H\right] + e_{R,t} \qquad (110)$$

β_1^H, β_2^H , β_3^H are respectively, the coefficients that measure central bank responses to inflation, output deviations and NEER variations $\left(\Delta\hat{Z}_t^H\right)$.

- **Rest of EAC economy**

$$\hat{R}_t^{RE} = \beta_0^{RE} \hat{R}_{t-1}^{RE} + (1-\beta_0^{RE})\left[\beta_1^{RE} \hat{\pi}_t^{RE} + \beta_2^{RE} \hat{y}_t^{RE} + \beta_3^{RE} \Delta\hat{Z}_t^{RE}\right] + e_{R,t} \qquad (111)$$

β_1^{RE}, β_2^{RE} , β_3^{RE} are respectively, the coefficients that measure central bank responses to inflation, output deviations and NEER variations $\left(\Delta\hat{Z}_t^{RE}\right)$.

2.8. Government

The government in each economy of the monetary union finances its expenditures in purchases of aggregate public goods using lump-sum taxes paid by households, such as that:

$$P_t^H G_t^H = T_t^H; \quad \text{and} \quad P_t^{RE} G_t^{RE} = T_t^{RE} \tag{112}$$

The public spending is assumed to be exogenous and follows the autoregressive process:

$$G_t^H = \rho_g G_{t-1}^H + e_{g,t}; \quad \text{and} \quad G_t^{RE} = \rho_g G_{t-1}^{RE} + e_{g,t} \tag{113}$$

Where $e_{\mathrm{G},t}$ is the i.i.d. zero mean normal random variable with standard deviation equals to $\sigma_{e_{\mathrm{G}}}$.

2.9. Rest of the World

The rest of the world in this model is assumed to be exogenous and its variables follows an autoregressive process such that:

$$AB_t^{RW} = \rho_{AB_t^{RW}} AB_{t-1}^{RW} + e_{AB_t^{RW},t} \tag{114}$$

AB_t^{RW} represents the absorption of the RW and $\rho_{AB_{RW}}$ is the coefficient of autoregressive process and $e_{AB_t^{RW},t}$ is the i.i.d. zero mean normal random variable with standard deviation equals to $\sigma_{e_{AB_t^{RW},t}}$.

$$R_t^{RW} = \rho_{R_t^{RW}} AB_{t-1}^{RW} + e_{R_t^{RW}} \tag{115}$$

R_t^{RW} represents the risk free interest rate of the RW and $\rho_{R_t^{RW}}$ is the coefficient of autoregressive process and $e_{R_t^{RW}}$ is the i.i.d. zero mean normal random variable with standard deviation equals to $\sigma_{e_{R_t^{RW}}}$.

$$\pi_t^{RW} = \rho_{\pi_t^{RW}} AB_{t-1}^{RW} + e_{\pi_t^{RW}} \tag{116}$$

π_t^{RW} represents the inflation of the RW and $\rho_{\pi_t^{RW}}$ is the coefficient of autoregressive process and is $e_{\pi_t^{RW}}$ is the i.i.d. zero mean normal random variable with standard deviation equals to $\sigma_{e_{\pi_t^{RW}}}$.

2.10. Equilibrium of the model

The equilibrium in the labor market, in the capital market, in the financial market, in the goods market and the balance of payment leads to the equilibrium of the system.

- **Labor market**

$$N_t^H = \int_0^1 N_t^H(j)dj \ ; \quad \text{and} \quad N_t^{RE} = \int_0^1 N_t^{RE}(j)dj \qquad (117)$$

- **Capital market**

$$K_t^H = \int_0^1 K_t^H(j)dj \ ; \quad \text{and} \quad K_t^{RE} = \int_0^1 K_t^{RE}(j)dj \qquad (118)$$

- **Financial market**

$$B_t^H = 0; \quad \text{and} \quad B_t^{RE} = 0 \qquad (119)$$

- **The goods market**

Let $Y_t^H \equiv \left(\int_0^1 Y_t^H(j)^{\frac{\chi-1}{\chi}} dj\right)^{\frac{\chi}{\chi-1}}$ and $Y_t^{RE} \equiv \left(\int_0^1 Y_t^{RE}(j)^{\frac{\chi-1}{\chi}} dj\right)^{\frac{\chi}{\chi-1}}$ denote aggregate output.

Thus, the goods market clearing condition satisfies:

$$Y_t^H = C_{H,t}^H + I_{H,t}^H + G_{H,t}^H + EX_t^H \text{ and } \quad Y_t^{RE} = C_{RE,t}^{RE} + I_{RE,t}^{RE} + G_{RE,t}^{RE} + EX_t^{RE} \qquad (120)$$

Where:

$$EX_t^H = \mu_1^H \left(\frac{P_{H,t}^H}{Z_{1,t}^H P_t^{RE}}\right)^{-\theta} AB_t^{RE} + \mu_2^H \left(\frac{P_{H,t}^H}{Z_{2,t}^H P_t^{RW}}\right)^{-\theta} AB_t^{RW} \qquad (121)$$

$$EX_t^{RE} = \mu_1^{RE} \left(\frac{P_{RE,t}^{RE}}{Z_{1,t}^{RE} P_t^H}\right)^{-\theta} AB_t^H + \mu_2^{RE} \left(\frac{P_{RE,t}^{RE}}{Z_{2,t}^{RE} P_t^{RW}}\right)^{-\theta} AB_t^{RW} \qquad (122)$$

Here EX_t^H and EX_t^{RE} represent total exports of the home economy and the RE economy. AB_t^H , AB_t^{RE} and AB_t^{RW} stand respectively for absorption in the home economy, in the RE economy and in the RW economy, defined such as[12]:

$$AB_t^H = C_t^H + I_t^H + G_t^H; \quad \text{and} \quad AB_t^{RE} = C_t^{RE} + I_t^{RE} + G_t^{RE} \qquad (123)$$

Then the domestic's aggregate resource constraints can be rewritten as:

[12] AB_t^{RW} is an exogenous process.

$$Y_t^H = \left(\frac{P_{H,t}^H}{P_t^H}\right)^{-\theta}\left[(1-\mu_1^H-\mu_2^H)AB_t^H + \mu_1^H\left(\frac{1}{RER_{RE,t}^H}\right)^{-\theta}AB_t^{RE} + \mu_2^H\left(\frac{1}{RER_{RW,t}^H}\right)^{-\theta}AB_t^{RW}\right]$$

(124)

$$Y_t^{RE} = \left(\frac{P_{RE,t}^{RE}}{P_t^{RE}}\right)^{-\theta}\left[(1-\mu_1^{RE}-\mu_2^{RE})AB_t^{RE} + \mu_1^{RE}\left(\frac{1}{RER_{H,t}^{RE}}\right)^{-\theta}AB_t^{H} + \mu_2^{RE}\left(\frac{1}{RER_{RW,t}^{RE}}\right)^{-\theta}AB_t^{RW}\right]$$

(125)

- **The balance of payment**

The evolution of net foreign assets (NFA) at the aggregate level can be expressed for each economy of the monetary union as:

$$Z_{2,t}^H D_t^H = Z_{2,t}^H R_{RW,t-1}\Psi_{d,t-1}^H(d_{t-1}^H, \Phi_{t-1}^H)D_{t-1}^H + EX_t^H - \left(IM_{RE,t}^H + IM_{RW,t}^H\right) \quad (126)$$

Where $IM_{RE,t}^H$ and $IM_{RW,t}^H$ are imports of home economy from the RE economy and the RW, respectively.

$$Z_{2,t}^{RE} D_t^{RE} = Z_{2,t}^{RE} R_{RW,t-1}\Psi_{d,t-1}^{RE}(d_{t-1}^{RE}, \Phi_{t-1}^{RE})D_{t-1}^{RE} + EX_t^{RE} - \left(IM_{H,t}^{RE} + IM_{RW,t}^{RE}\right) \quad (127)$$

Where $IM_{H,t}^{RE}$ and $IM_{RW,t}^{RE}$ are respectively imports of home economy from the the RE economy and the RW.

The expression of the evolution of total real NFA position in percentage of steady-state output is:

$$d_t^H = R_{RW,t}\Psi_{d,t-1}^H \frac{1}{\pi_t^H} d_{t-1}^H + \frac{1}{Y}\left(\frac{P_{H,t}^H}{P_t^H}Y_t^H - C_t^H - I_t^H - G_t^H\right) \quad (128)$$

$$d_t^{RE} = R_{RW,t}\Psi_{d,t-1}^{RE} \frac{1}{\pi_t^{RE}} d_{t-1}^{RE} + \frac{1}{Y}\left(\frac{P_{RE,t}^{RE}}{P_t^{RE}}Y_t^{RE} - C_t^{RE} - I_t^{RE} - G_t^{RE}\right) \quad (129)$$

2.10. The log-linearized model

- **Demand side**

$$\hat{y}_t^H = (1-\mu_1^H-\mu_2^H)\left(\frac{C^H}{y^H}\hat{c}_t^H + \frac{i^H}{y^H}\hat{\imath}_t^H + \frac{g^H}{y^H}\hat{g}_t^H\right) + \mu_1^H\left(\frac{C^{RE}}{y^{RE}}\hat{c}_t^{RE} + \frac{i^{RE}}{y^{RE}}\hat{\imath}_t^{RE} + \frac{g^{RE}}{y^{RE}}\hat{g}_t^{RE}\right) + \mu_2^H\widehat{ab}_t^{RW} + \theta\mu_1^H\left(\frac{2-\mu_1^H-\mu_2^H}{(1-\mu_1^H-\mu_2^H)}\right)\widehat{rer}_t - \frac{\theta\mu_1^H}{(1-\mu_1^H-\mu_2^H)}\widehat{lopg}_t \quad (130)$$

$$\hat{y}_t^{RE} = (1-\mu_1^{RE}-\mu_2^{RE})\left(\frac{C^{RE}}{y^{RE}}\hat{c}_t^{RE} + \frac{i^{RE}}{y^{RE}}\hat{\imath}_t^{RE} + \frac{g^{RE}}{y^{RE}}\hat{g}_t^{RE}\right) + \mu_1^{RE}\left(\frac{C^H}{y^H}\hat{c}_t^H + \frac{i^H}{y^H}\hat{\imath}_t^H + \frac{g^H}{y^H}\hat{g}_t^H\right) + \mu_2^{RE}\widehat{ab}_t^{RW} + \theta\mu_1^{RE}\left(\frac{2-\mu_1^{RE}-\mu_2^{RE}}{(1-\mu_1^{RE}-\mu_2^{RE})}\right)\widehat{rer}_t - \frac{\theta\mu_1^{RE}}{(1-\mu_1^{RE}-\mu_2^{RE})}\widehat{lopg}_t \quad (131)$$

$$\hat{\lambda}_t^H = \beta(1+\hat{r}_{t+1}^H)E_t\hat{\lambda}_{t+1}^H \quad (132)$$

$$\hat{\lambda}_t^{RE} = \beta(1+\hat{r}_{t+1}^{RE})E_t\hat{\lambda}_{t+1}^{RE} \quad (133)$$

$$E_t\left(\hat{r}_{K,t+1}^H\right) = \hat{r}_{RW,t} - E_t\hat{\pi}_{t+1}^H - \gamma\left[\widehat{nw}_{t+1}^H - \hat{q}_t^H - \hat{k}_{t+1}^H\right] \quad (134)$$

$$E_t\left(\hat{r}_{K,t+1}^{RE}\right) = \hat{r}_{RW,t} - E_t\hat{\pi}_{t+1}^{RE} - \gamma\left[\widehat{nw}_{t+1}^{RE} - \hat{q}_t^{RE} - \hat{k}_{t+1}^{RE}\right] \quad (135)$$

$$\hat{r}_{K,t+1}^H = \left(1-\left(\frac{1-\delta}{r_K^H}\right)\right)\widehat{mpc}_t + \left(\frac{1-\delta}{r_K^H}\right)\hat{q}_t^H - \hat{q}_{t-1}^H \quad (136)$$

$$\hat{r}_{K,t+1}^{RE} = \left(1-\left(\frac{1-\delta}{r_K^{RE}}\right)\right)\widehat{mpc}_t + \left(\frac{1-\delta}{r_K^{RE}}\right)\hat{q}_t^{RE} - \hat{q}_{t-1}^{RE} \quad (137)$$

$$\hat{q}_t^H - \psi_I\left(\frac{\hat{\imath}_t^H}{\hat{k}_t^H} - \delta\right) = 1 \quad (138)$$

$$\hat{q}_t^{RE} - \psi_I\left(\frac{\hat{\imath}_t^{RE}}{\hat{k}_t^{RE}} - \delta\right) = 1 \quad (139)$$

- **Supply side**

$$\hat{y}_t^H = \hat{A}_t^{yH} + \alpha\hat{k}_t^H + (1-\alpha)\hat{n}_t^H \quad (140)$$

$$\hat{y}_t^{RE} = \hat{A}_t^{yRE} + \alpha\hat{k}_t^{RE} + (1-\alpha)\hat{n}_t^{RE} \quad (141)$$

$$\hat{w}_t^H = \hat{y}_t^H + \widehat{mc}_t^H - \hat{n}_t^H - \frac{\mu_1^H}{(1-\mu_1^H-\mu_2^H)}\left(\widehat{rer}_t^H - \widehat{lopg}_t^H\right) \quad (142)$$

$$\hat{w}_t^{RE} = \hat{y}_t^{RE} + \widehat{mc}_t^{RE} - \hat{n}_t^{RE} - \frac{\mu_1^{RE}}{(1-\mu_1^{RE}-\mu_2^{RE})}\left(\widehat{rer}_t^{RE} - \widehat{lopg}_t^{RE}\right) \quad (143)$$

$$\widehat{mpc}_t^H = \hat{y}_t^H + \widehat{mc}_t^H - \hat{k}_t^H - \frac{\mu_1^H}{(1-\mu_1^H-\mu_2^H)}\left(\widehat{rer}_t^H - \widehat{lopg}_t^H\right) \quad (144)$$

$$\widehat{mpc}_t^{RE} = \hat{y}_t^{RE} + \widehat{mc}_t^{RE} - \hat{k}_t^{RE} - \frac{\mu_1^{RE}}{(1-\mu_1^{RE}-\mu_2^{RE})}\left(\widehat{rer}_t^{RE} - \widehat{lopg}_t^{RE}\right) \quad (145)$$

$$\hat{\pi}_t^H = (1-\mu_1^H-\mu_2^H)\hat{\pi}_{H,t}^H + \mu_1^H\hat{\pi}_{RE,t}^H + \mu_2^H\hat{\pi}_{RW,t}^H \quad (146)$$

$$\hat{\pi}_t^{RE} = (1-\mu_1^{RE}-\mu_2^{RE})\hat{\pi}_{RE,t}^{RE} + \mu_1^H\hat{\pi}_{H,t}^{RE} + \mu_2^{RE}\hat{\pi}_{RW,t}^{RE} \quad (147)$$

$$\hat{\pi}_{H,t}^H = \beta E_t\hat{\pi}_{H,t+1}^H + \frac{(1-\eta^{RE})(1-\beta\eta^{RE})}{\eta^{RE}}\widehat{mc}_t^H \quad (148)$$

$$\hat{\pi}_{RE,t}^{RE} = \beta E_t\hat{\pi}_{RE,t+1}^{RE} + \frac{(1-\eta^{RE})(1-\beta\eta^{RE})}{\eta^{RE}}\widehat{mc}_t^{RE} \quad (149)$$

$$\hat{\pi}_{RE,t}^H = \beta E_t\hat{\pi}_{RE,t+1}^H + \frac{(1-\eta^H)(1-\beta\eta^H)}{\eta^H}\widehat{lopg}_{RE,t}^H \quad (150)$$

$$\hat{\pi}_{RW,t}^H = \beta E_t\hat{\pi}_{RW,t+1}^H + \frac{(1-\eta^{RE})(1-\beta\eta^{RE})}{\eta^{RE}}\widehat{lopg}_{RW,t}^H \quad (151)$$

$$\hat{\pi}_{H,t}^{RE} = \beta E_t\hat{\pi}_{H,t+1}^{RE} + \frac{(1-\eta^{RE})(1-\beta\eta^{RE})}{\eta^{RE}}\widehat{lopg}_{H,t}^{RE} \quad (152)$$

$$\hat{\pi}_{RW,t}^{RE} = \beta E_t\hat{\pi}_{RW,t+1}^{RE} + \frac{(1-\eta^{RE})(1-\beta\eta^{RE})}{\eta^{RE}}\widehat{lopg}_{RW,t}^{RE} \quad (153)$$

- **Exchange rate policies**

$$\hat{R}_t = \beta_0 \hat{R}_{t-1} + (1-\beta_0)[\beta_1 \hat{\pi}_t^{mu} + \beta_2 \hat{y}_t^{mu}] + e_{R,t} \quad (154)$$

$$\hat{R}_t^H = \beta_0^H \hat{R}_{t-1}^H + (1-\beta_0^H)\left[\beta_1^H \hat{\pi}_t^H + \beta_2^H \hat{y}_t^H + \beta_3^H \hat{Z}_t^H\right] + e_{R,t} \quad (155)$$

$$\hat{R}_t^{RE} = \beta_0^{RE} \hat{R}_{t-1}^{RE} + (1-\beta_0^{RE})\left[\beta_1^{RE} \hat{\pi}_t^{RE} + \beta_2^{RE} \hat{y}_t^{RE} + \beta_3^{RE} \hat{Z}_t^{RE}\right] + e_{R,t} \quad (156)$$

$$\hat{R}_t^H = \beta_0^H \hat{R}_{t-1}^H + (1-\beta_0^H)\left[\beta_1^H \hat{\pi}_t^H + \beta_2^H \hat{y}_t^H + \beta_3^H \hat{Z}_{H,t}^D\right] + e_{R,t} \quad (157)$$

$$\hat{R}_t^{RE} = \beta_0^{RE} \hat{R}_{t-1}^{RE} + (1-\beta_0^{RE})\left[\beta_1^{RE} \hat{\pi}_t^{RE} + \beta_2^{RE} \hat{y}_t^{RE} + \beta_3^{RE} \hat{Z}_{RE,t}^D\right] + e_{R,t} \quad (158)$$

$$\hat{R}_t^H = \beta_0^H \hat{R}_{t-1}^H + (1-\beta_0^H)\left[\beta_1^H \hat{\pi}_t^H + \beta_2^H \hat{y}_t^H + \beta_3^H \Delta\hat{Z}_t^H\right] + e_{R,t} \quad (159)$$

$$\hat{R}_t^{RE} = \beta_0^{RE} \hat{R}_{t-1}^{RE} + (1-\beta_0^{RE})\left[\beta_1^{RE} \hat{\pi}_t^{RE} + \beta_2^{RE} \hat{y}_t^{RE} + \beta_3^{RE} \Delta\hat{Z}_t^{RE}\right] + e_{R,t} \quad (160)$$

- **States variables**

$$\hat{k}_{t+1}^H = \delta \hat{i}_t^H + (1-\delta)\hat{k}_t^H \quad (166)$$

$$\hat{k}_{t+1}^{RE} = \delta \hat{i}_t^{RE} + (1-\delta)\hat{k}_t^{RE} \quad (167)$$

$$\widehat{nw}_{t+1}^H = \upsilon^H r_K^H \left[\left(\frac{k^H}{nw^H}\right)\hat{r}_{K,t}^H + \left(1-\frac{k^H}{nw^H}\right)\left(\hat{q}_{t-1}^H + \hat{k}_t^H\right)\left(1+\gamma\left(\frac{k^H}{nw^H}-1\right)\right)\widehat{nw}_t^H\right] \quad (168)$$

$$\widehat{nw}_{t+1}^{RE} = \upsilon^{RE} r_K^{RE} \left[\left(\frac{k^{RE}}{nw^{RE}}\right)\hat{r}_{K,t}^{RE} + \left(1-\frac{k^{RE}}{nw^{RE}}\right)\left(\hat{q}_{t-1}^{RE} + \hat{k}_t^{RE}\right)\left(1+\gamma\left(\frac{k^{RE}}{nw^{RE}}-1\right)\right)\widehat{nw}_t^{RE}\right] \quad (169)$$

$$\hat{d}_t^H = \frac{1}{\beta}\hat{d}_{t-1}^H + \hat{y}_t^H - \frac{c^H}{y^H}\hat{c}_t^H - \frac{i^H}{y^H}\hat{i}_t^H - \frac{g^H}{y^H}\hat{g}_t^H - \frac{\mu_1^H}{(1-\mu_1^H-\mu_2^H)}\left(\widehat{rer}_t^H - \widehat{lopg}_t^H\right) \quad (170)$$

$$\hat{d}_t^{RE} = \frac{1}{\beta}\hat{d}_{t-1}^{RE} + \hat{y}_t^{RE} - \frac{c^{RE}}{y^{RE}}\hat{c}_t^{RE} - \frac{i^{RE}}{y^{RE}}\hat{i}_t^{RE} - \frac{g^{RE}}{y^{RE}}\hat{g}_t^{RE} - \frac{\mu_1^{RE}}{(1-\mu_1^{RE}-\mu_2^{RE})}\left(\widehat{rer}_t^{RE} - \widehat{lopg}_t^{RE}\right) \quad (171)$$

- **Stochastic shocks**

$$\Phi_t^H = \rho_\Phi \Phi_{t-1}^H + e_{\Phi,t} \quad (172)$$

$$\Phi_t^{RE} = \rho_\Phi \Phi_{t-1}^{RE} + e_{\Phi,t} \quad (172)$$

$$A_t^H = \rho_A A_{t-1}^H + e_{A,t} \quad (173)$$

$$A_t^{RE} = \rho_A A_{t-1}^{RE} + e_{A,t} \quad (174)$$

$$e_{R,t} = \rho_{e_R} e_{R,t-1} + \varepsilon_{e_{R,t}} \quad (175)$$

$$e_{g,t}^H = \rho_{e_g} e_{g,t-1}^H + \varepsilon_{e_{g,t}} \quad (176)$$

$$e_{g,t}^{RE} = \rho_{e_g} e_{g,t-1}^{RE} + \varepsilon_{e_{g,t}} \quad (177)$$

$$e_{AB_t^{RW},t} = \rho_{AB_t^{RW}} e_{AB_t^{RW},t-1} + \varepsilon_{AB_t^{RW}} \quad (178)$$

$$e_{R_t^{RW},t} = \rho_{R_t^{RW}} e_{R_t^{RW},t-1} + \varepsilon_{R_t^{RW}} \quad (179)$$

$$e_{\pi_t^{RW},t} = \rho_{\pi_t^{RW}} e_{\pi_t^{RW},t-1} + \varepsilon_{\pi_t^{RW}} \quad (180)$$

4. Calibration of structural parameters and steady-state ratios

The calibration procedure within the DSGE empirical literature is the specification of priors' beliefs. Priors are values assigned to theoretical DSGE model parameters, steady state values and exogenous variables. These priors beliefs are formed through past experience, the validity of economic theories, value judgment, stylized facts about the economy in question and existing empirical literature (An & Schorfheide 2007; Adebayo and Mordi 2010; Fernandez- Villaverde 2010). Since the literature of DSGE model is scarce in LICs, namely in Africa, the calibrated parameters sources are twofold: Most of structural parameters and all the steady-sate ratios are calibrated using Bayesian method by means of EAC data (IMF 2014) spanning from the period of 2004-2014; A couple of few parameters are related to the standard parameters on DSGE modeling. The quantitative results obtained by calibration procedure of the two open-economy DSGE model are thus summarized in Table1.

Table 1: calibrated parameters and steady-state ratios in EAMU

Parameters	Values	Description
Financial transactions		
ψ_d	0.005	Elasticity of the risk premium with respect to NFA position
γ	1	Elasticity of the EFP with respect to firm's leverage ratio
$\frac{K}{NW}$	3.49	Steady-state capital net worth ratio
$R_K - R$	0.06	Steady state quarterly risk spread
Households		
β	0.97	Subjective discount factor
φ	1	Inverse elasticity of labor supply
σ	0.5	Inverse intertemporal elasticity of substitution in consumption
μ_1	0.14	Share of imported goods from the rest of EAC
μ_2	0.36	Share of imported goods from the rest of the world
θ	0.98	Elasticity o substitution between domestic and imported goods
$\frac{C}{Y}$	0.87	Consumption to GDP ratio
Production sector		
$(1-\nu)$	0.02	Entrepreneurs probability of leaving the economy
α	0.50	Capital contribution to production function
δ	0.02	Capital depreciation rate
ψ_I	0.2	Capital adjustment cost parameter
η	0.8	Probability of not adjusting prices

$\frac{\chi}{\chi-1}$	0.78	Steady-state mark-up
Exchange rate policies		
β_0	0.5	Smoothing coefficient
β_1	1.5	Inflation stabilizing coefficient
β_2	0.5	Output stabilizing coefficient
β_3	$0.3 \leq \beta_3 < 0.7$	NEER targeting coefficient
Government		
G/Y	0.24	Public expenditure to GDP ratio
T/Y	0.17	Lump-sum transfer to GDP ratio

5. Simulations of counterfactual scenarios for EAMU effectiveness

The quantitative results of the model are also derived by the simulations approach by means of Matlab and Dynare softwares, using the above-calibrated parameters. Under the assumption that the EAC Monetary Union has been settled in EAC, the aim is to assess the exchange policy that can ensure the effectiveness of the EAC Monetary Union and be costless for the entire partner states. Thus, in the one hand we evaluate the dynamics of the theoretical model when the EAC Monetary Union faced, financial shock (plot 1), supply shock (plot 2) and demand shock (plot3) under alternatives exchange rate policies. In the other linking, we perform the welfare analysis between the different exchange rate policies for monetary union effectiveness. Throughout the paper, in each plot, the blue line reflects the dynamic of the model when the shock occurs under a managed exchange rate policy or a peg exchange rate policy whereas the red line reflects the dynamic of the model when the shock occurs under a pure floating exchange rate policy.

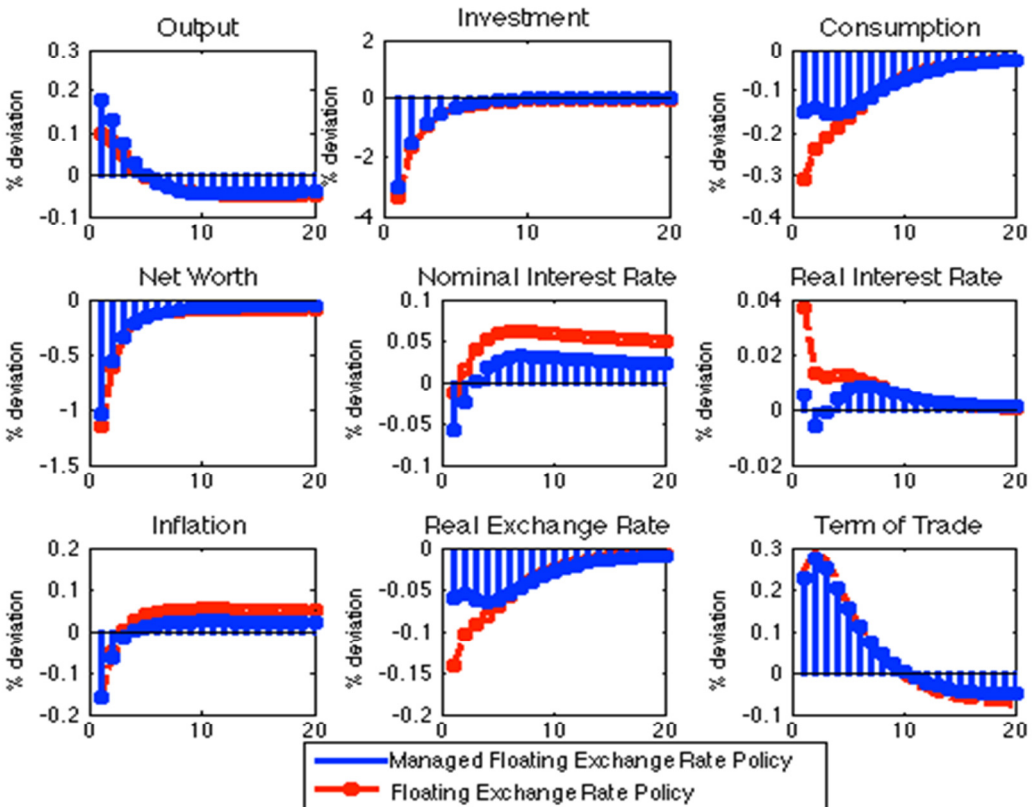
5.1. Supply shock under alternatives exchange rate policies in EAMU

Plot 1 displays the dynamics of output, investment, consumption, net worth, nominal interest rate, real interest rate, inflation, real exchange rate and term of trade, of EAC monetary Union in response to a one standard deviation of positive productive shock, under alternatives exchange rate policies.

The positive domestic productivity shock induces an increase of output in the union. The hump-shaped pattern of output is generated by the real and nominal rigidities in the model. This supply shock leads to a decrease in marginal cost and inflation. Under managed floating policy, to stabilize the expected inflation, the monetary authority

revises downwardly the nominal interest rates. But the decline of nominal interest rate is insufficient to offset the decrease of inflation, as result the real interest rate rises up. Consequently, decline in consumption and the appreciation of the current real effective exchange rate are observed[13]. However, the appreciation of real effective exchange rate is not enough to substantially decrease the current value of the debt denominated in foreign currency, leading to decrease the net worth and that is unfavorable to investment. The share of investment purchased abroad remains expensive in domestic currency, which decrease investment more.

Plot 1 : Effects of a positive productivity shock under alternatives exchange rate policies in EAMU



The reactions of the monetary authority introduce a difference between the two exchange rate policies. Indeed, in the case of managed exchange rate policy, after the positive productivity shock, the appreciation pressure of the exchange rate leads the

[13] The real effective exchange rate (REER) represents an average of the bilateral real effective exchange rate between the economy and each of its trading partners, weighted by the respective trade shares of each partner.

monetary authority to lower the nominal interest rate. In contrast, under the pure floating exchange rate policy, the monetary authority does not react to change in the nominal effective exchange rate and the nominal interest rate remains unchanged. An initial drop of nominal interest rate is caused by the decline of inflation. Consequently, inflation decreases and the real interest rate increases more under pure floating exchange rate policy than under managed floating exchange rate policy. This relative increase in real interest rate under the pure floating exchange rate regime leads to the larger drop in consumption, the more appreciation of real effective exchange rate, and the greater increase in output.

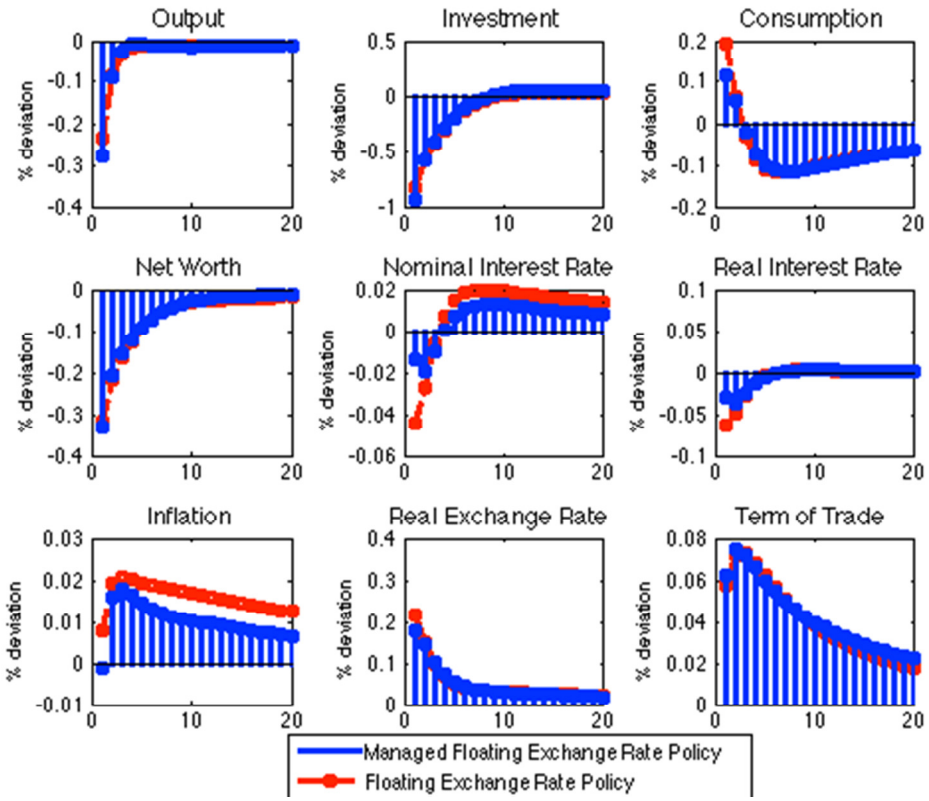
Overall, this analysis of impulse responses of different macroeconomic variables demonstrates that in EAMU shock effects are more cushioned under pure floating exchange rate policy than under the managed floating exchange rate policy facing a domestic supply shock.

5.2. Demand shocks under alternatives exchange rate policies in EAMU

Plot 2 displays the dynamics of output, investment, consumption, net worth, nominal interest rate, real interest rate, inflation, real exchange rate and term of trade, of EAC monetary Union in response to a one standard deviation of negative foreign demand shock, under alternatives exchange rate policies.

The negative foreign demand shock negatively affects both investment and output. The entrepreneurs demand for loans decreases and this induces to decrease the real interest rate. Moreover, to cope with contractionary effects of the shock and given the unchanged expected inflation, monetary authority decreases the nominal interest rate. As response, the current inflation rate increases, the real interest rate goes down and leads to the increase of consumption. By the uncovered interest rate parity, this leads to the real effective exchange rate depreciation. This real depreciation increases the cost of investment purchased abroad and decrease the net worth of entrepreneurs since the value in local currency of the debt denominated in foreign currency increases. Those developments increase the risk premium, which further negatively affects the investment.

Plot 2 : Effects of a negative foreign demand shock under alternatives exchange rate policies in EAMU



By analyzing each the exchange rate policy involved, it appears that the pure floating exchange rate policy provide more stability than the managed floating exchanged rate policy. In fact, in the case of the managed exchange rate policy, given the contraction in foreign demand and the low level of expected inflation, the monetary authority must decrease less its nominal interest rate because of the current and expected depreciation pressure. Therefore, the current inflation increases more under pure floating exchange rate policy than under managed floating exchange rate policy. As result, under the managed exchange rate policy the decrease in real interest rate is limited and the effective real exchange rate is more depreciated. Consequently, output decreases more under managed floating exchange rate policy.

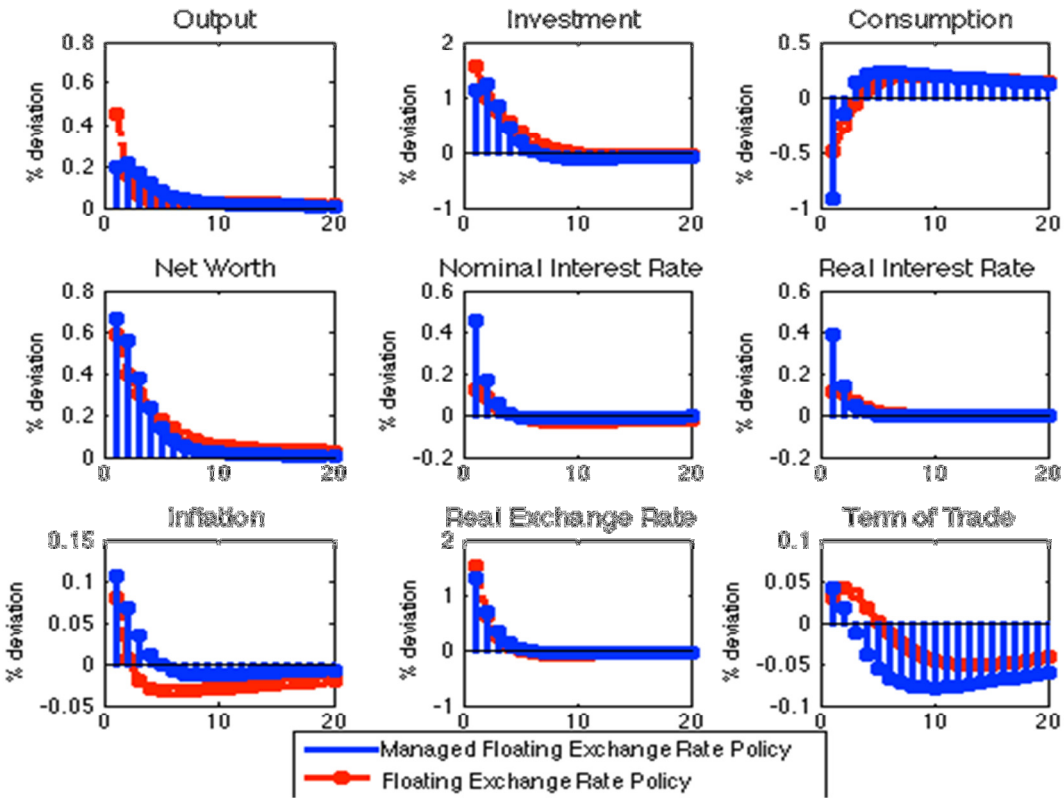
Overall, results reveals that, in the EAMU, managed exchange rate policy is less desirable than pure floating exchange rate policy in presence of foreign demand shock.

5.3. Financial shock under alternatives exchange rate policies in EAMU

Plot 3 displays the dynamics of output, investment, consumption, net worth, interest rates, inflation, real exchange rate and net exports, of EAC monetary Union in response to a one standard deviation positive economy risk premium shock, under alternatives exchange rate policies.

External financial condition affects the EAC monetary union via the domestic debt denominated in foreign currency. The positive risk premium shock increases the external financial premium, which lowers the external borrowing and leads to the increase of domestic nominal and real interest rates. Consequently, the depreciation of the current real effective exchange rate is observed. However, the depreciation of real effective exchange rate is not enough to substantially increase the current value of the debt denominated in foreign currency, the entrepreneurs' net worth remains positive. The modest increase of entrepreneurial net worth is favorable to investment and output.

Plot 3 : Effects of a positive risk premium shock under alternatives exchange rate policies in EAMU



By looking in each of exchange rate policy involved, it appears that the pure floating exchange rate policy provide more stability than the managed floating exchanged rate policy. In fact, the current inflation increases more under managed floating exchange rate policy than under pure floating exchange rate policy. The nominal and real interest rate increases more under the managed floating exchange rate than under the pure floating exchange rate. Whereas, the investment and output increase more under the pure floating exchange rate regime than under the managed exchanged rate regime.

Overall, we can say that in EAC Monetary union, pure floating exchange rate policy is a better absorber of real foreign shock, namely financial shock, than the managed floating exchange rate policy.

6. Welfare analysis of alternative exchange rate policies in EAMU

To assess the performance of alternatives policies, the basic New Keynesian model makes use of some quantitative criterion. The seminal work of Rotenberg and Woodford (1999) introduced the welfare-based criterion as a formal criterion of policies performance evaluation. The criterion is based on the second order approximation to the utility loses experienced by the representative consumer as a consequence of deviations from the efficient allocation.

The welfare costs can thus be expressed as:

$$\mathbb{W}\big((1+\varpi)C,N\big) = E\big(\mathbb{W}(C_t,N_t)\big) = \mathbb{W}\big((1+\varpi^M)C,N\big) + \mathbb{W}\big((1+\varpi^V)C,N\big) \tag{181}$$

The welfare costs implies thus the fraction of steady state consumption that households would be willing to decline in order to avoid the effect of shocks.

A second-order Taylor approximation of the unconditional expectation of utility function around steady state yields:

$$\mathbb{W}\big((1+\varpi^{M})C,N\big)+\mathbb{W}\big((1+\varpi^{V})C,N\big)=$$
$$\mathbb{W}(C,N)+C^{1-\sigma}E\big(\hat{C}_t\big)-\frac{1}{2}\sigma C^{1-\sigma}V\big(\hat{C}_t\big)-N^{1+\omega}E\big(\widehat{N}_t\big)-\frac{1}{2}\omega N^{1+\omega}V\big(\widehat{N}_t\big) \quad (182)$$

ϖ^{M} is the component of the welfare metric that measures the effect of the shocks on the means of the variables and is defined by:

$$\varpi^{M}=\Big[1+(1-\sigma)E\big(\hat{C}_t\big)-\frac{(1-\sigma)N^{1+\omega}}{C^{1-\sigma}}E\big(\widehat{N}_t\big)\Big]^{\frac{1}{1-\sigma}}-1 \quad (183)$$

ϖ^{V}represents the component of the welfare metric that measures the effect of the shocks on the variances of the variables and is given by:

$$\varpi^{V}=\Big[1-\frac{1}{2}\sigma(1-\sigma)V\big(\hat{C}_t\big)-\frac{1}{2}\omega\frac{(1-\sigma)N^{1+\omega}}{C^{1-\sigma}}V\big(\widehat{N}_t\big)\Big]^{\frac{1}{1-\sigma}}-1 \quad (184)$$

Tables (2) states the welfare loss for the EAC monetary Union after the supply shock, the demand shock and the financial shock. The results suggest that the pure floating exchange rate policy is a better policy in term of welfare stability facing demand shock and foreign shock, whereas, the managed exchanged rate performs well to cushion supply shock and domestic shock.

Table 2: Welfare losses across alternatives exchange rate policies in the EAMU (%)

Nature of Shocks	**Managed Floating Exchange Rate Policy**	**Pure Floating Exchange Rate Policy**
Supply shock	0.40	0.72
Demand Shock	0.30	0.23
Financial Shock	0.70	0.42

7. Partner States case study

7.1. Burundi

7.1.1. Calibration of parameters

Most of structural parameters and all the steady-sate ratios are calibrated using Bayesian method by means of Burundi data (IMF 2014) spanning from the period of 2004-2014. The quantitative results obtained by calibration procedure of the two open-economy DSGE model for Burundi are summarized in Table3.

Table 3: calibrated parameters and steady-state ratios in Burundi

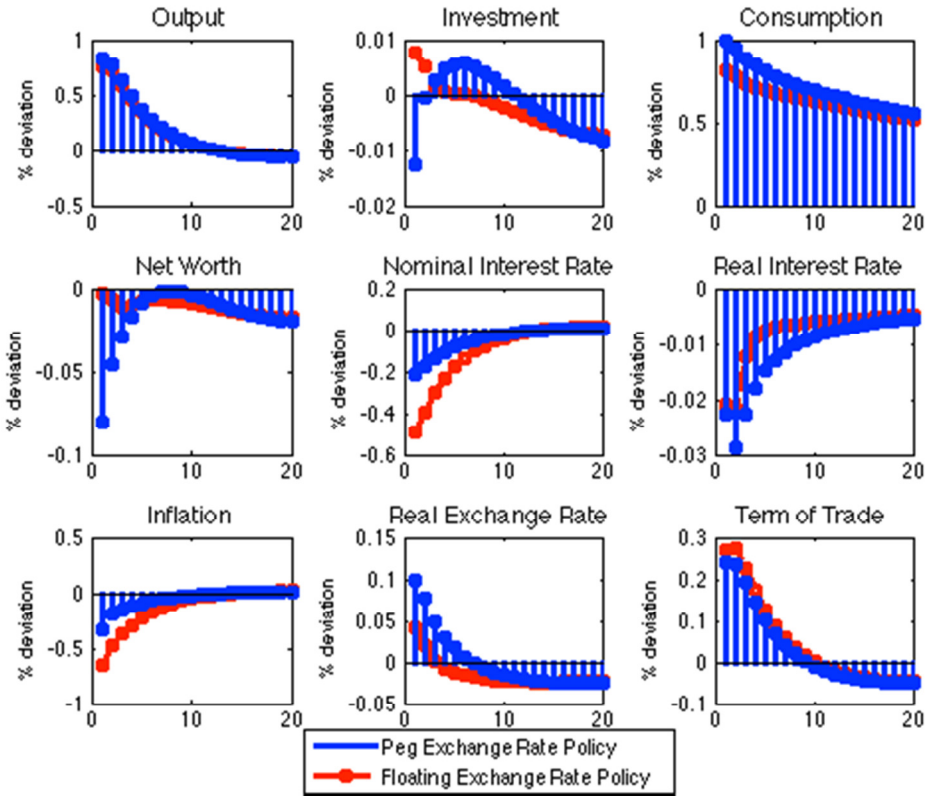
Parameters	Values	Description
Financial transactions		
ψ_d	0.003	Elasticity of the risk premium with respect to NFA position
γ	0.7	Elasticity of the EFP with respect to firm's leverage ratio
$\frac{K}{NW}$	3	Steady-state capital net worth ratio
$R_K - R$	0.04	Steady state quarterly risk spread
Households		
β	0.91	Subjective discount factor
φ	1	Inverse elasticity of labor supply
σ	0.5	Inverse intertemporal elasticity of substitution in consumption
μ_1	0.14	Share of imported goods from the rest of EAC
μ_2	0.36	Share of imported goods from the rest of the world
θ	0.44	Elasticity o substitution between domestic and imported goods
$\frac{C}{Y}$	0.32	Consumption to GDP ratio
Production sector		
$(1-\nu)$	0.02	Entrepreneurs probability of leaving the economy
α	0.50	Capital contribution to production function
δ	0.02	Capital depreciation rate
ψ_I	0.2	Capital adjustment cost parameter
η	0.6	Probability of not adjusting prices
$\frac{\chi}{\chi-1}$	0.78	Steady-state mark-up
Exchange rate policies		
β_0	0.1	Smoothing coefficient
β_1	1.8	Inflation stabilizing coefficient
β_2	0.4	Output stabilizing coefficient
β_3	1	NEER targeting coefficient
Government		
G/Y	0.34	Public expenditure to GDP ratio
T/Y	0.14	Lump-sum transfer to GDP ratio

7.1.2. Supply shock under Peg exchange rate policy versus floating exchange rate policy in Burundi

Plot 4 displays the dynamics of macroeconomic variables in response to a one standard deviation of positive productive shock in Burundi, under peg exchange rate policy and pure floating exchange rate policy.

The positive domestic productivity shock induces an increase of output in Burundi. Under peg exchange rate policy, to stabilize the expected inflation, the monetary authority intervenes and revises downwardly the nominal interest rates. The decline of nominal interest rate is more important as the decrease of inflation, leading consequently to the decline of real interest rate and the depreciation of the current real effective exchange rate. This depreciation of real effective exchange rate lower the entrepreneurs' net worth because the current value of the debt denominated in foreign currency increases and that affects negatively the investment. Moreover the share o investment purchased abroad is expensive in domestic currency, which lowers investment more.

Plot 4 : Effects of a positive productivity shock under Peg exchange rate policy versus pure floating exchange rate policy in Burundi



In the case of the pure exchange rate policy, the impossibility for the monetary authority of lowering the nominal interest rate and letting the real exchange rate to depreciate, leads to the amplification of the negative response of inflation. As result, real interest rate deeply declines, but the resulting depreciation of real effective exchange rate is limited relative to the peg exchange rate case. This limited depreciation of the real exchange rate stabilizes the entrepreneurs net worth around the steady state and consequently positively affects the investment.

Overall, in Burundi, under the peg exchange rate policy, the effect of a positive supply shock decreases investment. Whereas under the pure floating exchange rate policy, the effect of positive demand shock significantly increases investment. Hence, shock effects are more cushioned under pure floating exchange rate policy than under the peg exchange rate policy when Burundi faces a domestic supply shock.

7.1.3. Demand shocks under Peg exchange rate policy versus floating exchange rate policy

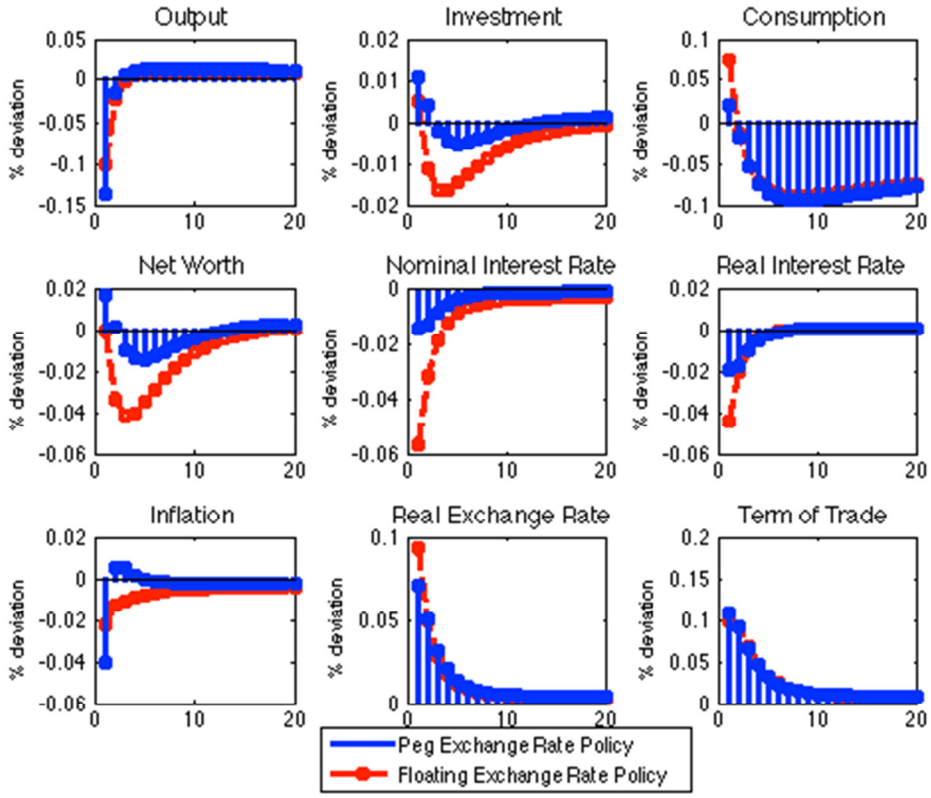
Plot 5 displays the dynamics of macroeconomic variables in response to a one standard deviation of negative foreign demand shock in Burundi, under peg exchange rate policy and pure floating exchange rate policy.

The negative foreign demand shock induces an adverse effect on output under both exchange rate policies. Under peg exchange rate policy, the monetary authority intervenes and revises downwardly the nominal interest rates, leading consequently to the decline of real interest rate. As result, the consumption increases and the current real effective exchange rate depreciate. However, the depreciation of real effective exchange rate is insufficient to lower the entrepreneurs' net worth and in turn stabilize the net worth around the steady state. In response, investment increases moderately.

In the case of the pure exchange rate policy, following the negative foreign demand shock, the nominal interest rate is deeply and negatively affected. Given the current deflation, the real interest rate decrease further and induces the depreciation of the real effective exchange rate. However, the resulting depreciation of real effective exchange rate is limited as the peg exchange rate case. This limited depreciation of

the real exchange rate stabilizes the entrepreneurs net worth around the steady state and consequently positively affects the investment.

Plot 5 : Effects of a negative foreign demand shock under peg exchange rate policy versus pure floating exchange rate policy in Burundi

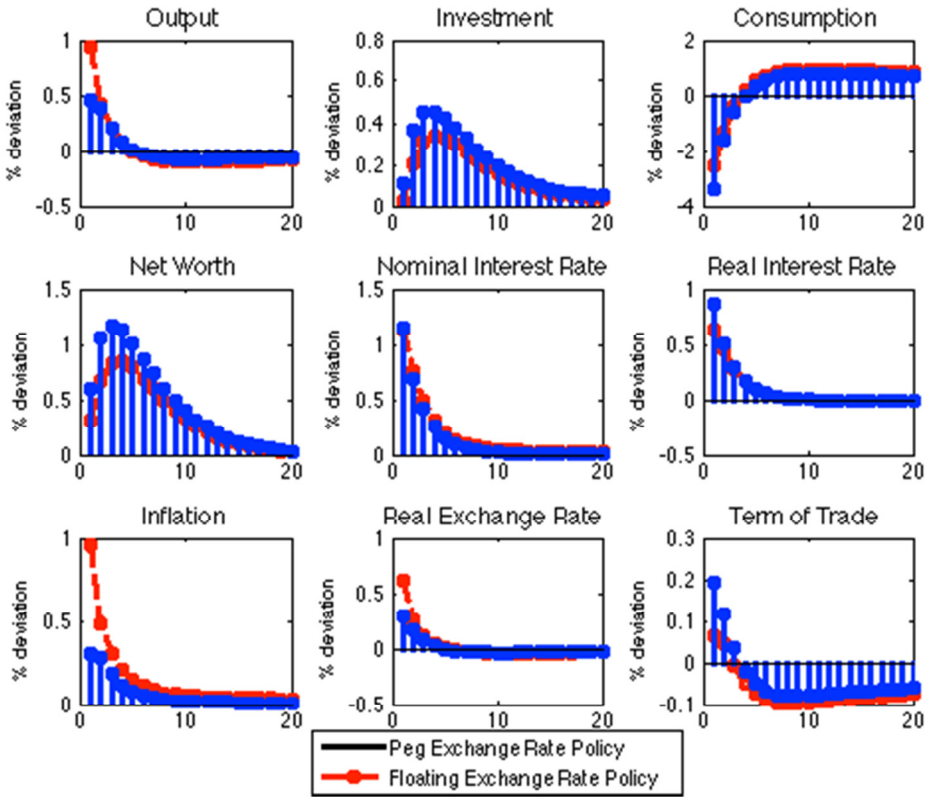


Overall, the negative foreign demand shock has adverse effects in Burundi. The shock reduces output and increases deflation under the both exchange rate policies. However, the negative effects are more pronounced under the peg exchange rate policy than under the pure floating exchange rate policy. Hence, in Burundi, peg exchange rate policy is less desirable than pure floating exchange rate policy in presence of foreign demand shock.

7.1.4. Financial shock under Peg exchange rate policy versus floating exchange rate policy

Plot 6 displays the dynamics of macroeconomic variables in response to a one standard deviation of positive risk premium shock in Burundi, under peg exchange rate policy and pure floating exchange rate policy.

Plot 6 : Effects of a positive risk premium shock under Peg exchange rate policy versus pure floating exchange rate policy in Burundi.



The positive risk premium shock increases the external financial premium, which lowers the external borrowing and leads to the increase of domestic nominal and real interest rates. Consequently, the depreciation of the current real effective exchange rate is observed. However, the depreciation of real effective exchange rate is not enough to substantially increase the current value of the debt denominated in foreign currency, the entrepreneurs' net worth remains positive. The modest increase of entrepreneurial net worth is favorable to investment and output.

By looking in each of exchange rate policy involved, it appears that the pure floating exchange rate policy provide more stability than the peg exchanged rate policy. In fact, the output increases less under peg exchange rate policy than under pure floating

exchange rate policy. The nominal and real interest rate increases more under the peg exchange rate than under the pure floating exchange rate. The consumption decreases more under the peg exchange rate regime than under the pure floating exchanged rate regime. Overall, for Burundi, pure floating exchange rate policy is a better absorber of financial shock, than the peg floating exchange rate policy.

7.1.5. Welfare analysis under Peg exchange rate policy versus pure floating exchange rate policy in Burundi

Tables (4) reveals the welfare loss for Burundi after the supply shock, the demand shock and the financial shock. The results suggest that the pure floating exchange rate policy performs better than the peg exchange rate policy in term of welfare stability facing foreign and domestic shocks.

Table 4: Welfare losses under Peg exchange rate policy versus pure floating exchange rate policy in Burundi (%)

Nature of Shocks	**Peg Exchange Rate Policy**	**Pure Floating Exchange Rate Policy**
Supply shock	0.050	0.020
Demand Shock	0.058	0.033
Financial Shock	0.056	0.032

7.2. Kenya

7.2.1. Calibration of parameters

Most of structural parameters and all the steady-sate ratios are calibrated using Bayesian method by means of Kenya data (IMF 2014) spanning from the period of 2004-2014. The quantitative results obtained by calibration procedure of the two open-economy DSGE model for Burundi are summarized in Table 5.

Table 5: calibrated parameters and steady-state ratios in Kenya

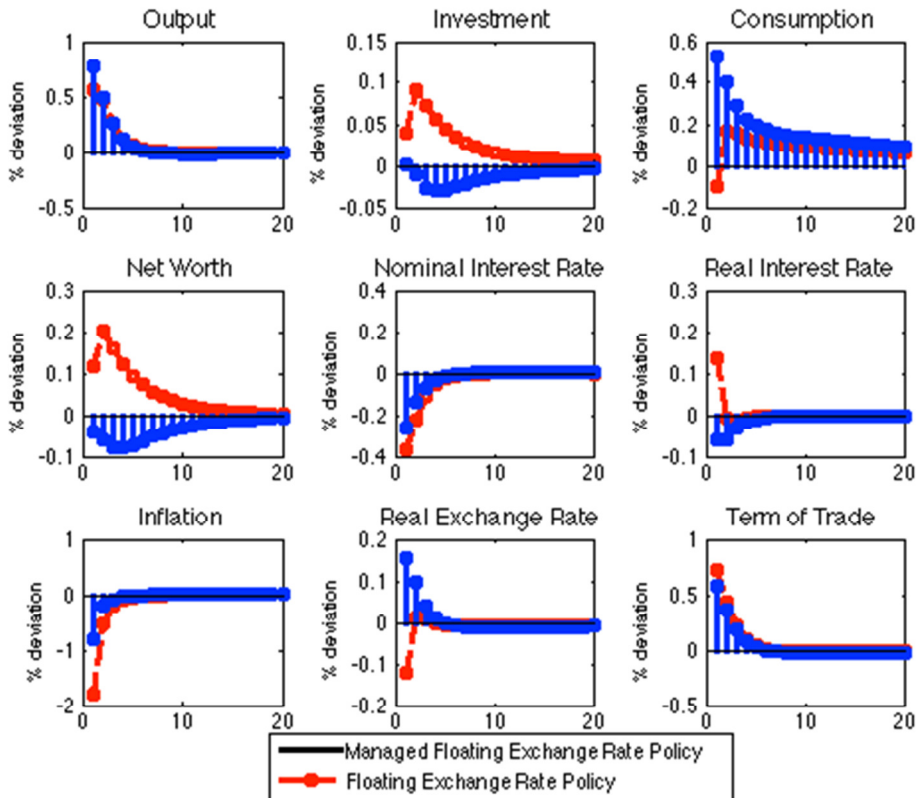
Parameters	Values	Description
Financial transactions		
ψ_d	0.005	Elasticity of the risk premium with respect to NFA position
γ	1	Elasticity of the EFP with respect to firm's leverage ratio
$\frac{K}{NW}$	3.48	Steady-state capital net worth ratio
$R_K - R$	0.05	Steady state quarterly risk spread
Households		
β	0.97	Subjective discount factor
φ	1	Inverse elasticity of labor supply
σ	0.5	Inverse intertemporal elasticity of substitution in consumption
μ_1	0.14	Share of imported goods from the rest of EAC
μ_2	0.36	Share of imported goods from the rest of the world
θ	0.9	Elasticity o substitution between domestic and imported goods
$\frac{C}{Y}$	0.30	Consumption to GDP ratio
Production sector		
$(1-\nu)$	0.02	Entrepreneurs probability of leaving the economy
α	0.50	Capital contribution to production function
δ	0.02	Capital depreciation rate
ψ_I	0.2	Capital adjustment cost parameter
η	0.4	Probability of not adjusting prices
$\frac{\chi}{\chi-1}$	0.78	Steady-state mark-up
Exchange rate policies		
β_0	0.4	Smoothing coefficient
β_1	1.9	Inflation stabilizing coefficient
β_2	0.6	Output stabilizing coefficient
β_3	0.5	NEER targeting coefficient
Government		
G/Y	0.28	Public expenditure to GDP ratio
T/Y	0.23	Lump-sum transfer to GDP ratio

7.2.2. Supply shocks under managed floating exchange rate versus pure floating exchange rate policy in policies in Kenya

Plot 7 displays the dynamics of macroeconomic variables in response to a one standard deviation of positive productive shock, under alternatives exchange rate policies.

The positive domestic productivity shock induces an increase of output and investment in Kenya. This supply shock leads to a decrease in marginal cost and inflation. Under managed floating policy, to stabilize the expected inflation, the monetary authority revises downwardly the nominal interest rates. The nominal interest rate declines as much as the inflation does, as result the real interest rate declines. Consequently, the depreciation of the current real effective exchange rate is observed. However, the depreciation of the real effective exchange rate increases the cost of investment purchased abroad and decreases the net worth of entrepreneurs. Both developments lead to a null investment.

Plot 7: Effects of a positive productivity shock under managed floating exchange rate policy versus pure floating exchange rate policy in Kenya



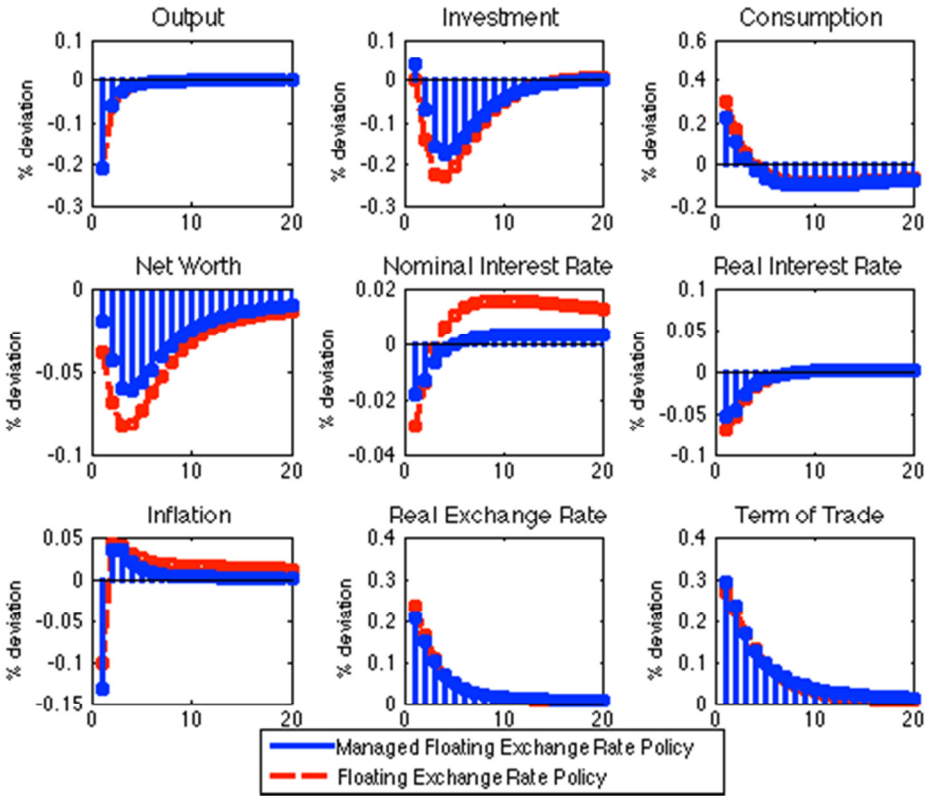
Similarly, under the pure floating exchange rate policy, the monetary authority does not react to change in the nominal effective exchange rate and the nominal interest rate remains unchanged. An initial drop of nominal interest rate is caused by the decline of inflation. Consequently, the real interest rate increases under pure floating exchange rate policy whereas it decreases under managed floating exchange rate policy. This relative increase in real interest rate under the pure floating exchange rate regime leads to the drop in consumption, the appreciation of real effective exchange rate, and the greater increase in output. Overall, in Kenya, shock effects are more cushioned under pure floating exchange rate policy than under the managed floating exchange rate policy facing a domestic supply shock.

7.2.3. Demand shocks under managed floating exchange rate versus pure floating exchange rate policy in policies in Kenya

Plot 8 displays the dynamics of output, investment, consumption, net worth, nominal interest rate, real interest rate, inflation, real exchange rate and term of trade, of EAC monetary Union in response to a one standard deviation of negative foreign demand shock, under alternatives exchange rate policies.

The negative foreign demand shock negatively affects output under both exchange rate policies. The entrepreneurs demand for loans decreases and this induces to decrease the real interest rate. Moreover, to cope with contractionary effects of the shock and given the unchanged expected inflation, monetary authority decreases the nominal interest rate under managed exchange rate policy. As response, the current inflation rate decreases, the real interest rate goes down and leads to the increase of consumption. By the uncovered interest rate parity, this leads to the real effective exchange rate depreciation. This real depreciation increases the cost of investment purchased abroad and decrease the net worth of entrepreneurs since the value in local currency of the debt denominated in foreign currency increases. By analyzing each of the exchange rate policy involved, it appears that the pure floating exchange rate policy provide more stability than the managed floating exchanged rate policy in Kenya facing negative foreign demand shock.

Plot 8: Effects of a negative foreign demand shock under managed floating exchange rate policy versus pure floating exchange rate policy in Kenya



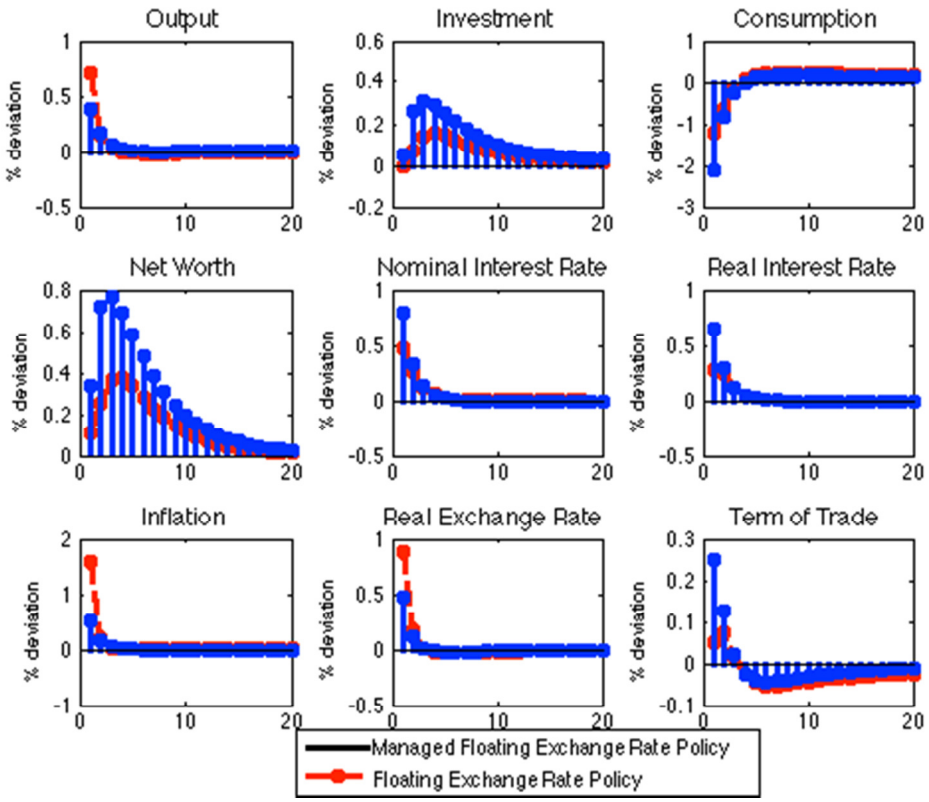
7.2.4. Financial shock under managed floating exchange rate versus pure floating exchange rate policy in Kenya

Plot 9 displays the dynamics of macroeconomic variables in Kenya in response to a one standard deviation positive economy risk premium shock, under alternatives exchange rate policies.

The positive risk premium shock increases the external financial premium, which lowers the external borrowing and leads to the increase of domestic nominal and real interest rates. Consequently, the depreciation of the current real effective exchange rate is observed. However, the depreciation of real effective exchange rate is not enough to substantially increase the current value of the debt denominated in foreign currency, the entrepreneurs' net worth remains positive. The modest increase of entrepreneurial net worth is favorable to investment and output. By looking in each of exchange rate policy involved, it appears that the pure floating exchange rate policy provide more stability than the managed floating exchanged rate policy. In fact, the

nominal and real interest rate increases more under the managed floating exchange rate than under the pure floating exchange rate. Whereas, the investment and output increase more under the pure floating exchange rate regime than under the managed exchanged rate regime. Overall, in Kenya, pure floating exchange rate policy is a better absorber of financial shock, than the managed floating exchange rate policy.

Plot 9 : Effects of a positive risk premium shock under managed floating exchange rate policy versus pure floating exchange rate in Kenya



7.2.5. Welfare analysis under managed floating exchange rate policy versus pure floating exchange rate policy in Kenya

Tables (6) reveals the welfare loss in Kenya after the supply shock, the demand shock and the financial shock. The results suggest that the pure floating exchange rate policy performs better than the managed floating exchange rate policy in term of welfare stability facing foreign and domestic shocks.

Table 6: Welfare losses under managed floating exchange rate policy versus pure floating exchange rate policy in Kenya (%)

Nature of Shocks	**Managed Floating Exchange Rate Policy**	**Pure Floating Exchange Rate Policy**
Supply shock	0.072	0.021
Demand Shock	0.073	0.022
Financial Shock	0.070	0.020

7.3. Rwanda

7.3.1. Calibration of parameters

Most of structural parameters and all the steady-sate ratios are calibrated using Bayesian method by means of Rwanda data (IMF 2014) spanning from the period of 2004-2014. The quantitative results obtained by calibration procedure of the two open-economy DSGE model for Burundi are summarized in Table 7.

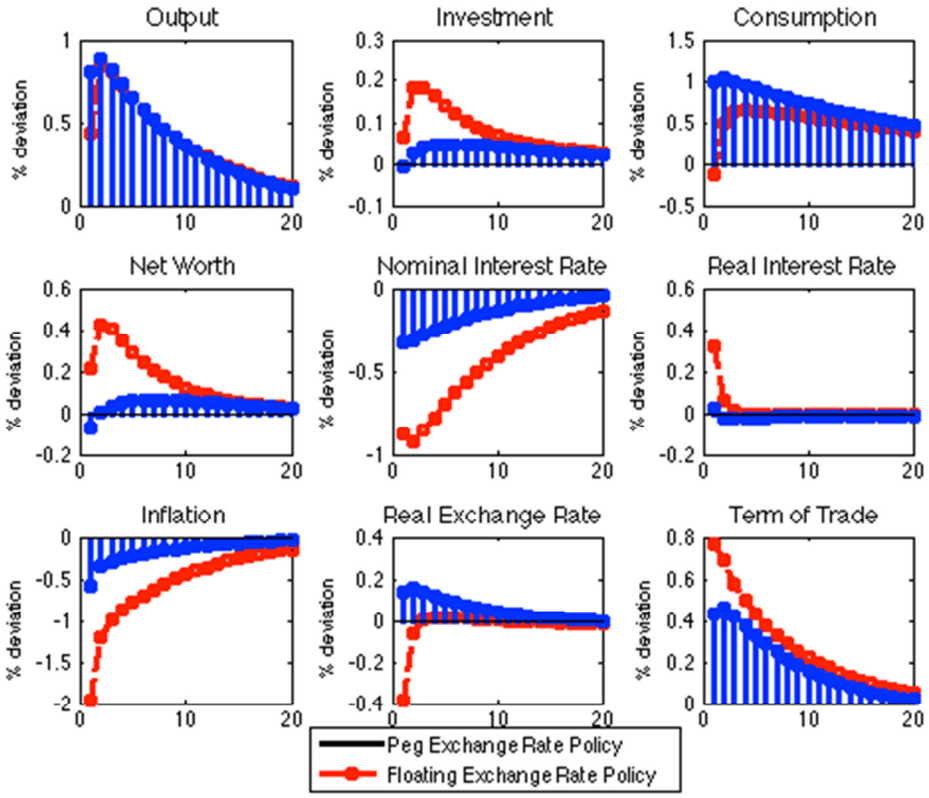
Table7: calibrated parameters and steady-state ratios in Rwanda

Parameters	Values	Description
Financial transactions		
ψ_d	0.004	Elasticity of the risk premium with respect to NFA position
γ	0.86	Elasticity of the EFP with respect to firm's leverage ratio
$\frac{K}{NW}$	3.40	Steady-state capital net worth ratio
$R_K - R$	0.04	Steady state quarterly risk spread
Households		
β	0.98	Subjective discount factor
φ	1	Inverse elasticity of labor supply
σ	0.5	Inverse intertemporal elasticity of substitution in consumption
μ_1	0.14	Share of imported goods from the rest of EAC
μ_2	0.36	Share of imported goods from the rest of the world
θ	0.5	Elasticity o substitution between domestic and imported goods
$\frac{C}{Y}$	0.32	Consumption to GDP ratio
Production sector		
$(1-\nu)$	0.02	Entrepreneurs probability of leaving the economy
α	0.50	Capital contribution to production function
δ	0.02	Capital depreciation rate
ψ_I	0.2	Capital adjustment cost parameter
η	0.5	Probability of not adjusting prices
$\frac{\chi}{\chi-1}$	0.78	Steady-state mark-up
Exchange rate policies		
β_0	0.4	Smoothing coefficient
β_1	1.4	Inflation stabilizing coefficient
β_2	0.5	Output stabilizing coefficient
β_3	1	NEER targeting coefficient
Government		
G/Y	0.26	Public expenditure to GDP ratio
T/Y	0.14	Lump-sum transfer to GDP ratio

7.3.2. Supply shocks under alternatives peg exchange rate policy versus floating exchange rate policy in Rwanda

Plot 10 displays the dynamics of macroeconomic variables in response to a one standard deviation of positive productive shock in Rwanda, under peg exchange rate policy and pure floating exchange rate policy.

Plot 10: Effects of a positive productivity shock under Peg exchange rate policy versus pure floating exchange rate policy in Rwanda



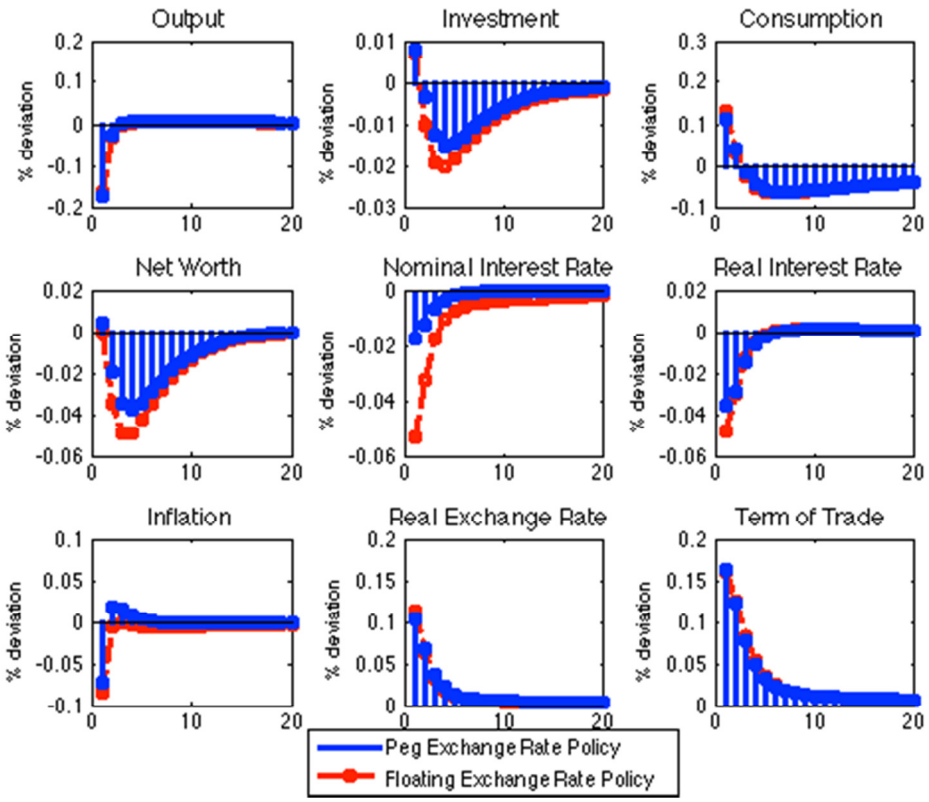
A persistent growth in factor productivity leads to augment in equilibrium investment and output in Burundi. This shock induces a decrease of marginal cost and inflation. Under peg exchange rate policy, to stabilize the expected inflation, the monetary authority intervenes and revises downwardly the nominal interest rates. The decline of nominal interest rate leads to stabilize the real interest rate and the current real effective exchange rate depreciate moderately. This depreciation of real effective exchange rate lowers moderately the entrepreneurs' net worth and affects negatively the investment. Likewise, in the case of the pure exchange rate policy, the impossibility for the monetary authority to intervenes and stabilizes the nominal

interest rate leads the nominal interest to decline less than the inflation. As result, the real interest rate increases. Hence the decrease of consumption and the appreciation of the current real effective exchange rate are observed. The appreciation of the real exchange rate increases the net worth and that is favorable to investment. Overall, in Rwanda, the positive effect of positive productivity shock is more important under the pure floating exchange rate policy rather than the peg exchange rate policy.

7.3.3. Demand shocks under peg exchange rate policy exchange rate policy versus floating exchange rate policy in Rwanda

Plot 11 displays the dynamics of macroeconomic variables in response to a one standard deviation of negative foreign demand shock in Rwanda, under peg exchange rate policy and pure floating exchange rate policy.

Plot 11: Effects of a negative foreign demand shock under peg exchange rate policy versus floating exchange rate policy in Rwanda



The negative foreign demand shock induces an adverse effect on output under both exchange rate policies. Under peg exchange rate policy, the monetary authority

intervenes and revises downwardly the nominal interest rates, leading consequently to the decline of real interest rate. As result, the consumption increases and the current real effective exchange rate depreciate. The depreciation of real effective exchange rate lowers the entrepreneurs' net worth. Similarly, in the case of the pure exchange rate policy, following the negative foreign demand shock, the nominal interest rate is deeply and negatively affected. Given the current deflation, the real interest rate decrease further and induces the depreciation of the real effective exchange rate. The resulting depreciation of real effective exchange rate leads to a null entrepreneurs net worth. Overall, the negative foreign demand shock has adverse effects in Rwanda under both exchange rate policies. But the pure floating exchange rate policy performs quite more than peg exchange rate policy to inhibit the effects of shock.

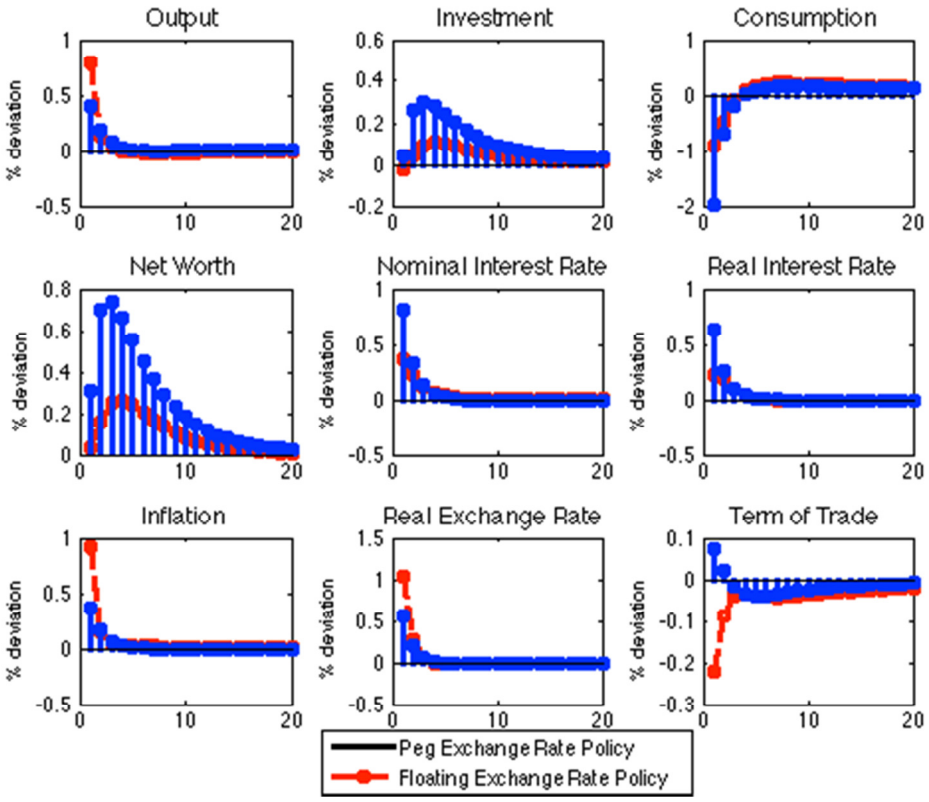
7.3.4. Financial shock under Peg exchange rate poly versus floating exchange rate policy in Rwanda

Plot 12 displays the dynamics of macroeconomic variables in response to a one standard deviation of positive risk premium shock in Rwanda, under peg exchange rate policy and pure floating exchange rate policy.

The positive risk premium shock increases the external financial premium, which lowers the external borrowing and leads to the increase of domestic nominal and real interest rates. Consequently, the depreciation of the current real effective exchange rate is observed. The depreciation of real effective exchange rate increases the net worth because the current value of the debt denominated in foreign currency decreases. This modest increase of entrepreneurial net worth is favorable to investment and output.

Looking on each of exchange rate policies involved, it appears that the pure floating exchange rate policy provide more stability than the peg exchanged rate policy. In fact, the output increases less under peg exchange rate policy than under pure floating exchange rate policy. The nominal and real interest rate increases more under the peg exchange rate than under the pure floating exchange rate. The consumption decreases more under the peg exchange rate regime than under the pure floating exchanged rate regime. Overall, for Rwanda, pure floating exchange rate policy is a better absorber of financial shock, than the peg floating exchange rate policy.

Plot 12 : Effects of a positive risk premium shock under Peg exchange rate policy versus floating exchange rate policy in Rwanda



7.3.5. Welfare analysis under Peg exchange rate policy versus pure floating exchange rate policy in Rwanda

Tables (8) reveals the welfare loss for Rwanda after the supply shock, the demand shock and the financial shock. The results suggest that the pure floating exchange rate policy performs better than the peg exchange rate policy in term of welfare stability facing foreign and domestic shocks.

Table 8: Welfare losses under Peg exchange rate policy versus pure floating exchange rate policy in Rwanda (%)

Nature of Shocks	**Peg Exchange Rate Policy**	**Pure Floating Exchange Rate Policy**
Supply shock	0.16	0.050
Demand Shock	0.18	0.055
Financial Shock	0.14	0.058

7.4. Tanzania

7.4.1. Calibration of parameters

Most of structural parameters and all the steady-sate ratios are calibrated using Bayesian method by means of Tanzania data (IMF 2014) spanning from the period of 2004-2014. The quantitative results obtained by calibration procedure of the two open-economy DSGE model for Burundi are summarized in Table 9.

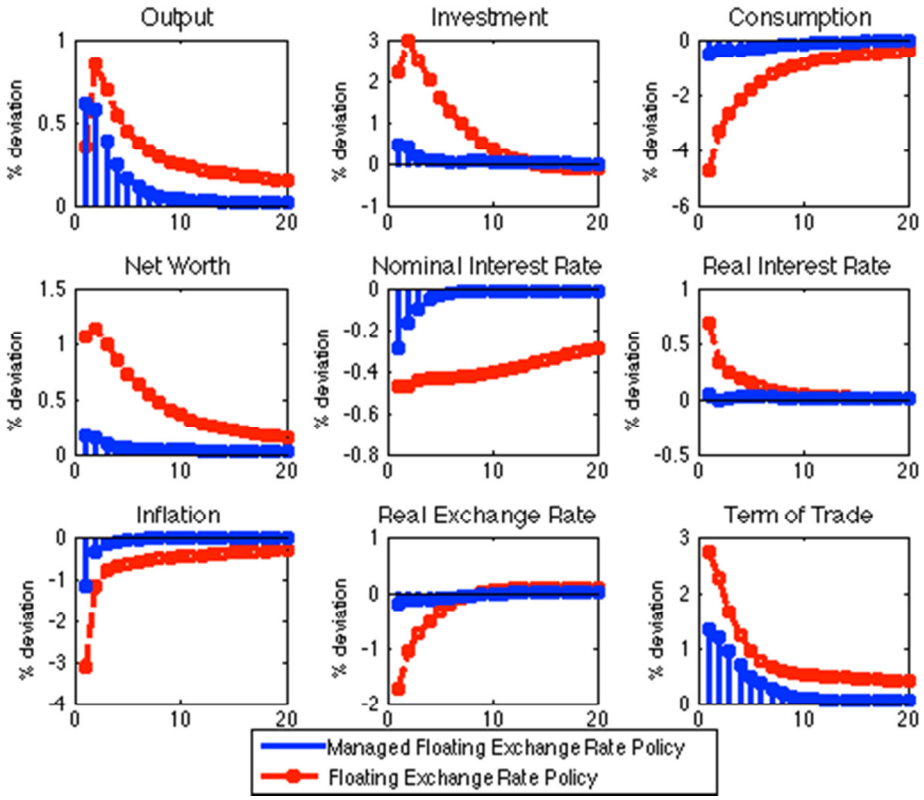
Table 9: calibrated parameters and steady-state ratios in Tanzania

Parameters	Values	Description
Financial transactions		
ψ_d	0.006	Elasticity of the risk premium with respect to NFA position
γ	1	Elasticity of the EFP with respect to firm's leverage ratio
$\frac{K}{NW}$	3.21	Steady-state capital net worth ratio
$R_K - R$	0.045	Steady state quarterly risk spread
Households		
β	0.99	Subjective discount factor
φ	1	Inverse elasticity of labor supply
σ	0.5	Inverse intertemporal elasticity of substitution in consumption
μ_1	0.14	Share of imported goods from the rest of EAC
μ_2	0.36	Share of imported goods from the rest of the world
θ	1	Elasticity o substitution between domestic and imported goods
$\frac{C}{Y}$	0.28	Consumption to GDP ratio
Production sector		
$(1-\nu)$	0.02	Entrepreneurs probability of leaving the economy
α	0.50	Capital contribution to production function
δ	0.02	Capital depreciation rate
ψ_I	0.2	Capital adjustment cost parameter
η	0.7	Probability of not adjusting prices
$\frac{\chi}{\chi-1}$	0.78	Steady-state mark-up
Exchange rate policies		
β_0	0.6	Smoothing coefficient
β_1	1.2	Inflation stabilizing coefficient
β_2	0.6	Output stabilizing coefficient
β_3	1	NEER targeting coefficient
Government		
G/Y	0.24	Public expenditure to GDP ratio
T/Y	0.15	Lump-sum transfer to GDP ratio

7.4.2. Supply shocks under managed floating exchange rate versus pure floating exchange rate policy in Tanzania

Plot 13 displays the dynamics of macroeconomic variables in response to a one standard deviation of positive productive shock, under alternatives exchange rate policies in Tanzania.

Plot 13: Effects of a positive productivity shock under managed floating exchange rate policy versus pure floating exchange rate policy in Tanzania



The positive domestic productivity shock induces an increase of output in Tanzania. The supply shock leads to a decrease in marginal cost and inflation. Under managed floating policy, to stabilize the expected inflation, the monetary authority revises downwardly the nominal interest rates. But the decline of nominal interest rate is insufficient to offset the decrease of inflation, as result the real interest rate rises up. Consequently, decline in consumption and the appreciation of the current real effective exchange rate are observed. The appreciation of real effective exchange rate induces the increase of the entrepreneur net worth because the current value of the debt denominated in foreign currency decreases and that is favorable to investment. Moreover, the share of investment purchased abroad becomes cheaper in domestic

currency, which increase investment more. These effects of increasing investment are adding to its initial rise due to the growth in productivity.

The reactions of the monetary authority introduce a difference between the two exchange rate policies. Indeed, in the case of managed exchange rate policy, after the positive productivity shock, the appreciation pressure of the exchange rate leads the monetary authority to lower the nominal interest rate. In contrast, under the pure floating exchange rate policy, the monetary authority does not react to change in the nominal effective exchange rate and the nominal interest rate remains unchanged. An initial drop of nominal interest rate is caused by the decline of inflation. Consequently, inflation decreases and the real interest rate increases more under pure floating exchange rate policy than under managed floating exchange rate policy. This relative increase in real interest rate under the pure floating exchange rate policy, leads to the larger drop in consumption, the more appreciation of real effective exchange rate, and the greater increase in output. Overall, this analysis of impulse responses of different macroeconomic variables demonstrates that in Tanzania, shock effects are more cushioned under pure floating exchange rate policy than under the managed floating exchange rate policy facing a domestic supply shock.

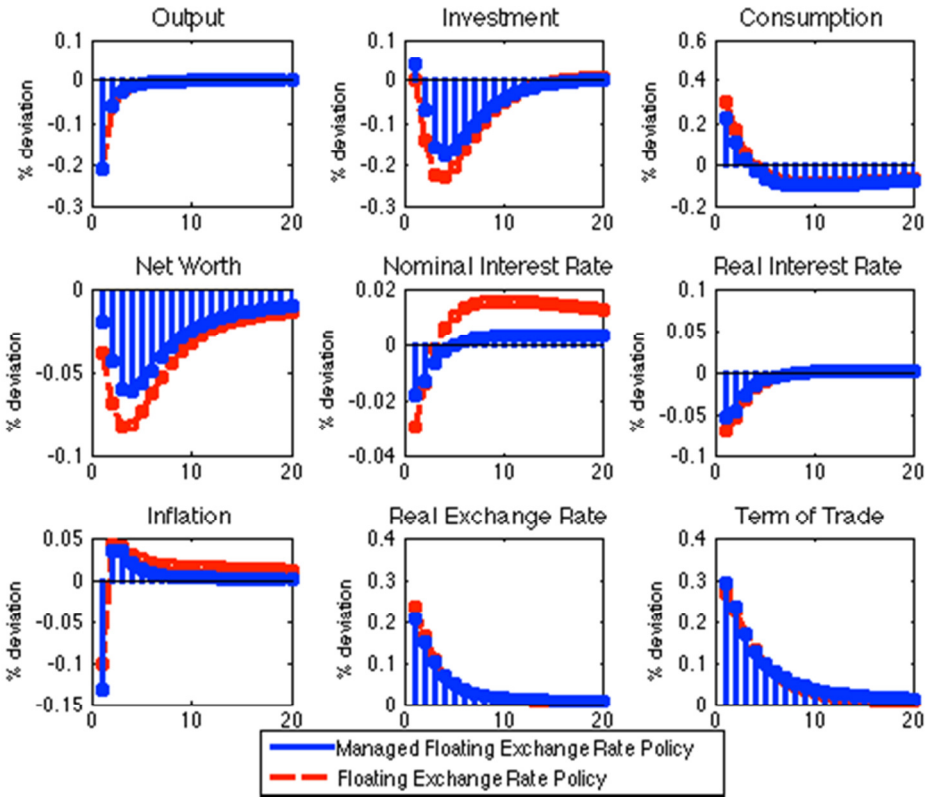
7.4.3. Demand shocks under managed floating exchange rate policy versus pure floating exchange rate policy in Tanzania

Plot 14 displays the dynamics of macroeconomic variables in response to a one standard deviation of negative foreign demand shock, under alternatives exchange rate policies in Tanzania.

The negative foreign demand shock negatively affects output and leads to worthless investment in Tanzania. The entrepreneurs demand for loans decreases and this induces to decrease the real interest rate. To handle the adverse effects of the shock and given the unchanged expected inflation, monetary authority decreases the nominal interest rate. As response, the real interest rate goes down and leads to the increase of consumption. By the uncovered interest rate parity, this leads to the real effective exchange rate depreciation. This real depreciation increases the cost of investment purchased abroad and decrease the net worth of entrepreneurs since the value in local currency of the debt denominated in foreign currency increases. Those developments increase the risk premium, which further negatively affects the

investment. Overall, results reveals that, in Tanzania, managed exchange rate policy is less desirable than pure floating exchange rate policy in presence of foreign demand shock.

Plot 14: Effects of a negative foreign demand shock under managed floating exchange rate policy versus pure floating exchange rate policy in Tanzania



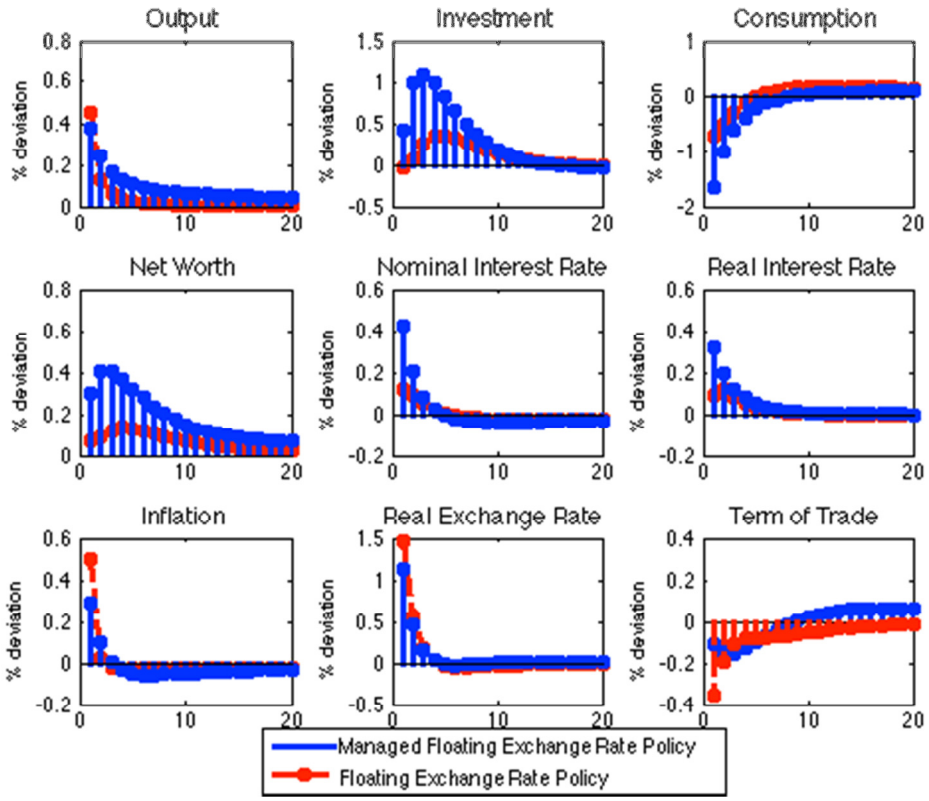
7.4.4. Financial shock under managed floating exchange rate policy versus pure floating exchange rate policy in Tanzania

Plot 15 displays the dynamics of macroeconomic variable in response to a one standard deviation positive economy risk premium shock, under alternatives exchange rate policies in Tanzania.

The positive risk premium shock increases the external financial premium, which lowers the external borrowing and leads to the increase of domestic nominal and real interest rates. Consequently, the depreciation of the current real effective exchange rate is observed. However, the depreciation of real effective exchange rate is not enough to substantially increase the current value of the debt denominated in foreign

currency, the entrepreneurs' net worth remains positive. The modest increase of entrepreneurial net worth is favorable to investment and output.

Plot 15: Effects of a positive risk premium shock under managed floating exchange rate policy versus pure floating exchange rate policy in Tanzania



Taking in account each of exchange rate policies involved, it appears that the pure floating exchange rate policy provide more stability than the managed floating exchanged rate policy. In fact, the nominal and real interest rate increases more under the managed floating exchange rate than under the pure floating exchange rate whereas, output increases more under the pure floating exchange rate regime than under the managed exchanged rate regime. Overall, in Tanzania, pure floating exchange rate policy is a better absorber of financial shock, than the managed floating exchange rate policy.

7.4.5. Welfare analysis under managed floating exchange rate policy versus pure floating exchange rate policy in Tanzania

Tables (10) reveals the welfare loss in Tanzania after the supply shock, the demand shock and the financial shock. The results suggest that the pure floating exchange rate policy performs better than the managed floating exchange rate policy in term of welfare stability facing foreign and domestic shocks.

Table 10: Welfare losses under managed floating exchange rate policy versus pure floating exchange rate policy in Tanzania (%)

Nature of Shocks	**Managed Floating Exchange Rate Policy**	**Pure Floating Exchange Rate Policy**
Supply shock	0.08	0.01
Demand Shock	0.18	0.09
Financial Shock	0.19	0.03

7.5. Uganda

7.5.1. Calibration of parameters

Most of structural parameters and all the steady-sate ratios are calibrated using Bayesian method by means of Uganda data (IMF 2014) spanning from the period of 2004-2014. The quantitative results obtained by calibration procedure of the two open-economy DSGE model for Burundi are summarized in Table 11.

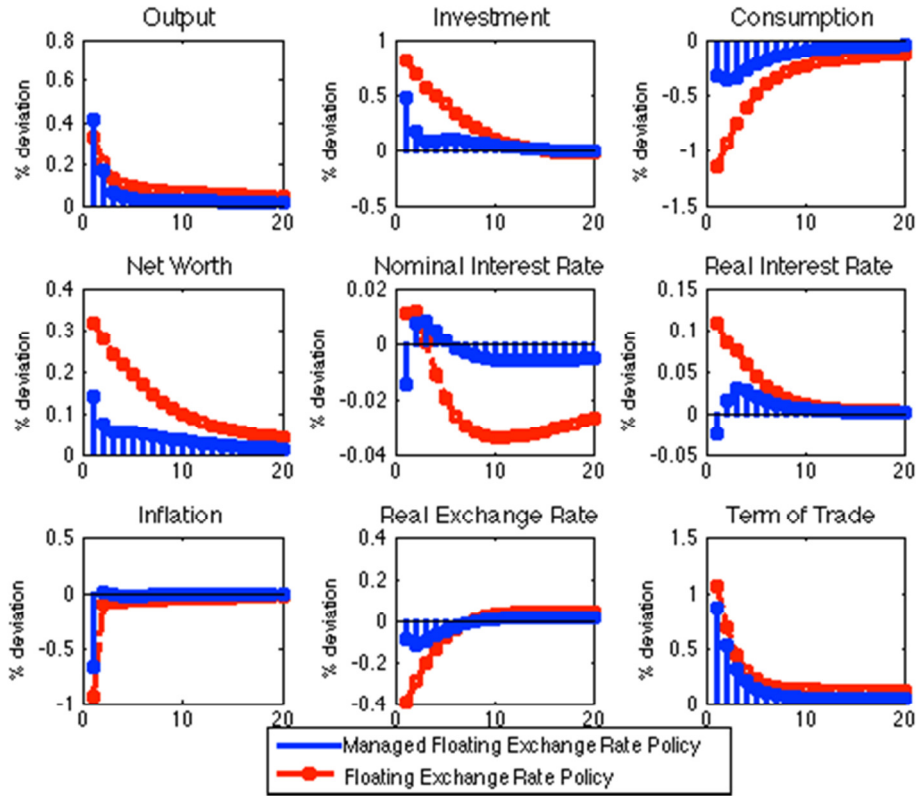
Table 11: calibrated parameters and steady-state ratios in Uganda

Parameters	Values	Description
Financial transactions		
ψ_d	0.0045	Elasticity of the risk premium with respect to NFA position
γ	0.9	Elasticity of the EFP with respect to firm's leverage ratio
$\frac{K}{NW}$	3.48	Steady-state capital net worth ratio
$R_K - R$	0.055	Steady state quarterly risk spread
Households		
β	0.98	Subjective discount factor
φ	1	Inverse elasticity of labor supply
σ	0.5	Inverse intertemporal elasticity of substitution in consumption
μ_1	0.14	Share of imported goods from the rest of EAC
μ_2	0.36	Share of imported goods from the rest of the world
θ	1	Elasticity o substitution between domestic and imported goods
$\frac{C}{Y}$	0.28	Consumption to GDP ratio
Production sector		
$(1-\nu)$	0.02	Entrepreneurs probability of leaving the economy
α	0.50	Capital contribution to production function
δ	0.02	Capital depreciation rate
ψ_I	0.2	Capital adjustment cost parameter
η	0.7	Probability of not adjusting prices
$\frac{\chi}{\chi-1}$	0.78	Steady-state mark-up
Exchange rate policies		
β_0	0.8	Smoothing coefficient
β_1	1.8	Inflation stabilizing coefficient
β_2	0.7	Output stabilizing coefficient
β_3	1	NEER targeting coefficient
Government		
G/Y	0.26	Public expenditure to GDP ratio
T/Y	0.14	Lump-sum transfer to GDP ratio

7.5.2. Supply shocks under managed floating exchange rate policy versus pure floating exchange rate policy in Uganda

Plot 16 displays the dynamics of macroeconomic variables in response to a one standard deviation of positive productive shock, under alternatives exchange rate policy in Uganda.

Plot 16 : Effects of a positive productivity shock under managed floating exchange rate policy versus pure floating exchange rate policy in Uganda



The positive domestic productivity shock induces an increase of output and investment in Uganda. Under managed floating policy, to stabilize the expected inflation, the monetary authority revises downwardly the nominal interest rates. The nominal interest rate decline as more as the inflation does, as result the real interest rate declines. Consequently, decline in consumption and the appreciation of the current real effective exchange rate are observed. The appreciation of real effective exchange rate increases the entrepreneurs' net worth because the current value of the debt denominated in foreign currency decreases. Both depreciation and the increases of net worth induce increases of investment. Furthermore, the share of investment purchased abroad becomes cheaper in domestic currency, which further increases investment.

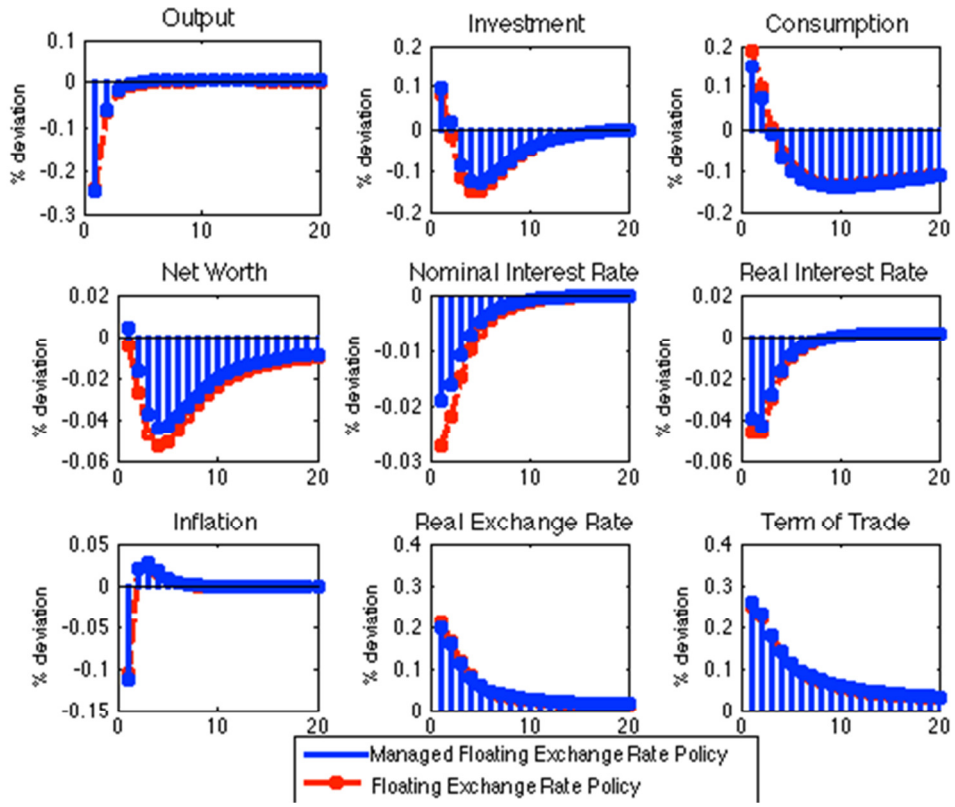
The reactions of the monetary authority introduce a difference between the two exchange rate policies. Indeed, in the case of managed exchange rate policy, after the positive productivity shock, the appreciation pressure of the exchange rate leads the monetary authority to lower the nominal interest rate. In contrast, under the pure floating exchange rate policy, the monetary authority does not react to change in the nominal effective exchange rate and the nominal interest rate remains unchanged. An initial drop of nominal interest rate is caused by the decline of inflation. Consequently, inflation decreases and the real interest rate increases more under pure floating exchange rate policy than under managed floating exchange rate policy. This relative increase in real interest rate under the pure floating exchange rate regime leads to the greater increase in net worth and investment. Overall, in Uganda, shock effects are more cushioned under pure floating exchange rate policy than under the managed floating exchange rate policy facing a domestic supply shock.

7.5.3. Demand shocks under managed floating exchange rate policy versus pure floating exchange rate policy in Uganda

Plot 17 displays the dynamics of macroeconomic variables in response to a one standard deviation of negative foreign demand shock, under alternatives exchange rate policies in Uganda.

The negative foreign demand shock negatively affects output in Uganda. The entrepreneurs demand for loans decreases and this induces to decrease the real interest rate. To cope with contractionary effects of the shock and given the unchanged expected inflation, monetary authority decreases the nominal interest rate. As response, real interest rate goes down further and leads to the increase of consumption. By the uncovered interest rate parity, this leads to the real effective exchange rate depreciation. This real depreciation moderately increases the cost of investment purchased abroad leads to null net worth. By analyzing each the exchange rate policy involved, it appears that the pure floating exchange rate policy provide more stability than the managed floating exchanged rate policy. In fact, output decreases more under managed floating exchange rate policy. Overall, in Uganda, managed exchange rate policy is less desirable than pure floating exchange rate policy in presence of foreign demand shock.

Plot 17 : Effects of a negative foreign demand shock under managed floating exchange rate policy versus pure floating exchange rate policy in Uganda



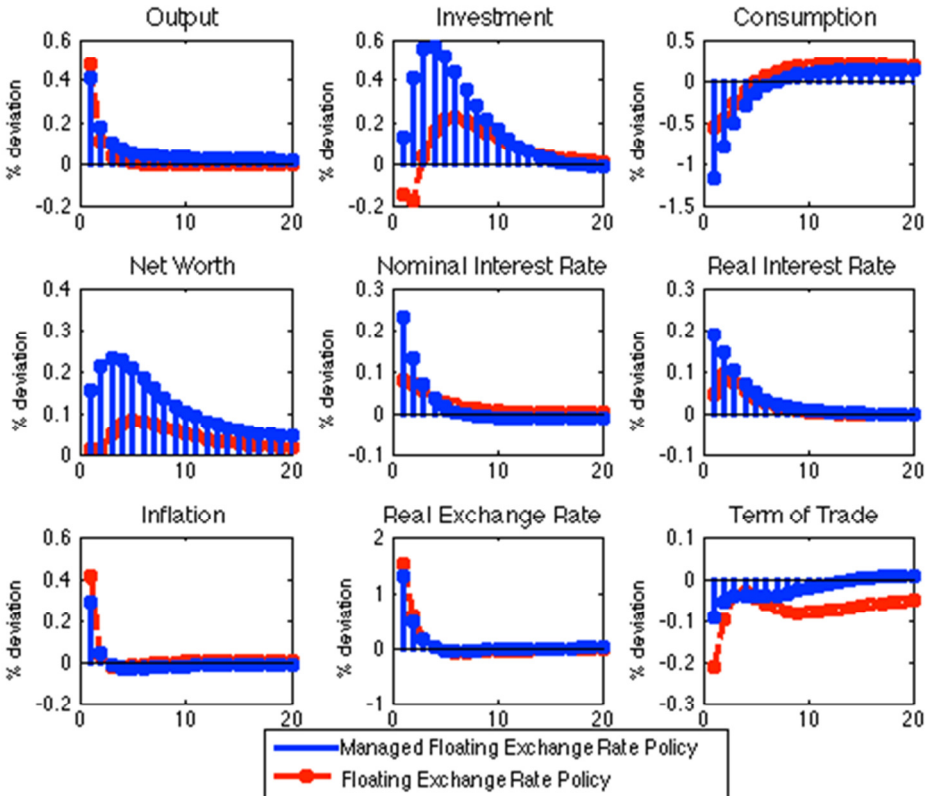
7.5.4. Financial shock under managed floating exchange rate policy versus pure floating exchange rate policy in Uganda

Plot 18 displays the dynamics of macroeconomic variables in response to a one standard deviation of positive risk premium shock, under alternatives exchange rate policies in Uganda.

The positive risk premium shock increases the external financial premium, which lowers the external borrowing and leads to the increase of domestic nominal and real interest rates. Consequently, the depreciation of the current real effective exchange rate is observed. However, the depreciation of real effective exchange rate is not enough to substantially increase the current value of the debt denominated in foreign currency, the entrepreneurs' net worth remains positive. By looking in each of exchange rate policy involved, it appears that the pure floating exchange rate policy provide more stability than the peg exchanged rate policy. In fact, the output increases less under managed exchange rate policy than under pure floating exchange rate policy. The nominal and real interest rate increases more under the managed exchange

rate than under the pure floating exchange rate. The consumption decreases more under the managed exchange rate regime than under the pure floating exchanged rate regime. Overall, for Uganda, pure floating exchange rate policy is a better absorber of financial shock, than the managed floating exchange rate policy.

Plot 18 : Effects of a positive risk premium shock under managed floating exchange rate policy versus pure floating exchange rate policy in Uganda



7.5.5. Welfare analysis under managed floating exchange rate policy versus pure floating exchange rate policy in Uganda

Tables (12) reveals the welfare loss in Uganda after the supply shock, the demand shock and the financial shock. The results suggest that the pure floating exchange rate policy performs better than the managed floating exchange rate policy in term of welfare stability facing foreign and domestic shocks.

Table12: Welfare losses under managed floating exchange rate policy versus pure floating exchange rate policy in Uganda (%)

Nature of Shocks	**Peg Exchange Rate Policy**	**Pure Floating Exchange Rate Policy**
Supply shock	0.19	0.06
Demand Shock	0.24	0.08
Financial Shock	0.16	0.01

8. Conclusion and policy implications

The launched of the monetary union for the EAC raises a great challenge regarding the appropriate monetary policy framework for macroeconomic stabilization, shocks resilience and balanced development of all the partners' states. The aim of this paper was thus to assess the effectiveness of the East Africa Monetary Union relative to alternatives exchange rate policies. We develop a Two open country Dynamic Stochastic General Equilibrium (DSGE) model with financial micro-foundation to evaluate the East Africa Monetary Union effectiveness under fixed exchange rate policy, managed floating exchange rate policy, target exchange rate policy and pure floating exchange rate policy. The counterfactual simulations were based on three main shocks, namely, supply shock, demand shock and financial shock. The counterfactual simulations and the welfare analysis reveal the preeminence of the pure floating exchange rate policy for the effectiveness of the East Africa Monetary Union. Specifically, results reveal that in the EAMU, firstly, shock effects are more cushioned under pure floating exchange rate policy than under the managed floating exchange rate policy facing a domestic supply shock. Secondly, managed exchange rate policy is less desirable than pure floating exchange rate policy in presence of foreign demand shock. Thirdly, pure floating exchange rate policy is a better absorber of financial shock, than the managed floating exchange rate policy. However, the **welfare analysis** suggests that the pure floating exchange rate policy is a better policy in term of welfare stability facing demand shock and foreign shock, whereas, the managed exchanged rate performs well to cushion supply shock and domestic shock.

The partner states case study reveals that:

- In **Burundi**, firstly, supply shock effects are more cushioned under pure floating exchange rate policy than under the peg exchange rate policy. Secondly, peg exchange rate policy is less desirable than pure floating exchange rate policy in presence of foreign demand shock. Thirdly, pure floating exchange rate policy is a better absorber of financial shock, than the peg floating exchange rate policy. The welfare analysis confirms that the pure floating exchange rate policy performs better than the peg exchange rate policy in term of welfare stability facing foreign and domestic shocks.

- In **Kenya**, firstly, managed floating exchange rate performs less than the pure floating exchange rate policy facing a domestic supply shock. Secondly, the pure floating exchange rate policy provide more stability than the managed floating exchanged rate policy in Kenya facing negative foreign demand shock. Thirdly, the pure floating exchange rate policy is a better absorber of financial shock, than the managed floating exchange rate policy. The welfare analysis suggests that the pure floating exchange rate policy performs better than the managed floating exchange rate policy in term of welfare stability facing foreign and domestic shocks.

- In **Rwanda,** firstly, the positive effect of positive productivity shock is more important under the pure floating exchange rate policy rather than the peg exchange rate policy. Secondly, the pure floating exchange rate policy performs quite more than peg exchange rate policy to inhibit the effects of negative foreign demand shock. Thirdly, the pure floating exchange rate policy is a better absorber of financial shock, than the peg floating exchange rate policy. The welfare analysis reveals that the pure floating exchange rate policy performs better than the peg exchange rate policy in term of welfare stability facing foreign and domestic shocks.

- In **Tanzania,** firstly, shock effects are more cushioned under pure floating exchange rate policy than under the managed floating exchange rate policy facing a domestic supply shock. Secondly, managed exchange rate policy is less desirable than pure floating exchange rate policy in presence of foreign demand shock. Thirdly, the pure floating exchange rate policy is a better absorber of financial shock, than the managed floating exchange rate policy. The welfare analysis suggests that the pure floating exchange rate policy performs better than the managed floating exchange rate policy in term of welfare stability facing foreign and domestic shocks.

- In **Uganda**, firstly, following a domestic supply shock, managed floating exchange rate performs less than the pure floating exchange rate policy. Secondly, managed exchange rate policy is less desirable than pure floating exchange rate

policy in presence of foreign demand shock. Thirdly, pure floating exchange rate policy is a better absorber of financial shock than the managed floating exchange rate policy. The welfare analysis reveals that the managed floating exchanges rate policy in term of welfare stability facing foreign and domestic shocks.

This results leads to the following policy implications:

- Policymakers should keep going in the implementation of the EAMU because partner state performs well within than outside the union.

- Policymakers should adopt the floating exchange rate policy as the core monetary policy framework for the EAMU instead of peg, managed or target exchange rate policy.

- Partner states should harmonize their monetary policy framework around the pure floating exchange rate policy.

- While choosing the instruments of common monetary policy under pure floating exchange rate policy, policymakers should take in consideration the exposure of EAC to external financial shocks and the reliance on debt denominated in foreign currency.

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