Sources of Macroeconomic Fluctuations in a Franc Zone Country: A Bayesian estimation

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Abstract

The Central African Economic and Monetary Community (CEMAC) is a constituent of the Franc Zone (FZ), whose roots may be traced back to 1901 when France created the West African Bank. Since its inception, FZ's monetary authorities' objective and monetary policy instruments have been evolving. Nevertheless, some FZ's features have endured, namely the fixed exchange rate between that monetary union's common currency (CFAF) and France's currency, the free capital mobility between Franc Zone countries (FZC) and France, the ceiling on the monetary budget financing and the obligation of FZC to entrust a share of their foreign exchange reserves to the French Treasury in exchange for the convertibility of CFAF into France's currency. Using Cameroon's data over 1979 and 2014, we estimate a DSGE model of a small open economy model that take into account some of those features. We find that technology and fiscal shocks drive the bulk of economic fluctuations.

Key Words: Franc Zone - Cameroon - DSGE model - Metropolis-Hasting

JEL Classification: C68 E32 F41 F45

1 Introduction

The Franc Zone (FZ) is constituted by the Central African Economic and Monetary Community (CEMAC) and the West Africa Economic and Monetary Union (WAEMU)[1]. Until the 1972 Accord, no contractual agreement had defined the tools and the goals of monetary policy in the Franc Zone countries (FZC). The 1972 Accord led to the creation of the Bank of Central African States (BEAC) which subsequently presided over the amount of loan to be extended to specific sectors of economy such as agricultural and foreign oriented sectors by setting a ceiling to commercial banks' refinancing.

In the nineteen-eighties, the FZC went through a deep economic, banking and ex-

[1] The CEMAC is made up of six countries: Cameroon, the Central African Republic, Chad, Congo (Republic of), Equatorial Guinea and, Gabon. The members of the WAEMU are Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and, Togo.

change rate crisis. Eventually, a maxi-devaluation of their common currency, the CFAF, was decided in January 1994 and the direct management of loans to the private sector was discontinued. The CEMAC was created in the same year and became operational after the ratification of the treaty by all its members in 1999.

Since then, under the aegis of the French Treasury and the Banque de France, BEAC's new mandate is to pursue a low inflation (around 3%) and the maintenance of an adequate foreign currency cover of the M2 aggregate. To hit monetary policy targets, monetary policy instruments are set at their country-specific values because economic integration is deficient in the CEMAC. Specifically, BEAC's Monetary Programming (MP) model is run at a country level to check that government credits, quantitative targets on BEAC refinancing of commercial banks, and required reserve ratios are in accordance with BEAC monetary targets (Honohan(1990), Iossifov et al. (2009)). For example, the country-specific M2 aggregate is set by analyzing and extrapolating the balance of payments' deficit and the financial needs of the private and public sector.

CEMAC's monetary authorities consider that MP and the declaration of BEAC's mandate are an improvement from the policy practice prior to 1994. Interestingly, they shied away from using a dynamic stochastic general equilibrium (DSGE) framework from the outset because they did not want to rely on "complex econometric model with many equations that requires reliable economic data" (BEAC (1994)). We do not deal FZ's monetary policy in this paper. Instead, our aim is to tackle the effects of shocks and fiscal policy in a small open economy model where some of the most enduring features of a FZ's monetary policy and institutional provisions are parametrized. We depart from estimating reduced form equations that is implicit in the MP approach and we implement the Bayesian approach to estimate the model because it alleviates some of the pitfalls pertaining to data scarcity and/or quality and because it is immune to the Lucas critique[2].

This is not an easy task for a FZC. In fact, since the inception of the FZ or more recently of the CEMAC, numerous targets and instruments have been set forth, a few of them have been enacted, albeit with various degree of compliance (Coquet et al. (1992), IMF (2016), Nkodia (2011), Iossifov et al. (2009)). The last iteration of the convergence criteria, which was presented in late 2015 and slated to enter in force on January 1st 2017, relies on a three-year average formula of a set of indicators i.e. an essentially backward looking framework. The purpose of all those convergence criteria, which dramatically step up surveillance across the CEMAC, is to achieve a moderate inflation in member countries and safeguard the integrity of that institutional monetary union by seeking a sustainable level of government domestic and foreign debt.

During our estimation period, moderate inflation is mainly achieved by setting the ceiling of monetary budget financing to ten percent of the previous year's tax revenues. Obviously, the implementation of administered price in many FZC dampens down nationwide inflationary pressure indicator but may also biases it [3]. The non-accumulation of domestic and external payment arrears has a safe place in the three iterations of mul-

[2] For example, prior distributions of unknown parameters can be used to set restrictions on their estimated values though the related time series are not available while measurement errors in observed time series can be partially accounted for.

[3] For instance, the prices of fuels, cement or power are set by the Cameroon's government.

tilateral surveillance. In our model, we accommodate for the latter by using a risk premium term that translates into a higher interest rate when net foreign assets are below their non-stochastic steady state level. For the non-accumulation of domestic arrears, domestic banks' lending to the government, and for that matter, to firms is modeled to preclude non-performing loans.

Since its creation, the CFAF has been pegged to France's currency at a fixed exchange rate. The fixed exchange rate feature of the FZ arrangement is captured in our model economy by assuming the endogeneity of the base money and letting Calvo type homogenous goods price setters use France's inflation rate as the target inflation. In fact, pegging the CFAF exchange rate to the Euro or whichever French currency is per se ensuring long run inflation rate convergence between the CEMAC and France. Moreover, the endogeneity of base money is germane to a fixed exchange rate unless perfect sterilization is put in place.

In the CEMAC, surliquidity stemming from external financing of foreign oil-extracting companies (Iossifov et al. (2009)), shallow financial system and failed sterilization have been wreaking havoc on the transmission of monetary policy. CEMAC's governments and monetary authorities primarily turn to surveillance criteria to deal with the issue instead of fostering the reduction of participation cost, intermediation cost and guaranteeing the enforceability of contracts to increase bank financing of firms and households (IMF (2015)). In our model economy, excess liquidity is not addressed head on. Instead, we set the banking finance ratio to total input costs to a very low value.

The FZ mechanism requires each CEMAC country transfer at least 50% of its foreign exchange reserves to a special French Treasury account named *compte d'opérations* (no less than 65% before 2007) and entrust the BEAC with the balance. We do not account for that breakdown of exchange reserves in our model economy because data are unavailable.

For a member country of any currency union, devising an optimal fiscal policy rule is particularly valuable because only fiscal policy instruments are available to their governments. Owing to the fact that government expenditure and revenues data series are sketchy for all members of the FZ, such a goal seems to have been mostly off the radar in those countries. Therefore, the parameters of a feedback policy rule cannot be identified in the Bayesian estimation if the related data series are missing[4]. At best, one is left with using calibrated parameters to gain an insight into the effects of fiscal policy shocks[5].

For decades, FZ Monetary Authorities have been relying on country-specific annual data to devise monetary policy because of a dearth in high frequency data and poor economic integration among its members (Masson and Patillo (2005)). Accordingly, we use Cameroon's annual data to estimate a model economy that accounts for the discussed FZ's features and provisions.

[4] Amongst FZC, Chad and Gabon have no government revenue data while others have at best ten data points between 1979 and 2014 (World Development Indicator database).

[5] Through the years, monetary policy in the Franc Zone must have been relying too on some form of guess work or calibration.

The small country produces a homogenous good using intermediate goods purchased from monopolist producers. The homogenous good is consumed at home or exported overseas at world prices after repackaging. Intermediate monopolist producers use labor and capital service to produce a variety of goods whose prices are set according to a Calvo-pricing mechanism[6]. Importers repackage a foreign homogenous good that is either used as a consumption or an investment good. Banks receive deposits from households and use them to build up reserves, purchase government bonds and extend loans to firms. Firms use the loans to finance a fraction of their repackaging and labor cost.

One of the findings of the paper is that technology and fiscal policy shocks explain most of the aggregate fluctuations in the country. The paper is organized in four sections: The model is outlined in the second section and then estimated in the third section. We comment our results in the fourth section and conclude the paper in the fifth section.

2 The Model[7]

2.1 The production of the final homogenous good

The competitive producer of the domestic homogenous good Q_t combines intermediate goods of monopolist producers using a Dixit-Stiglitz aggregator production function

$$Q_t = \left[\int_0^1 Q_{j,t}^{\frac{\theta-1}{\theta}} \, dj \right]^{\frac{\theta}{\theta-1}} \qquad \theta > 1 \tag{1}$$

where θ is the elasticity of substitution between different varieties of domestic good and $\lambda_d \equiv \theta/(\theta-1)$ the markup parameter in the domestic goods market. Profit maximization subject to the given prices of intermediate goods $P_{j,t}$ and the market price of the final good P_t gives the equilibrium demand for each j intermediate good $Q_{j,t}$ and the domestic good's price

$$Q_{j,t} = \left(\frac{P_{j,t}}{P_t} \right)^{-\theta} Q_t \tag{2}$$

$$P_t = \left[\int_0^1 (P_{j,t})^{1-\theta} \, dj \right]^{\frac{1}{1-\theta}} \tag{3}$$

2.2 The production of intermediate goods

There is a continuum of j intermediate producers in the economy. The jth intermediate firm combines labor, $h_{j,t}$, and capital services, $K_{j,t}$, to produce $Q_{j,t}$.

[6] In their DSGE model for Mozambique, Peiris and Saxegaard (2007) use a Rotemberg-type quadratic adjustment costs for price setting. Both nominal rigidity schemes are equivalent.

[7] The DSGE model of a small open economy has been described in numerous papers. Here, we adapt the model in Christiano et al. (2011).

$$Q_{j,t} = \varepsilon_t^q \left(K_{j,t}\right)^{\alpha} \left(z_t h_{j,t}\right)^{1-\alpha} - \phi z_t \tag{4}$$

where z_t is the permanent technology shock whose rate of growth is $\mu_{z,t} = z_t/z_{t-1}$, ε_t^q a covariance stationary transitory technology shock and ϕ a fixed cost of production.

A fraction ν^f of wages is borrowed from banks. Cost minimization by the representative intermediate producer gives two marginal cost functions

$$\lambda_t = \frac{w_t R_t^f}{\varepsilon_t^q (1-\alpha) \left(\frac{k_{j,t}}{\mu_{z,t}}\right)^{\alpha} \left(\frac{1}{h_{j,t}}\right)^{\alpha}} \tag{5}$$

$$\lambda_t = \frac{1}{\alpha \varepsilon_t^q \left(\frac{k_{j,t}}{h_{j,t}}\right)^{\alpha-1} \left(\mu_{z,t}\right)^{1-\alpha}} \overline{r}_t^k \tag{6}$$

where $\overline{r}_t^k, w_t$ and $k_{j,t}$ are respectively the scaled values of the rental rate of capital, nominal wages (W_t) and capital services ($K_{j,t}$). The gross effective borrowing interest rate is defined $R_t^f \equiv \nu^f R_t^l + \left(1-\nu^f\right)$ where ν^f the fraction of wages is borrowed from banks and, R_t^l the gross lending interest rate[8].

After choosing the optimal combination of labor and capital, intermediate firms sets their price of its output in a Calvo-type friction environment. On the other hand, firms that receive the green light to change their price choose the optimum price with a probability $(1-\xi)$. Firms that are not allowed to optimize their price in the current period adjust the previous period's price by a factor which is a combination of the Central Bank's target inflation, $\overline{\pi}_t^c$, and the previous period's inflation, π_{t-1}.

$$P_t = \left(\pi_{t-1}\right)^{\kappa_d} \left(\overline{\pi}_t^c\right)^{1-\kappa_d} P_{t-1} \tag{7}$$

where κ_d is the price indexation parameter. There is a random probability ξ that a firm sets P_t at period t.

2.3 Households

The economy is populated by a continuum of households indexed j $\in (0,1)$. The representative household's expected lifetime utility function is

$$E_0 \sum_{t=0}^{t=\infty} \beta^t \left[\varepsilon_t^c \ln(C_{j,t} - \mathfrak{h} C_{j,t-1}) - \frac{A_L}{1+\sigma_L} h_{j,t}^{1+\sigma_L} + \frac{A_q}{1-\sigma_q} \varepsilon_t^m \left(\frac{M_{j,t+1}^c}{z_t P_t}\right)^{1-\sigma_q}\right]$$

where E_0 is the conditional expectation operator, $C_{j,t}$ an aggregate consumption index, $h_{j,t}$ the level of hours worked, $M_{j,t}^c$ the nominal cash holdings, β the consumer subjective discount factor, $1/\sigma_L$ the Frisch labor supply elasticity and, $1/\sigma_q$ the interest elasticity of demand for real cash balances. A degree of habit persistence in consumption, $\mathfrak{h}$, is assumed. The demand for real money balance shock ε_t^m and the

[8] Stationarized variables are obtain as follows:
Nominal variables $D_{j,t+1}, W_t, S_t B_{t+1}^*, T_t$ and, $M_{j,t+1}^c$ are divided by $z_t P_t$ while real variables $\overline{K}_{j,t+1}, I_{j,t}, C_{j,t}$ and , $G_{j,t}$ are scaled by z_t. Low caps are used for stationarized variables.

consumption preference shock , ε_t^c, follow an AR(1) process. It is assumed that the household owns and operates firms and financial intermediaries, banks for short. The budget constraint is given by

$$R_{t-1}^d D_{j,t} + W_t h_{j,t} - R_{t-1}^* \Phi_{j,t-1} S_{t-1} B_{j,t}^* + \Pi_t - P_t^c C_{j,t} - T_t - M_{j,t+1}^c + M_{j,t}^c - D_{j,t+1} + S_t B_{j,t+1}^* - P_t^i I_{j,t} - P_t \left(a\left(u_{j,t}\right) \overline{K}_{j,t} + P_t^{k'} \Delta_t \right) + R_t^k u_{j,t} \overline{K}_{j,t} = 0$$

where R_{t-1}^d and R_{t-1}^* are the gross domestic and foreign interest rates respectively, $D_{j,t}$ is the bank deposits, $B_{j,t}^*$ net foreign assets (NFA), T_t the lump sum tax, S_{t-1} the nominal exchange rate, $u_{j,t}$ the level of capital utilization, R_t^k the rate of return on a unit of physical capital, $P_t^{k'}$ the price of installed capital and Π_t the sum of firms' and banks' profits. The resource cost of capital utilization measured in units of physical capital is defined as in Schmitt-Grohe and Uribe (2004)

$$a\left(u_{j,t}\right) = \sigma_a \left(u_{j,t} - 1\right) + \frac{\sigma_b}{2} \left(u_{j,t} - 1\right)^2, \qquad \sigma_a,\ \sigma_b > 0 \tag{8}$$

The risk adjustment term on NFA that ensures a well-behaved steady state equilibrium is given by

$$\Phi_{j,t} = \exp\left(-\tilde{\phi}_b \left(B_{j,t}^* - B^* \right) - \tilde{\phi}_s \left(\left(R_t^* - R_t^d \right) - \left(R^* - R^d \right) \right) + \tilde{\phi}_t^u \right) \quad \tilde{\phi}_b,\ \tilde{\phi}_s > 0 \tag{9}$$

where $\tilde{\phi}_t^u$ is an AR(1) process, B^*, R^* and R^d the non-stochastic steady state (NSS) values of the corresponding variables[9]. The response to a deviation of NFA from its NSS value precludes a Ponzi-type steady state equilibrium. The interest rate differential accounts for free capital mobility between FZC and France and the fact that the CFAF is pegged to a floating currency. Therefore, that interest rate differential should be considered as a proxy of France's uncovered interest rate parity which is transmitted to FZC.

The law of motion for physical stock is given by

$$\overline{K}_{j,t+1} = (1-\delta) \overline{K}_{j,t} + \left(1 - \widetilde{S} \left(\frac{I_{j,t}}{I_{j,t-1}} \right) \right) I_{j,t} + \Delta_{j,t} \qquad \widetilde{S}(1) = \widetilde{S}'(1) = 0, \widetilde{S}''(1) > 0 \tag{10}$$

where the second term is the technology that transforms investment I_t into physical capital (Christiano et al(2001)), $\Delta_{j,t}$ the physical capital purchased in competitive market from other households and δ the depreciation rate of capital.

Dropping the j's indexes, the first order conditions (FOCs) with respect to I_t, $\overline{K}_{t+1}$, u_t, B_{t+1}^*, h_t, D_{t+1}, M_{t+1}^c, and C_t in stationarized form is given by

$$-\psi_{z,t} p_t^i + \psi_{z,t} P_t^{k'} \left\{ 1 - \widetilde{S}_t - \frac{\mu_{z,t} i_t}{i_{t-1}} \widetilde{S}_t' \right\} + \beta \mu_{z,t+1} \psi_{z,t+1} P_{t+1}^{k'} \left(\frac{i_{t+1}}{i_t} \right)^2 \widetilde{S}_{t+1}' = 0 \tag{11}$$

[9] The form of the risk adjustment term used here is discussed in Christiano et al. (2011).

$$\psi_{z,t} = \beta \frac{\psi_{z,t+1}}{\mu_{z,t+1}} R^k_{t+1} \frac{1}{\pi_{t+1}} \qquad \text{where} \tag{12}$$

$$R^k_t \equiv \frac{\pi_t}{\mu_{z,t} P^{k'}_{t-1}} \left[u_t P^i_t a'(u) - a_t(u_t) P^i_t + P^{k'}_t (1-\delta) \right]$$

$$\overline{r}^k_t = a'(u_{j,t})\, p^i_t$$

$$\psi_{z,t} - \beta E_t \left(\frac{\psi_{z,t+1}}{\pi_{t+1}\mu_{z,t+1}} \right) R^*_t \Phi_t = 0 \tag{13}$$

$$w_t = \frac{\varepsilon^h_t A_L h^{\sigma_L}_t}{\psi_{z,t}} \tag{14}$$

$$-\psi_{z,t} + \beta E_t \frac{\psi_{z,t+1}}{\pi_{t+1}\mu_{z,t+1}} R^d_t = 0 \tag{15}$$

$$m^c_{t+1} = \left[\frac{\psi_{z,t} - \beta E_t \psi_{z,t+1} \frac{1}{\pi_{t+1}\mu^z_{t+1}}}{A_q} \right]^{\frac{-1}{\sigma_q}} \tag{16}$$

$$\varepsilon^c_t \left(\frac{1}{c_t - \mathfrak{h} \frac{c_{t-1}}{\mu_{z,t}}} \right) - \psi_{z,t} p^c_t + \beta \varepsilon^c_{t+1} E_t \left(\frac{-\mathfrak{h}}{\mu_{z,t+1} c_{t+1} - \mathfrak{h} c_t} \right) = 0 \tag{17}$$

where $\psi_{z,t} \equiv v_t z_t P_t$ marginal value of wealth in terms of one unit of the homogenous domestic good at time t and v_t the Lagrange multiplier on the budget constraint.

The aggregate consumption bundle is a CES function of domestic (C^d_t) and imported consumption goods (C^m_t).

$$C_t = \left[(1-\omega_c)^{\frac{1}{\eta_c}} \left(C^d_t \right)^{\frac{(\eta_c - 1)}{\eta_c}} + \omega_c^{\frac{1}{\eta_c}} \left(C^m_t \right)^{\frac{(\eta_c - 1)}{\eta_c}} \right]^{\frac{\eta_c}{(\eta_c - 1)}} \tag{18}$$

where ω_c is the share of imports in consumption and η_c the elasticity of substitution between domestic and foreign good. The price of the three consumption goods P^c_t, P_t and P^m_t, are given to the household, the domestic producers and importers respectively. Competitive importing firms produce the imported good by transforming one-for-one the homogenous foreign good. The domestic currency price of the homogenous foreign good is given by $P^m_t = S_t P^*_t$, where P^*_t is the foreign currency price of the homogenous good. Importing firms borrow a fraction ν^m of their total cost from banks. The gross interest rate on such loan is R^l_t. The FOCs give the demand for the domestically produced and imported consumption goods (c^d_t and c^m_t):

$$c^m_t = \omega_c \left(q^e_t R^m_t \right)^{-\eta_c} c_t \tag{19}$$

$$c^d_t = (1-\omega_c) \left[\frac{1}{p^c_t} \right]^{-\eta_c} c_t \tag{20}$$

where $q^e_t \equiv \frac{S_t P^*_t}{P^c_t}$ is the real exchange rate, S_t the nominal exchange rate and $R^m_t \equiv \nu^m R^l_t + (1-\nu^m)$. The relative price of the consumption good is given by

$$p_t^c = \left[(1 - \omega_c) + \omega_c * (p_t^m)^{1-\eta_c} \right]^{\frac{1}{1-\eta_c}} \quad (21)$$

where the relative price of the imported consumption good is defined by $p_t^m \equiv q_t^e p_t^c R_t^m$. The consumer inflation index computed from (21) is

$$\pi_t^c \equiv \pi_t \left[\frac{(1 - \omega_c) + \omega_c * (p_t^m)^{1-\eta_c}}{(1 - \omega_c) + \omega_c * \left(p_{t-1}^m\right)^{1-\eta_c}} \right]^{\frac{1}{1-\eta_c}} \quad (22)$$

A representative competitive firm produces the aggregate investment good using the domestically produced homogenous good and imported investment good in production function.

Similarly to the aggregate consumption good, the FOCs for a CES investment bundle given P_t^i, P_t and P_t^m gives the demand for the domestically produced and imported investment goods (i_t^d and i_t^m)

$$i_t^m = \omega_i \left(q_t^e R_t^m\right)^{-\eta_i} i_t \quad (23)$$

$$i_t^d = (1 - \omega_i) \left[\frac{1}{p_t^i} \right]^{-\eta_i} i_t \quad (24)$$

where the investment price index p_t^i is given by

$$p_t^i = \left[(1 - \omega_i) + \omega_i * (p_t^m)^{1-\eta_i} \right]^{\frac{1}{1-\eta_i}} \quad (25)$$

The relative price of the imported input is denoted by $p_t^m \equiv q_t^e p_t^c R_t^m$ and the investment inflation index is given by

$$\pi_t^i \equiv \pi_t \left[\frac{(1 - \omega_i) + \omega_i * (p_t^m)^{1-\eta_i}}{(1 - \omega_i) + \omega_i * \left(p_{t-1}^m\right)^{1-\eta_i}} \right]^{\frac{1}{1-\eta_i}} \quad (26)$$

2.4 The banking sector

The representative household's deposits D_t are used to finance loans to firms (S_t^w), lend to the government ($B_{g,t}^{bk}$) and build up reserves (R_t^{bk}). The balance sheet constraint of banks is given by

$$D_t = B_{g,t}^{bk} + S_t^w + R_t^{bk} \quad (27)$$

Banks' reserves do not earn interest. However, reserves are held because should banking activities of deposit-taking and lending end up with a shortage of reserves in one bank, it would be costly to get cash from other banks or more likely from the Central Bank in the case of a FZC. Therefore, we assume that only excess reserves are lent. Denoting the rate of required reserves on deposits by η_{res}, the amount of excess reserves that can be lent is

$$(1 - \eta_{res}) D_t = B_{g,t}^{bk} + S_t^w \quad (28)$$

The representative bank receives interest payments from firm and the government and pay out interest on household deposits. Those transactions generate a profit at some cost. We assume a quadratic cost where all variables are contemporaneously dated because we do not deal with non-performing loans. Each period, the representative bank chooses $B^{bk}_{g,t}$, and S^w_t to maximize its profit Π^{bk}_t subject to its balance sheet constraint

$$\Pi^{bk}_t = r^g_t B^{bk}_{g,t} + r^l_t S^w_t - r^d_t D_t - \frac{1}{2}\delta^{bk}\left(\alpha_{bkbg} B^{bk}_{g,t} + \alpha_{sw} S^w_t\right)^2 \tag{29}$$

where δ^{bk} is a scale parameter, α_{bkbg} and α_{sw} cost parameters, r^g_t the lending interest rates to the government and r^l_t the lending interest rate to firms. The FOCs give the following scaled loan to the government (or demand for government bonds) and loan supply to firms

$$r^g_t = \frac{r^d_t}{(1-\eta_{res})} + \frac{\delta^{bk}\alpha^2_{bkbg}}{\mu_{z,t}\pi_t} b^{bk}_{g,t} - \left(\delta^{bk}\alpha_{bkbg}\alpha_{sw}\right) s^w_t \tag{30}$$

$$r^l_t = \frac{r^d_t}{(1-\eta_{res})} + \delta^{bk}\alpha_{sw}\alpha_{bkbg}\frac{b^{bk}_{g,t}}{\mu_{z,t}\pi_t} - \delta^{bk}\alpha^2_{sw} s^w_t \tag{31}$$

2.5 The government

Government resources come from new interest-bearing debt, a lump sum tax (T_t) and new cash injection by the Central Bank. Those resources are used to consume domestically produced goods (G_t) and service government debt ($B^{bk}_{g,t}$). Thus, the government's flow constraint may be written as

$$B^{bk}_{g,t+1} = G_t + R^g_t B^{bk}_{g,t} - T_t - \lambda^{FZ} T_{t-1} \tag{32}$$

where R^g_t is the gross interest rate on government debt held by banks and λ^{FZ} the monetary union's parameter[10]. Public spending and lump sum tax are AR(1) processes.

$$T_t = \xi^T_t \left(\overline{T}\right)^{1-\rho_T} (T_{t-1})^{\rho_T} \tag{33}$$

$$G_t = \xi^T_t \left(\overline{G}\right)^{1-\rho_G} (G_{t-1})^{\rho_G} \tag{34}$$

where $\overline{T} = \eta^T Q$ and $\overline{G} = \eta^G Q$ and Q the NSS level of output.

2.6 The Central Bank

The FZ mechanism requires each CEMAC member state transfer a fraction of its foreign exchange reserves to the French Treasury and entrust the BEAC with the balance. The rationale for pooling foreign exchange reserves in a monetary union is well documented. Nevertheless, several member states are reluctant to entrust the BEAC with reserves that are not earmarked for CEMAC pooling arrangement (IMF (2013)). We omit that breakdown of exchange reserves in our model.

[10] According to the FZ Agreement, monetary finance of government's deficit cannot exceed 20% of previous period collected tax.

Setting capital gain on foreign exchange reserves to zero, the quasi-fiscal surplus, S_t^{CBK}, of the Central Bank is given by

$$S_t^{CBK} = S_t \Delta CBXR_{t+1} - \Delta MB_{t+1} \tag{35}$$

where $CBXR_t$ is the country's foreign exchange reserves at the Central Bank, MB_t the monetary base which is the sum of currency held by the household, M_t^c, and reserves held by the banking sector in the vaults of the Central Bank (R_t^{bk}.) The flow constraint pertaining to the country is obtained by equalizing the quasi-fiscal surplus to difference between Central Bank's "expenditures" and earnings (Agenor and Montiel (1996)). Here, it is given by

$$S_t CBXR_{t+1} - S_{t-1} CBXR_t - \Delta MB_{t+1} = i_{t-1}^{*FZ} S_{t-1} CBXR_t - \lambda^{FZ} T_{t-1} \tag{36}$$

where i_{t-1}^{*FZ} is the interest rate received on foreign exchange reserves, whose gross value R_t^{*FZ} is assumed to follow an AR(1)[11].

2.7 Aggregation and Resource constraints

The model is closed by the equilibria of the domestic good market and the balance of payments.

The domestically produced good is transformed one for one by exporters. Therefore, the domestic good market equilibrium is given by

$$Q_t = C_t^d + I_t^d + G_t + a(u_{j,t})\overline{K}_t + \left(\frac{R_t^x}{q_t^e p_t^c}\right)^{-\eta_x} Y_t^* \tag{37}$$

where Y_t^* is the foreign output, η_x the export elasticity with respect to the relative price of exports. The unit cost of a borrowed capital is defined by

$R_t^x \equiv \nu^x R_t^l + (1-\nu^x)$, where ν^x the fraction of borrowed repackaging cost by exporting firms.

The change in the country's foreign exchange reserves at the Central Bank equals net capital flows from abroad

$$S_t \Delta CBXR_{t+1} = \left[R_t^x \left(\frac{R_t^x}{q_t^e p_t^c}\right)^{-\eta_x} Y_t^* + S_t B_{t+1}^* + i_{t-1}^{*FZ} S_{t-1} CBXR_t \right] \tag{38}$$

$$- \left[q_t^e p_t^c R_t^m C_t^m + q_t^e p_t^c I_t^m + r_{t-1}^* \Phi_{t-1} S_{t-1} B_t^* + S_{t-1} B_t^* \right]$$

2.8 Shocks

Twelve stochastic exogenous variables are included in the model. There are two technology shocks: a neutral technology stationary shock ε_t^q and a labor neutral technology shock z_t whose growth rate $\mu_{z,t}$ is a stationary AR(1) process. On the demand side,

[11] Interest rates applicable to different deposit brackets are provided in Veyrune (2007)

there is a consumption preference shock ε_t^c and demand for real money balance shock ε_t^m. Two fiscal policy shocks are included: - the government spending shock (G) and the lump-sum tax shock (T). Monetary policy related shocks include the inflation target shock ($\overline{\pi_t}^c$), the interest rate on foreign reserves shock (R_t^{*FZ}), the nominal exchange rate shock (s_t) and the banks' reserves (R_t^{bk}). A foreign inflation shock (π^*) and a risk premium shock on foreign assets interest rate $\widetilde{\varepsilon}_t^u$ complete the set of exogenous stochastic variables. In the model, all shocks are defined by an AR(1)

$$\varepsilon_t^\iota = \xi_t^\iota \left(\overline{\varepsilon^\iota}\right)^{1-\rho_{\varepsilon^\iota}} \left(\varepsilon_{t-1}^\iota\right)^{\rho_{\varepsilon^\iota}} \tag{39}$$

where ι denotes any of the above shocks, ρ_{ε^ι} its persistence and ξ_t^ι its related covariance stationary component whose prior distribution is given in Table 1.

3 Estimation of the model

3.1 Estimation methodology

The model is estimated using the Bayesian technique. First, a stationarized log-linear version of the model is computed and then it is used to find its log-linear approximation in the steady state's neighborhood. A state-space representation of the transformed model helps compute the likelihood function of the model that is needed to find the posterior density of the estimated parameters. Let Γ be the parameter vector to be estimated, Λ a sample of data and $\mathcal{M}$ the model. The posterior density of the parameters, $P\left(\Gamma|\Lambda,\mathcal{M}\right)$, is given by Bayes formula

$$P\left(\Gamma|\Lambda,\mathcal{M}\right) = \frac{P\left(\Lambda|\Gamma,\mathcal{M}\right)P\left(\Gamma|\mathcal{M}\right)}{\int P\left(\Lambda|\Gamma,\mathcal{M}\right)P\left(\Gamma|\mathcal{M}\right)d\Gamma} \tag{40}$$

The denominator is the marginal data density which gives some clue on the average model fit to the data. In the numerator, prior beliefs about parameters values given the model, $P\left(\Gamma|\mathcal{M}\right)$, is updated by the data information contained in the likelihood function of the model $P\left(\Lambda|\Gamma,\mathcal{M}\right)$. The Metropolis-Hasting procedure of selecting a vector draw Γ^* enables the Markov Chain Monte Carlo (MCMC) method to generate a chain of the posterior $P\left(\Gamma|\Lambda,\mathcal{M}\right)$ [12].

Here, we heavily rely on theory to choose our priors given in Table 1 because, to our knowledge, there is no empirical work pertaining to Cameroon in the Bayesian framework. Not for that matter is one for any FZC. So the Inverse Gamma distribution is used to describe the motion of standard deviation of shocks. Next, parameters whose values are expected to fall between 0 and 1 are assumed to follow a Beta distribution while those which are restricted to be positive follow a Gamma distribution[13]. The parameter estimates (posteriors) are computed numerically with MCMC method consisting of two separate chains using Dynare (Adjemian et al.(2011)).

[12] Fernandez-Villarverde (2010) gives a theoretical account of the challenges and opportunities of Bayesian techniques.

[13] Del Negro and Schorffheide (2006) provide a discussion on priors.

3.2 Data

Aside from monetary aggregates and interest rates, FZ's monetary institutions do not collect high-frequency data. Consequently, the state of the art monetary policy framework to date, the so-called MP, uses annual country by country data to fine-tune country specific monetary policy. We yield to those constraints and estimate our model economy using Cameroon's annual data over 1979-2014.

The domestic observable time series are the Gross Domestic Product (GDP), foreign exchange reserves, money, consumption, the deposit interest rate, capital stock, bank deposits, the consumer price inflation and claims on the private sector by banks. Italy's export unit price index is used as a proxy for the price of foreign good because it is among Cameroon's main trading partners. The one year US deposit Libor is used to proxy the international interest rate[14].

3.3 Fixed parameters

We calibrate a subset of the model's parameters. In order to set the fraction of input costs that are borrowed from local banks, we take our cue from two pieces of information. First, Iossifov and al. (2009) find that while the highly capital-intensive oil sector is the main economic sector in CEMAC oil producers, oil is chiefly extracted by foreign companies. Those companies eschew local financing because they can turn to international banks or credit markets to secure funds for investment. Second, a report from the IMF (2015a)) notes that banks hold large amounts of excess reserves because of the lack of safe lending opportunities, the absence of trust among interbank market participants and of appropriate sterilization policy. We account for those facts by setting the fraction of borrowed funds by intermediate good producers, exporters and importers to 0.01 ($\nu^f = \nu^x = \nu^m = 0.01$). Banks' reserves requirement η_{res} is fixed to 0.10. We set the ratio of government revenue and expenditure to GDP to the average value computed from available years of data ($\eta^T = 0.11, \eta^G = 0.12$). We assume that the budget stance does not require a monetary finance up to the 20% ceiling of previous year's revenue at all time and we set λ^{FZ} to its median value at 0.10. Owing to the low average real per capita growth rate of 0.08% and to obtain the average value of the interest rate in equilibrium, the subjective discount factor β is calibrated at 0.99. A few parameters that have proven to be difficult to identify are also fixed: the capital utilization cost parameters ($\sigma_a = 0.05, \sigma_b = 0.015$), the rate of depreciation of capital ($\delta^{bk} = 0.05$), the export elasticity $\eta_x = 1.5$, the inverse of the Frisch elasticity ($\sigma_L = 1$) and the parameter controlling the deviation of net foreign assets from its equilibrium value ($\phi_b = 0.01$).

3.4 Empirical results

Priors' and posteriors' parameter values are shown in Table 1, along with the 90% interval range of posterior parameters. The price indexation parameter κ_d is 0.56. It implies that non optimizing firms give more weight to previous year's inflation when

[14] Money and Libor series are extracted from International Financial Statistics (IMF). The stock of capital is extracted from Penn World Tables (Feenstra et al.(2015)). All other series are retrieved from the World Development Indicators database (The World Bank).

they set their current price. The Calvo proportion of firms that do not re-optimize ξ is 0.22, suggesting and expected lifetime of price of 1.29 year. The elasticities of substitution between domestic and imported goods are respectively $\eta_c = 2.36$ for consumption goods and $\eta_i = 0.05$ for investment goods. Therefore, households can more easily replace some of the imported consumption goods whereas firms have a hard time substituting imported investment goods with domestic investment goods because they are mostly poor substitutes when they exist. The posterior shares of imported goods in consumption ($\omega_c = 0.08$) and in investment ($\omega_i = 0.55$) corroborate the different degrees of substitutability highlighted by estimated demand elasticities. The share of *capital* income α is 0.31. While the extractive firms heavily use high-productivity capital service, the service and agricultural sectors are labor intensive sectors. Therefore, the labor's share should be *lower* than the share of capital service. The posterior elasticity of substitution between varieties of domestic goods (θ) implies a 3% mark-up in the domestic goods market. That value is much lower than those found in advanced economies - above 10% - where there are arguably many more ways to differentiate goods (PMG (2016)). The risk adjustment parameter $\tilde{\phi}_s$ is positive at 1.78, implying a lower premium on net foreign asset when interest rate differential is positive. It follows that if the deviation of the domestic interest from its NSS level is bigger than its foreign counterpart, the risk adjustment term Φ_t will be increasing to prompt the country to reduce its foreign liabilities. The posterior lending cost parameters α_{bkbg} and α_{sw} are respectively 0.16 and 0.17. The cost structure precludes failures which is in accordance with domestic banks' low risk appetite. Local banks lend to firms only if the risk of failure is as low as that incurred when lending to the government. The estimate for habit persistence $\mathfrak{h}$ is 0.82.

The range for AR(1) persistence estimate for all shocks is $0.57 - 0.98$ though all priors values are set to 0.85. The persistence of government expenditure and revenue shocks are on the low side of the range, respectively 0.69 and 0.57. It shows that monetary policy is biased towards the integrity of the FZ monetary union even though it is fine-tuned by country. Therefore, national fiscal policy should be flexible enough (low persistence) to accommodate the contingency of monetary policies that are set by the supranational monetary authorities. The highest shock persistence is obtained for the nominal exchange rate shock. This outcome is expected because of the fixed exchange rate between France's currency and the common currency of the FZ. Since its inception many decades ago, the parity was changed only once, in 1994.

The lowest standard deviation is estimated for the risk premium shock $\sigma_{\tilde{\phi}^u}$ and the largest for target inflation $\sigma_{\varepsilon^{\overline{\pi}^c}}$. There seems to be no proportional effects of those shocks on macroeconomic fluctuations as technology and fiscal shocks are shown to matter the most from variance decomposition.

Table 1: Priors and posteriors (InGa: Inverse Gamma)

		Prior			Posterior			
Parameter	Description	Density	Mean	Std.Dev	Mode	Std.Dev	90% Interval	
ξ	Calvo probability of no price reoptimization	Beta	0.2	0.02	0.222	0.022	0.192	0.265
κ_d	Price indexation parameter	Beta	0.51	0.05	0.56	0.047	0.491	0.644
α	Elasticity of output to capital	Beta	0.34	0.03	0.313	0.02	0.274	0.34
A_L	Constant in the demand for labor	Gamma	4	0.4	4.265	0.393	3.71	4.884
A_q	Constant in the demand for real money	Beta	0.75	0.08	0.766	0.071	0.623	0.857
h	Habit persistence	Beta	0.8	0.1	0.869	0.033	0.823	0.933
η_c	Elasticity of subst. between imported and domestic cons. good	Gamma	3.2	0.32	2.360	0.235	2.043	2.8
η_i	Elasticity of subst. between imported and domestic inv. good	Gamma	0.05	0.005	0.049	0.005	0.042	0.057
ω_c	Share of imported consumption	Beta	0.10	0.01	0.097	0.008	0.085	0.113
ω_i	Share of imported capital investment	Beta	0.60	0.06	0.543	0.025	0.515	0.595
σ_q	Demand for money curvature parameter	Gamma	10	1	9.975	1.018	8.393	11.8
θ	Elasticity of substitution between varieties of domestic goods	Gamma	31	3	32.901	3.303	28.35	39.23
α_{bkbg}	Bank's cost parameter relative to government bond	Beta	0.2	0.02	0.198	0.02	0.164	0.229
α_{sw}	Bank's cost parameter relative to firms' loans	Beta	0.2	0.02	0.199	0.019	0.168	0.23
$\tilde{\phi}_s$	Risk adjustment parameter	Gamma	1.25	0.1	1.779	0.092	1.632	1.937
$\rho_{\varepsilon^{\pi*}}$	Foreign inflation persistence	Beta	0.85	0.075	0.978	0.014	0.949	0.991
ρ_{ε^q}	Stationary output shock persistence	Beta	0.85	0.075	0.91	0.043	0.851	0.998
$\rho_{\overline{\pi}^c}$	Target inflation persistence	Beta	0.85	0.075	0.878	0.032	0.820	0.926
ρ_{ε^c}	Consumption shock persistence	Beta	0.85	0.075	0.777	0.114	0.585	0.948
ρ_{ε^m}	Money shock persistence	Beta	0.85	0.075	0.867	0.06	0.759	0.952
$\rho_{\tilde{\phi}^u}$	Risk premium shock persistence	Beta	0.85	0.075	0.87	0.081	0.718	0.957
ρ_{μ^z}	Trend growth shock persistence	Beta	0.85	0.075	0.712	0.068	0.599	0.818
ρ_T	Government revenue persistence	Beta	0.85	0.075	0.574	0.056	0.487	0.673
ρ_G	Government expenditure persistence	Beta	0.85	0.075	0.69	0.048	0.608	0.763
ρ_{ε^S}	Nominal exchange rate persistence	Beta	0.85	0.075	0.977	0.025	0.922	0.992
$\rho_{\varepsilon^{R*FZ}}$	Interest rate on reserves persistence	Beta	0.85	0.075	0.815	0.049	0.720	0.883
$\rho_{\varepsilon^{bkr}}$	Bank reserves persistence	Beta	0.85	0.075	0.886	0.069	0.750	0.963
$\sigma_{\varepsilon^{\pi*}}$	Size of foreign inflation shock	InGa	0.5	∞	0.085	0.011	0.073	0.109
σ_{ε^q}	Size of Stationary output shock	InGa	0.5	∞	0.113	0.018	0.089	0.146
$\sigma_{\varepsilon^{\overline{\pi}^c}}$	Size of Target inflation shock	InGa	0.5	∞	1.38	0.396	1.006	2.284
σ_{ε^c}	Size of Consumption shock	InGa	0.5	∞	0.412	0.174	0.237	0.736
$\sigma_{\tilde{\phi}^u}$	Size of risk premium shock	InGa	0.5	∞	0.068	0.007	0.059	0.081
$\sigma_{\varepsilon^{\mu^z}}$	Size of the trend growth shock	InGa	0.5	∞	0.091	0.013	0.075	0.12
σ_{ε^T}	Size of the government revenue shock	InGa	0.5	∞	0.102	0.015	0.083	0.132
σ_{ε^G}	Size of the government expenditure shock	InGa	0.5	∞	0.088	0.014	0.073	0.116
σ_{ε^S}	Size of the nominal exchange rate shock	InGa	0.5	∞	0.724	0.123	0.528	0.924
$\sigma_{\varepsilon^{R*FZ}}$	Size of the interest rate on reserves shock	InGa	0.5	∞	0.147	0.024	0.119	0.199
$\sigma_{\varepsilon^{bkr}}$	Size of Bank reserves shock	InGa	0.5	∞	0.23	0.377	0.111	1.117
σ_{ε^m}	Size of money shock	InGa	0.5	∞	0.162	0.022	0.133	0.202

4 Economic implications

The economic implications of the model are analyzed along two dimensions. We first look at shocks that are driving macroeconomic fluctuations by examining the variance decomposition. Second, we assess the transmission mechanisms in our setup by examining the impulse response functions of a one percent shock on a selected aggregate variables.

4.1 Variance decomposition

Table 2 shows the relative contribution of selected shocks to the forecast error variance of aggregate variables for 1, 2, 5 years horizon. Looking at output, investment, hours, net exports and net foreign assets, it can be noticed that macroeconomic fluctuations and the external accounts are mainly driven by four shocks: the permanent technology shock, the transitory technology shock, and fiscal policy shocks. In the first year (Table 2a), the permanent technology shock only affects investment, net foreign assets and net export. In the second year (Table 2b), only hours worked do not show an increasing contribution of the permanent technology shock. The bulk of their fluctuations is explained by government expenditure and taxes. In a five-year horizon (Table 2c), fiscal policy and permanent technology shocks are the main sources of fluctuations for the selected variables.

Owing to the CFAF pegging to France's currency and to the interest payments on a fraction of Cameroon's foreign exchange reserves by the French Treasury, it is perhaps useful look into the contribution of shocks on those variables to aggregate fluctuations. Using an arbitrary threshold of 10%, Table 2a and 2b show that a shock on the related interest rate has a sizeable contribution in a one to two years horizon. During that time, banks' loan to firms and to the government, households' deposits, net foreign assets and of course foreign exchange reserves are the aggregates that are affected the most by the reserves' interest rate shock. Using the same 10%-threshold for the effects of a nominal exchange rate shock, Table 2c and 2d show that its contribution is potent on government debt, inflation and net foreign asset only above a 5-year horizon.

Overall, the variance decomposition findings are consistent with Hoffmaister et al (1997) as far as output growth is concerned. They estimate a structural VAR containing five variables to assess the sources of output growth fluctuations in a sample of FZC and non-FZC from sub-Saharan Africa. Using two balanced panels of annual observations from 1971 to 1993, they find that domestic shocks (supply, fiscal and nominal) explain more of the output fluctuations than foreign shocks (terms of trade or trade balance and world interest rate) in FZC. However, our contribution extends their work because the DSGE model dramatically increases the set of variables, shocks and structural parameters to be reckoned with.

Table 2a: Forecast error variance decomposition period 1 (in %, computed at the posterior mean)

	ξ_t^q	$\xi_t^{\overline{\pi}^c}$	ξ_t^c	$\xi_t^{\mu_z}$	ξ_t^G	ξ_t^T	ξ_t^s	$\xi_t^{R^*FZ}$	Total
inflation	10.18	6.19	2.31	6.07	46.60	28.00	0.59	0.02	100
money	14.17	2.39	1.23	15.94	34.64	20.61	3.31	6.73	100
Government debt	26.82	1.56	1.91	27.38	17.17	5.58	5.45	14.06	100
Firms' debt	10.92	35.86	2.86	9.41	23.79	10.72	5.90	0.51	100
Deposit	25.38	1.14	1.17	28.18	17.37	6.44	7.09	13.18	100
Labor	4.53	1.62	0.03	2.12	50.76	39.96	0.70	0.24	100
Wage	3.40	14.88	0.54	22.59	35.29	21.03	2.00	0.24	100
Rate of return on capital	15.66	2.32	1.27	15.94	34.06	20.15	3.45	7.12	100
Real rental rate of capital	6.69	0.40	1.48	1.38	52.99	36.41	0.29	0.31	100
Output	6.04	2.89	4.48	0.99	53.95	31.32	0.21	0.08	100
Consumption	2.65	0.02	28.56	50.93	10.29	7.35	0.05	0.16	100
Investment	0.18	0.23	0.98	27.10	40.16	30.15	0.35	0.82	100
RER	7.49	0.08	1.58	0.62	53.52	36.24	0.17	0.26	100
Net Foreign Assets	11.56	1.59	0.81	12.72	35.21	23.02	2.25	11.89	100
Foreign exchange reserves	0.84	2.90	0.85	30.11	21.28	16.49	7.29	18.74	100
Capital stock	0.03	0.03	0.15	87.60	6.86	5.15	0.05	0.13	100
$\frac{\text{Net export}}{\text{Output}}$	17.61	4.70	1.51	47.96	16.32	9.88	1.24	0.77	100

Computed at the posterior mean

Table 2b: Forecast error variance decomposition period 2 (in %, computed at the posterior mean)

	ξ_t^q	$\xi_t^{\overline{\pi}^c}$	ξ_t^c	$\xi_t^{\mu_z}$	ξ_t^G	ξ_t^T	ξ_t^s	$\xi_t^{R^*FZ}$	Total
inflation	12.08	2.56	1.37	13.85	34.87	20.46	13.13	1.66	100
money	12.50	1.86	1.15	12.78	35.12	21.44	5.01	9.64	100
Government debt	29.70	1.00	2.68	27.21	18.37	5.21	8.52	7.24	100
Firms' debt	12.33	15.03	3.50	30.31	12.78	6.59	3.60	15.85	100
Deposit	28.07	0.74	1.59	28.46	18.21	6.02	9.33	7.54	100
Labor	4.95	1.09	1.80	7.72	45.08	35.38	3.74	0.19	100
Wage	13.43	11.07	0.40	17.45	26.20	15.71	1.39	14.32	100
Rate of return on capital	13.41	1.79	1.21	12.75	34.75	21.11	5.15	9.79	100
Real rental rate of capital	5.76	0.28	1.34	3.06	1.92	36.13	1.08	0.39	100
Output	3.51	1.57	5.36	17.03	42.62	26.45	0.11	3.32	100
Consumption	4.08	0.01	27.33	52.91	8.88	6.49	0.06	0.22	100
Investment	0.31	0.18	0.90	29.75	38.84	29.46	0.17	0.36	100
RER	5.97	0.12	1.50	2.64	52.20	35.97	0.87	0.68	100
Net Foreign Assets	9.13	3.81	0.78	10.02	35.71	25.06	1.96	12.25	100
Foreign exchange reserves	2.24	1.68	1.35	20.64	30.69	21.99	4.68	15.22	100
Capital stock	0.08	0.04	0.23	80.68	10.70	8.12	0.05	0.10	100
$\frac{\text{Net export}}{\text{Output}}$	9.49	1.86	1.15	38.72	25.94	19.08	1.48	2.26	100

Computed at the posterior mean

Table 2c: Forecast error variance decomposition period 5 (in %, computed at the posterior mean)

	ξ_t^q	$\xi_t^{\overline{\pi}^c}$	ξ_t^c	$\xi_t^{\mu_z}$	ξ_t^G	ξ_t^T	ξ_t^s	$\xi_t^{R^*FZ}$	Total
inflation	11.07	1.93	1.09	12.07	36.77	22.67	11.28	3.10	100
money	11.36	1.78	1.07	12.16	36.05	22.75	4.81	9.21	100
Government debt	31.91	0.59	4.42	23.49	18.18	5.01	11.29	5.01	100
Firms' debt	9.57	4.95	5.48	42.13	18.27	12.95	1.25	5.37	100
Deposit	30.81	0.49	2.55	26.32	17.40	5.43	10.95	5.97	100
Labor	7.88	0.76	12.41	16.51	33.30	25.71	2.83	0.57	100
Wage	27.63	9.06	0.36	16.91	20.81	12.52	1.08	11.61	100
Rate of return on capital	12.12	1.72	1.14	12.18	35.91	22.61	4.93	9.37	100
Real rental rate of capital	3.93	0.20	1.12	11.28	47.98	34.31	0.75	0.40	100
Output	3.50	0.66	6.46	31.47	33.56	23.00	0.08	1.24	100
Consumption	7.63	0.02	24.22	54.68	7.60	5.75	0.02	0.07	100
Investment	0.65	0.08	0.75	32.27	37.33	28.66	0.12	0.11	100
RER	4.09	0.11	1.41	9.85	48.74	34.57	0.63	0.56	100
Net Foreign Assets	17.50	3.46	1.08	17.50	23.92	15.72	13.41	6.15	100
Foreign exchange reserves	4.74	1.61	2.14	10.33	39.59	26.72	5.93	7.68	100
Capital stock	0.26	0.04	0.35	66.16	18.70	14.37	0.06	0.03	100
$\frac{\text{Net export}}{\text{Output}}$	2.63	0.39	0.51	33.84	34.75	26.88	0.48	0.50	100

Computed at the posterior mean

4.2 Impulse responses

The variance decompositions have shown that technology and fiscal policy shocks account for the bulk of aggregate fluctuations in the economy. We next examine the impulse response functions (IRFs) of one-percent size of those shocks to shed light on the propagation mechanism in the economy.

4.2.1 Permanent technology shock

Graph 1a shows the IRFs for a 1-percent positive permanent shock to technology. Hours, capital service, investment along with output decline from first to fifth year from where they move to their respective new NSS level. Aside from output, the decline of those aggregates is broadly consistent with the extreme case of fixed money supply, short run price stickiness and a demand for money that obeys to the quantity theory. In such a case, output must be constant and firms, that must produce the same amount with less inputs, reduce their investment (Basu et al (2004))[15]. In contrast to the latter theoretical case, output is not constant because monetary policy is more accommodative in order to mitigate the effects of a positive technology shock as the IRF of money shows.

Real wage rises initially then falls a year later before starting to revert to its new NSS. The revenue effect dominates in the first year only as real wage increase leads to a fall of labor supply. Aggregate consumption declines throughout the adjustment

[15] It is worth recalling that Franc Zone's monetary policy successive frameworks have been inspired by the quantity theory, including their latest Monetary Programming model.

process. The decline in aggregate consumption and the time profile of investment results in a trade balance surplus and an accumulation of foreign exchange reserves.

4.2.2 Transitory technology shock

The IRFs for a 1-percent positive transitory shock to technology is shown on Graph 1b. Firms need more time to adjust labor to its initial NSS level than capital service (more than 15 years vs 5 years) because of the time profile of their prices. The real rental rate of capital reverts to its initial NSS level in 5 years while the real wage needs almost 15 years to do so. Interestingly, after an initial fall, output overshoots its NSS level in the second year and converges to that level from above. The transitory technology shock results in an increase in output, consumption and investment that prompts monetary authorities to adopt a more restrictive policy to cool inflation off and obligates the government to seek bank financing to fulfill its budget constraint. In that respect, from the first to the fifth year, the IRFs show that money and the consumer price inflation move sideways to reach their initial NSS levels while government's bank debt decreases from beginning to end after an initial positive jump. The country's net foreign assets and accumulation of foreign exchange reserves improve along with the reversion of the trade balance to its initial NSS level.

4.2.3 Government expenditure shock

Government spending falls on domestic good only. So, output jumps the instant a one-percent shock hits government expenditure (Graph 1c). Firms instantly adjust to the new output level by substituting labor with capital service. Initially, the revenue effect dominates the substitution effect in the households' labor-leisure but starting from the second year, the substitution effect prevails though firms still prefer to use more capital in their production process. A hump-shape aggregate investment results from this shock, with a peak in the fifth year. The IRFs of consumption, net export, net foreign assets and foreign exchange reserves show that investment is the driving force behind the country external accounts. In effect, upon investment peak, net foreign assets stabilizes and foreign exchange loss starts to improve. Monetary finance is the main financing source of the government's budget until money reverts to its initial NSS in the fifth year. Interestingly, after a government expenditure shock, there is no surge in the consumer price inflation which reverts to its NSS level from below.

4.2.4 Government revenue shock

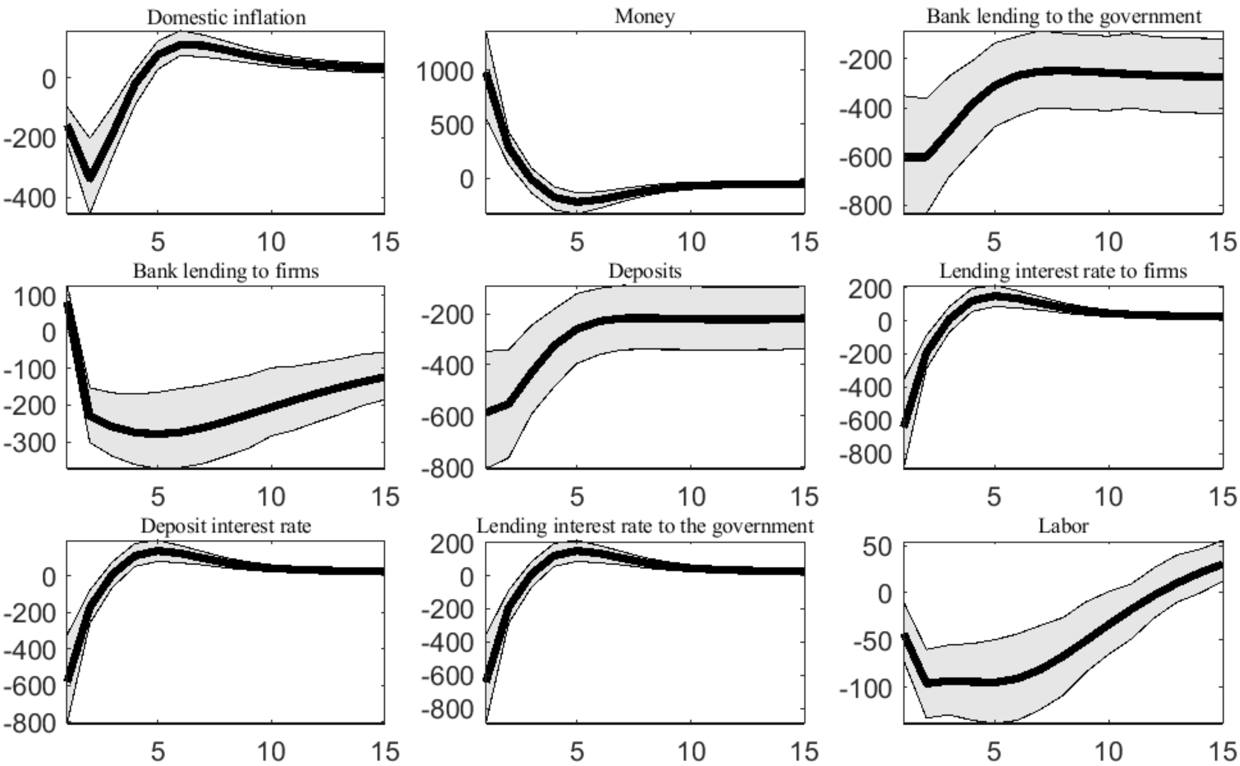
The IRFs of a 1-percent shock on government revenue is accompanied by an instantaneous fall in resources available for firms and households. Both the rate of return on investment in a unit of physical capital and the real rental rate of capital rise but the latter rises more (Graph 1d). Firms are compelled to use more labor than capital service. To recoup tax losses stemming from the shock, households supply more labor at a lower wage rate though and also reduce their consumption. The fall in consumption and investment (because of the wedge between cost and return in capital) leads to a fall in output. Consumer price inflation rises because firms pass on a fraction of the higher input cost to consumers thanks to price stickiness. Monetary authorities sharply decrease government's monetary finance. From the external account standpoint, there is an initial decline in imports which is milder than that of consumption or investment, hence the small trade balance deficit and the loss in net foreign assets. Starting from the second year, all variables gradually revert to their initial NSS level.

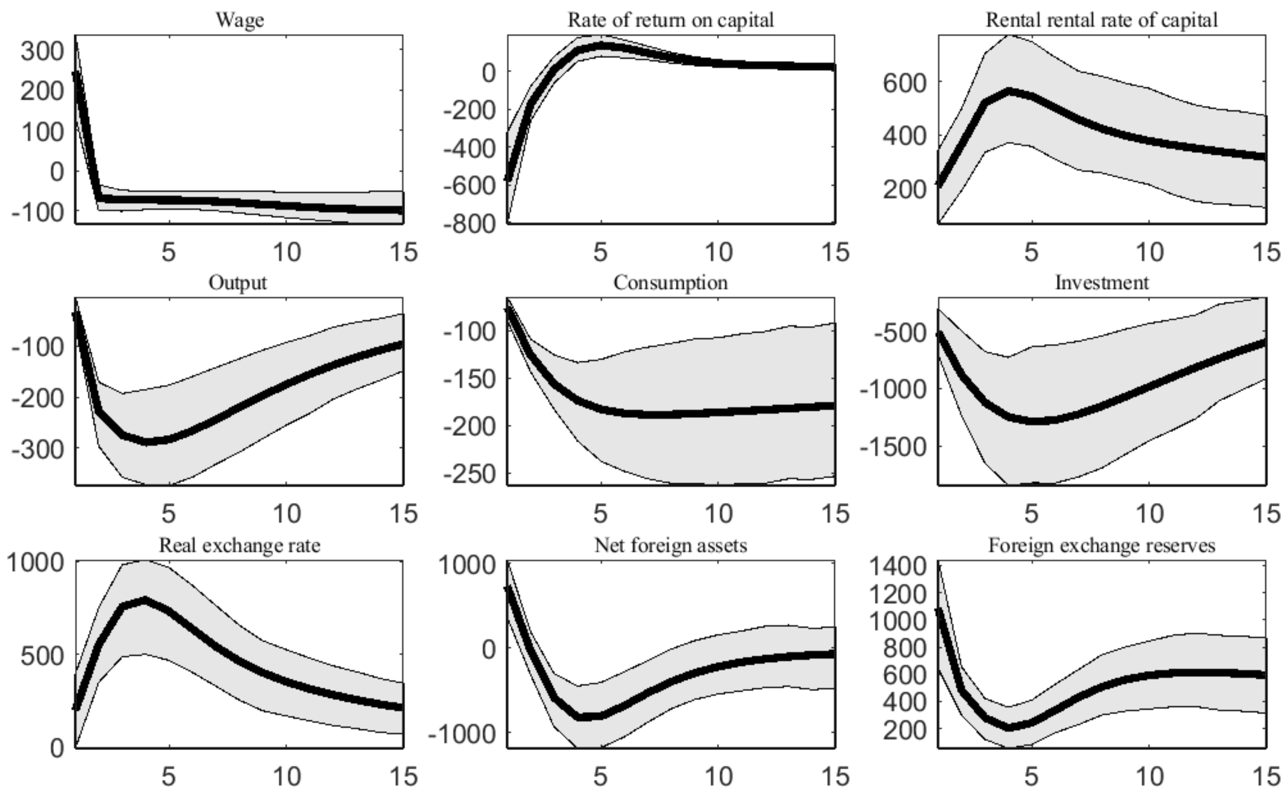
5 Conclusion

We have estimated a DSGE model of a small open economy that accounts for some of the FZ's most enduring features and provisions using the Bayesian method and Cameroon's data over the period 1979-2014. We find that technology shocks- transitory and permanent- and fiscal policy shocks are the driving force behind macroeconomic fluctuations in the country. A permanent technology shock and a tax revenue shock are both contractionary whereas a transitory technology shock and a government spending both lead to an output expansion. In the data, Cameroon's average real growth per capita is barely positive during our estimation period, suggesting that the country is mostly buffeted by shocks whose contractionary effects are long-lasting. Transitory technology and tax revenue shocks are inflationary. Foreign exchange accumulation is hampered by a positive shock on government expenditure. Overall, our findings suggest that FZ membership require Cameroon to elaborate and implement a very sound fiscal policy because of their sizeable effects on the economy. In addition, the current negative effect of permanent technology shock on aggregate fluctuations suggests that a brand new growth strategy is much needed to thrive in that monetary union.

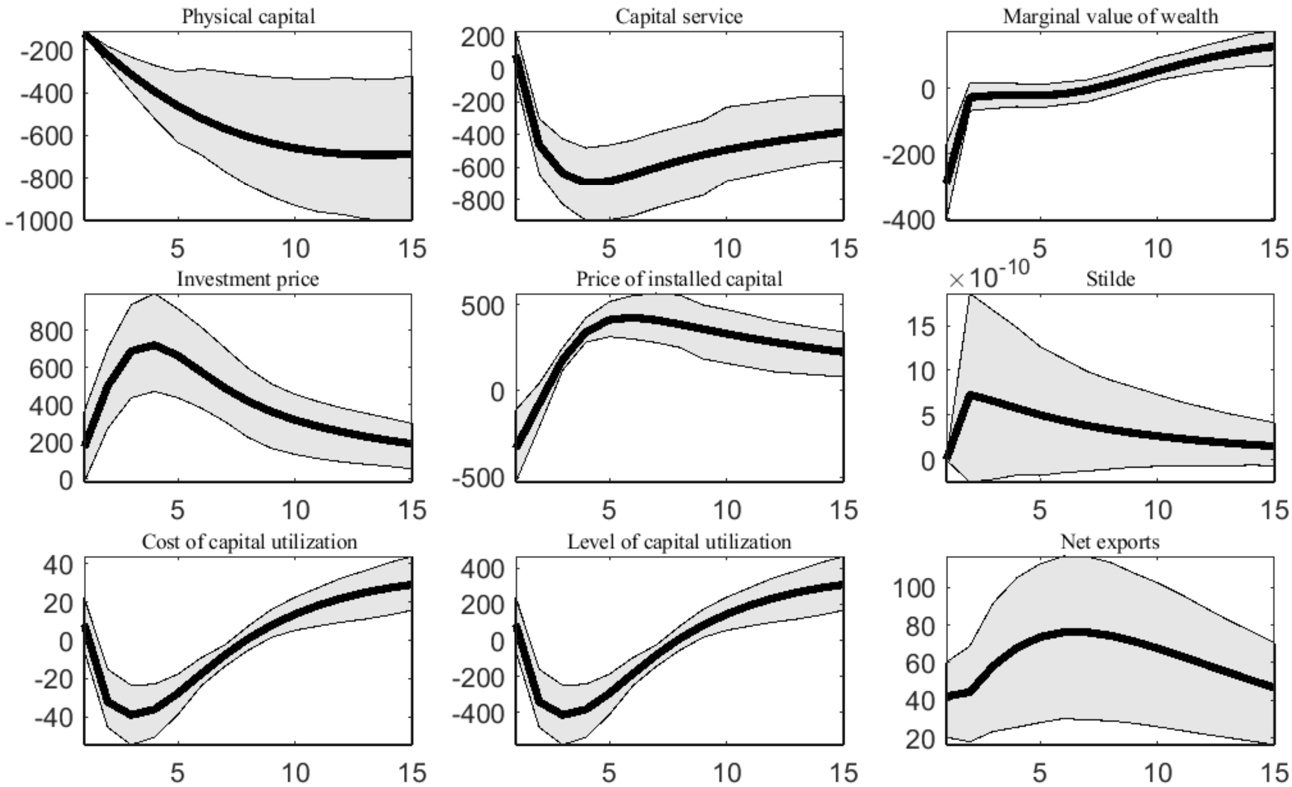
Graph 1: The impulse response functions (IRFs.)

Graph 1a: Permanent technology shock IRFs (basis point on the y-axis)

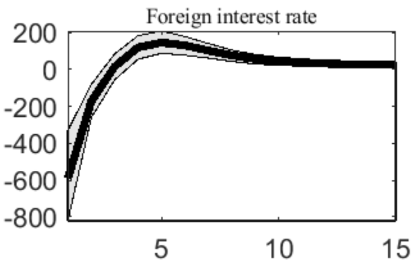




Wage
Rate of return on capital
Rental rental rate of capital
Output
Consumption
Investment
Real exchange rate
Net foreign assets
Foreign exchange reserves

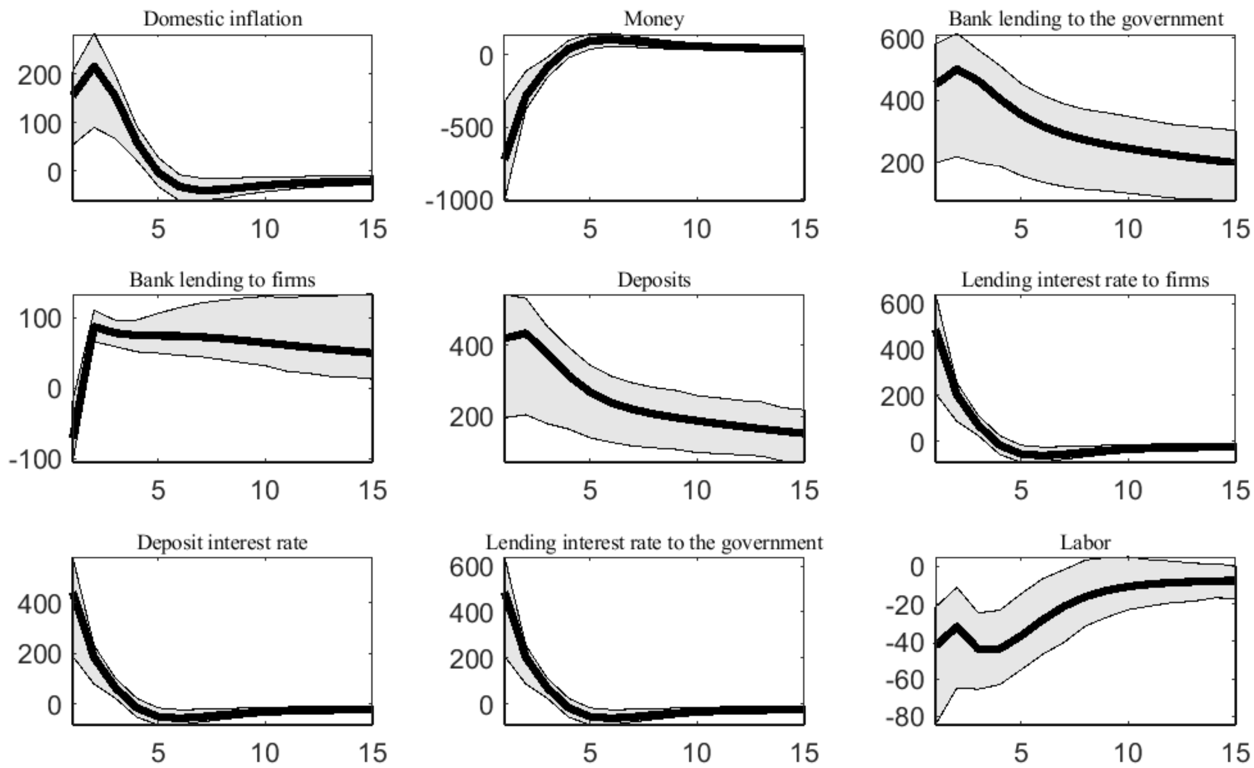


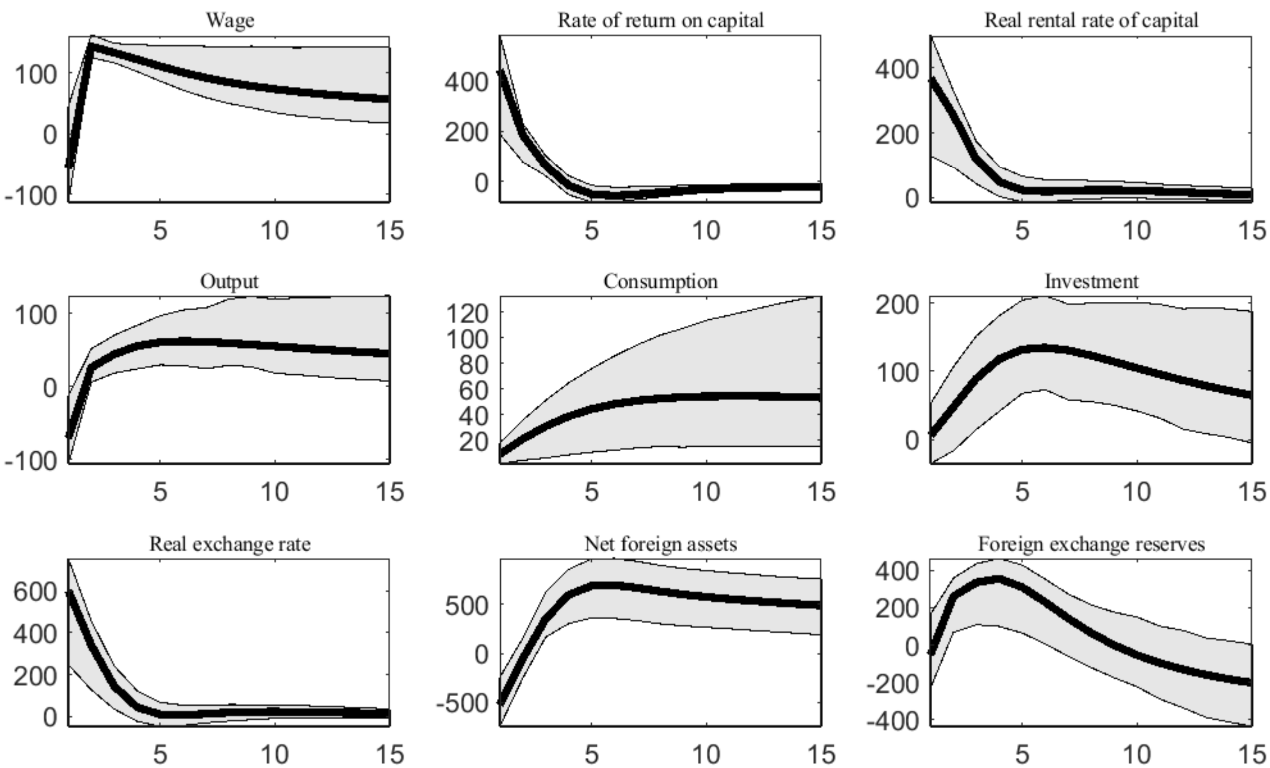
Physical capital
-200
-400
-600
-800
-1000
5
10
15
Capital service
200
0
-200
-400
-600
-800
5
10
15
Marginal value of wealth
0
-200
-400
5
10
15
Investment price
800
600
400
200
0
5
10
15
Price of installed capital
500
0
-500
5
10
15
×10^-10
Stilde
15
10
5
0
5
10
15
Cost of capital utilization
40
20
0
-20
-40
5
10
15
Level of capital utilization
400
200
0
-200
-400
5
10
15
Net exports
100
80
60
40
20
5
10
15

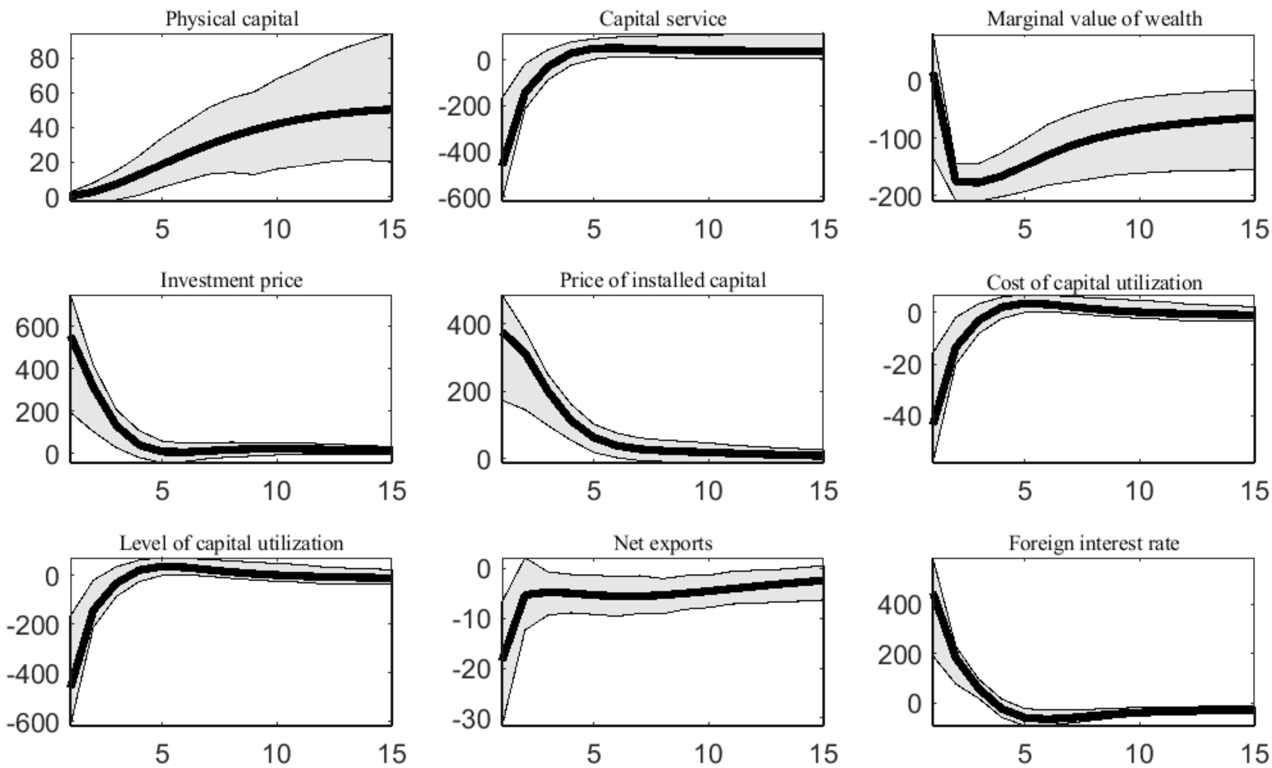


Foreign interest rate
200
0
-200
-400
-600
-800
5
10
15

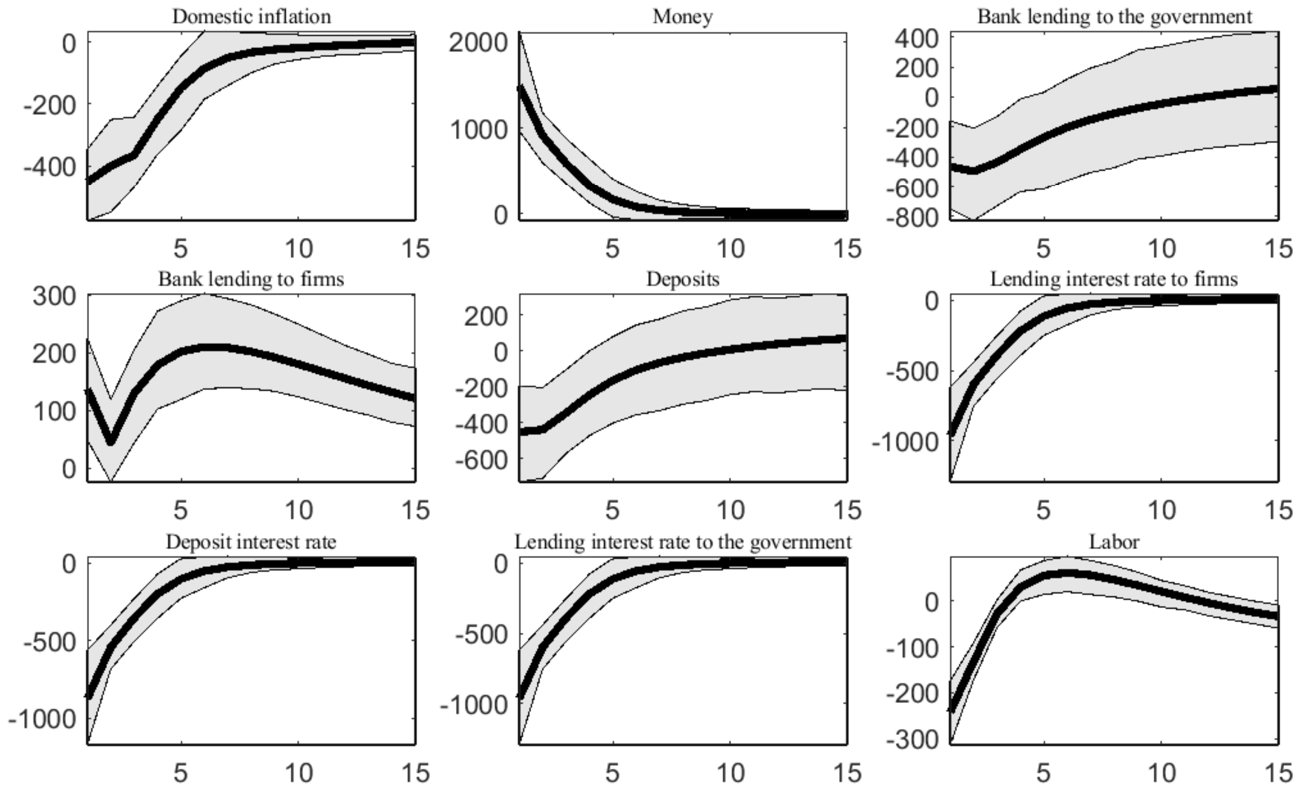
Graph 1b: Transitory technology shock IRFs (basis point on the y-axis)

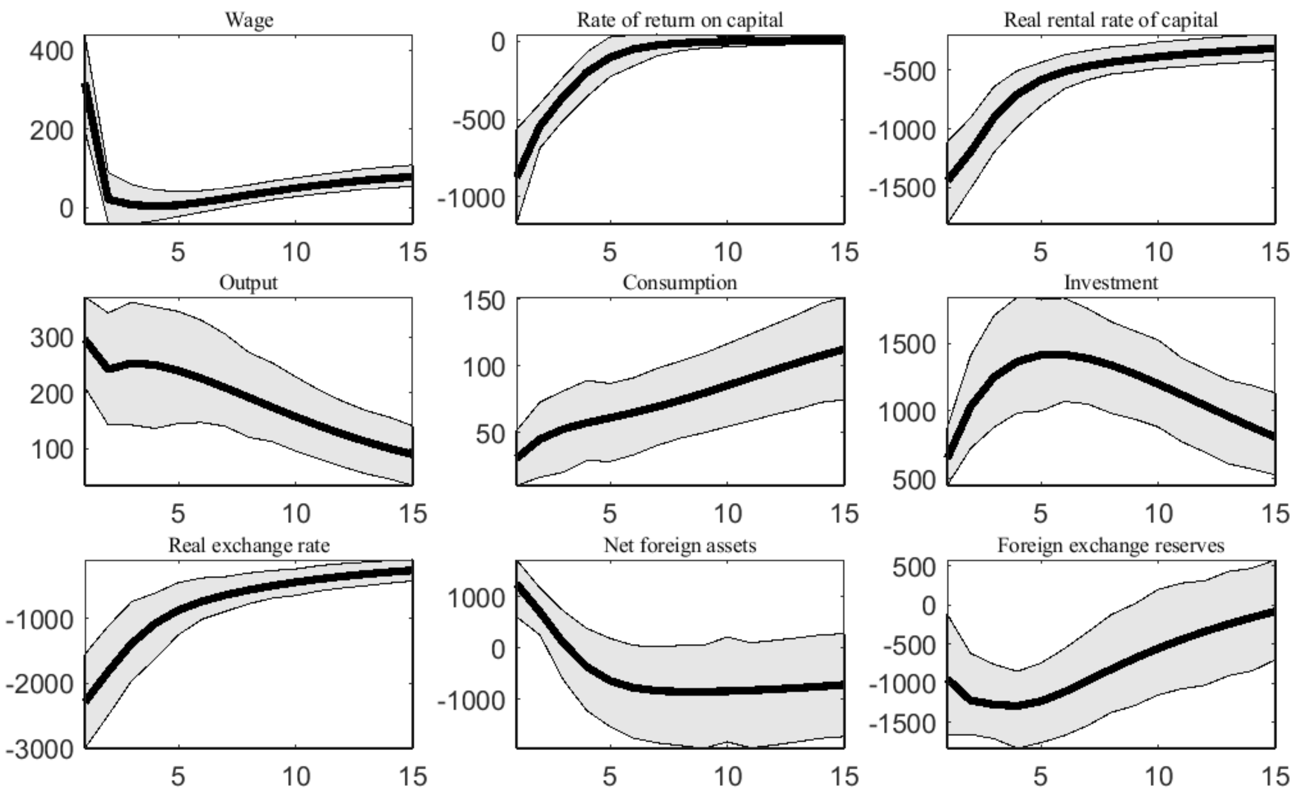



Wage
100
0
-100
5
10
15
Rate of return on capital
400
200
0
Real rental rate of capital
400
200
0
Output
100
0
-100
Consumption
120
100
80
60
40
20
Investment
200
100
0
Real exchange rate
600
400
200
0
Net foreign assets
500
0
-500
Foreign exchange reserves
400
200
0
-200
-400

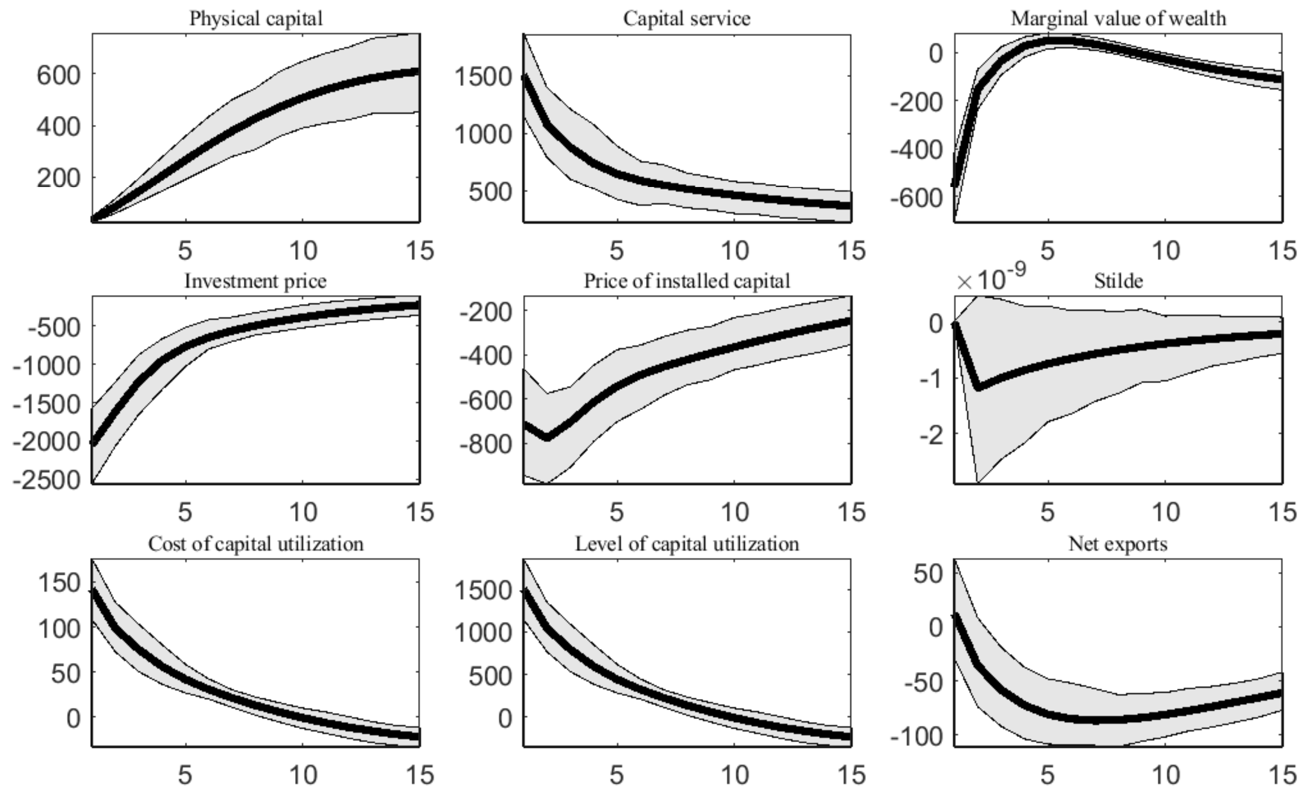

Physical capital
Capital service
Marginal value of wealth
Investment price
Price of installed capital
Cost of capital utilization
Level of capital utilization
Net exports
Foreign interest rate

Graph1c: Government expenditure shock IRFs (basis point on the y-axis)

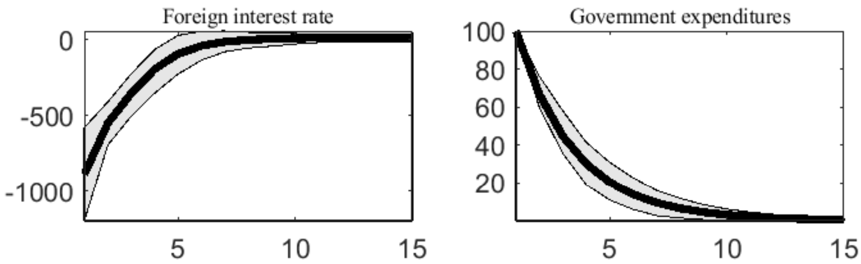




Wage
Rate of return on capital
Real rental rate of capital
Output
Consumption
Investment
Real exchange rate
Net foreign assets
Foreign exchange reserves

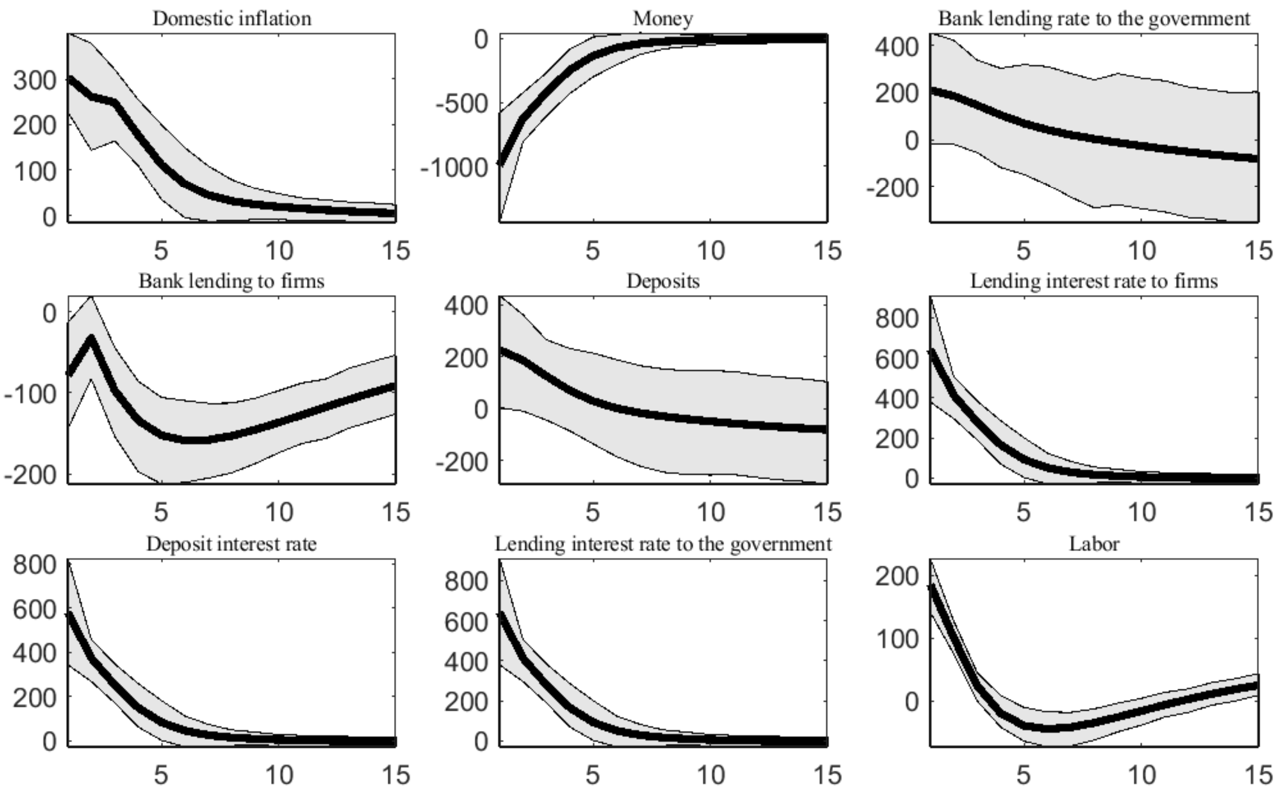


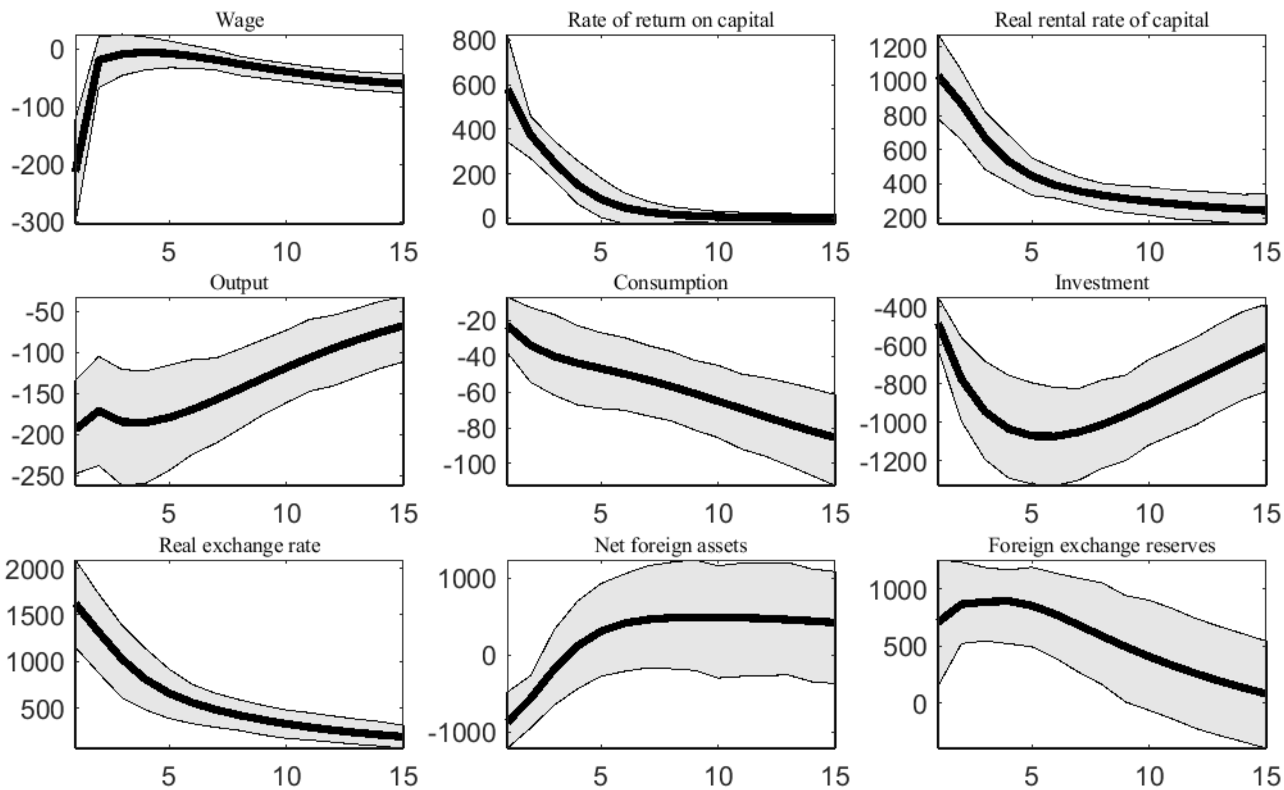
Physical capital
600
400
200
5
10
15
Capital service
1500
1000
500
Marginal value of wealth
0
-200
-400
-600
Investment price
-500
-1000
-1500
-2000
-2500
Price of installed capital
-200
-400
-600
-800
× 10^-9
Stilde
0
-1
-2
Cost of capital utilization
150
100
50
0
Level of capital utilization
1500
1000
500
0
Net exports
50
0
-50
-100



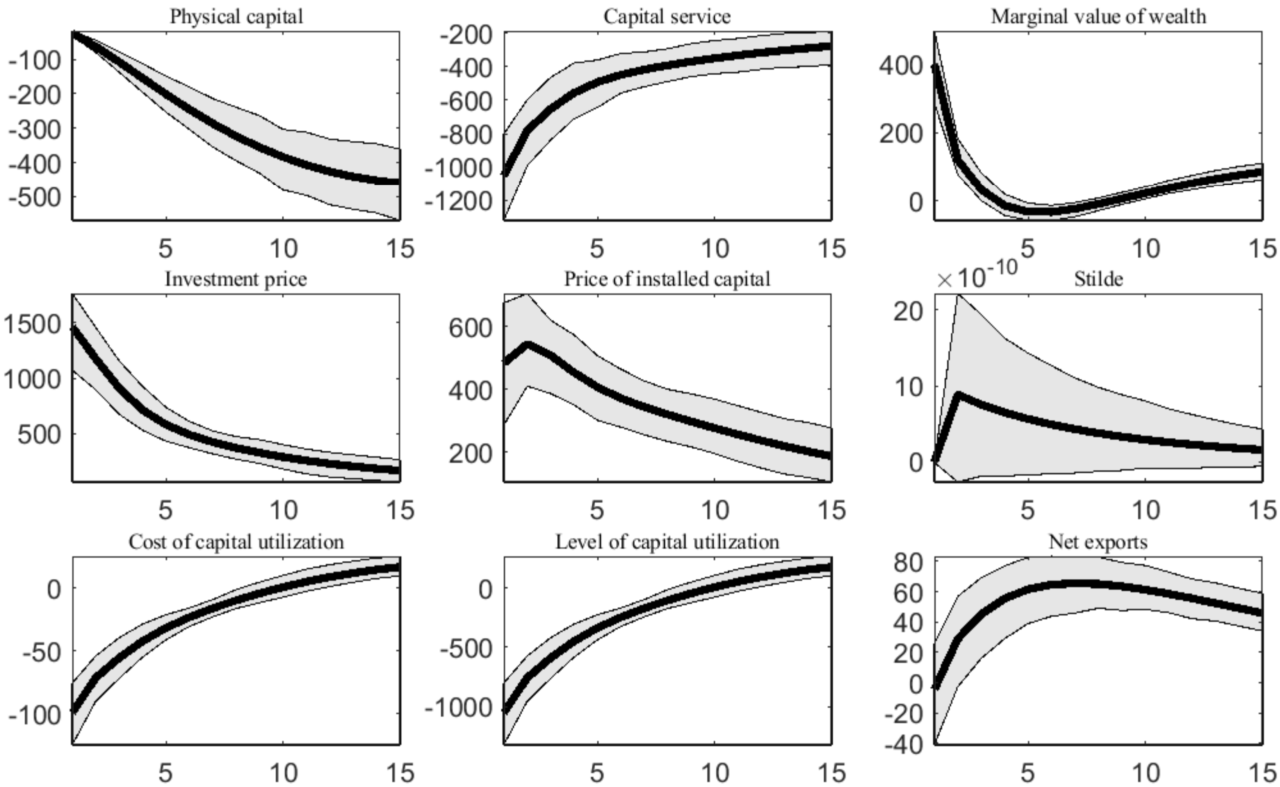
Foreign interest rate
0
-500
-1000
5
10
15
Government expenditures
100
80
60
40
20
5
10
15

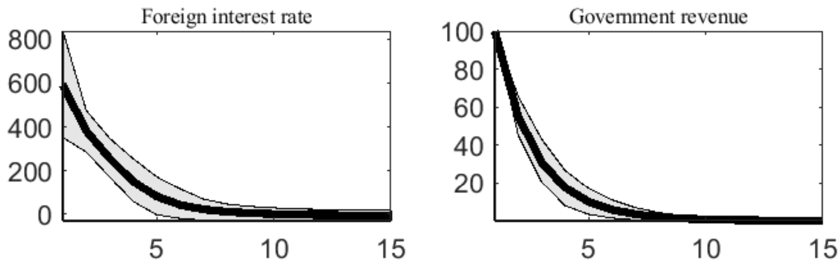
Graph 1d: Government revenue shock IRFs (basis point on the y-axis)





Wage
Rate of return on capital
Real rental rate of capital
Output
Consumption
Investment
Real exchange rate
Net foreign assets
Foreign exchange reserves
0
-100
-200
-300
800
600
400
200
0
1200
1000
800
600
400
200
-50
-100
-150
-200
-250
-20
-40
-60
-80
-100
-400
-600
-800
-1000
-1200
2000
1500
1000
500
1000
0
-1000
1000
500
0
5
10
15


Physical capital
-100
-200
-300
-400
-500
5
10
15
Capital service
-200
-400
-600
-800
-1000
-1200
5
10
15
Marginal value of wealth
400
200
0
5
10
15
Investment price
1500
1000
500
5
10
15
Price of installed capital
600
400
200
5
10
15
$\times 10^{-10}$
Stilde
20
10
0
5
10
15
Cost of capital utilization
0
-50
-100
5
10
15
Level of capital utilization
0
-500
-1000
5
10
15
Net exports
80
60
40
20
0
-20
-40
5
10
15



Foreign interest rate
800
600
400
200
0
5
10
15
Government revenue
100
80
60
40
20
5
10
15