Land Collateral and Rule-of-Thumb Households in a Franc Zone Country: A Bayesian Appraisal

NANA DAVIES, Charles

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Charles NANA DAVIES
University of Reims Champagne-Ardenne
charles.nana-davies@univ-reims.fr

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Abstract

We model the supply side of the banking sector, two types of households and a land asset collateral in a small open economy model that accounts for some of the most enduring features and provisions of the Franc Zone. The model is estimated using the Metropolis-Hasting algorithm and Cameroon's annual data from 1979 to 2016. Four findings stand out. First, sensible posteriors of some deep parameters are obtained when the proportion of rule-of-thumb households is set to forty-eight percent. Second, permanent technology, bank profit, consumption and foreign inflation shocks are the main drivers of macroeconomic fluctuations. Third, among those shocks, only a bank profit shock, which is associated with a sharp drop of wholesale interest rates, leads to an output expansion. Fourth, fiscal policy matters but through its effects on banks' balance sheet.

Key Words: Franc Zone - Cameroon - Land Collateral - Rule-of-Thumb households - 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 the 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 keep an adequate amount of foreign exchange reserves to back M2 money supply. To hit those aggregate monetary policy targets, monetary policy instruments are set at their country-specific values because economic integration is deficient in the CEMAC monetary union. 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 is set by analyzing and extrapolating the balance of payments' deficit and the financial needs of the private and the public sector.

CEMAC's monetary authorities used to consider that MP and the declaration of BEAC's mandate were an improvement from the policy practice prior to 1994. By the end of 2017, they were still contemplating the end of MP in order to "calibrate monetary policy operations based on autonomous liquidity factors forecasts" (IMF (2017a, b)).

We do not deal with FZ's monetary policy per se. Instead, our aim is to contribute to an informed decision making on such policy by tackling the effects of shocks in a DSGE open economy model where some of the most enduring features of FZ's monetary policy and institutional provisions are parametrized. We depart from estimating reduced form equations (BEAC (1994)) that is implicit in the MP approach by using the Bayesian approach because it alleviates some of the pitfalls pertaining to data scarcity or quality invoked by the proponents of MP[2].

This is not an easy task for a typical FZC though. 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 relies on a three-year average formula of a set of indicators i.e. an essentially backward looking framework. For example, from the 2017 budget, the new fiscal balance criterion sets a floor of -1.5 percent of GDP on the reference fiscal balance (IMF (2017b), (IMF (2019a))[3]. The purpose of achieving convergence criteria for the level of foreign and government domestic debts[4] is to achieve a moderate inflation in member countries and safeguard the integrity of a monetary union which is more institutional than optimal.

[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. Some ground work has been undertaken in Nana-Davies (2018).

[3] The new criterion defines the reference fiscal balance as the overall fiscal balance minus the sum of 20% of oil revenue and 80% percent of the difference between oil revenue and their average relative to GDP over the previous three years (IMF (2017)).

[4] Aside from the floor on the reference fiscal balance, the new set of convergence criteria includes: 3% target for consumer inflation, 70% cap on the public debt to GDP ratio and a negative ratio of the change in the stock of arrears (domestic and foreign) to GDP (IMF (2019)).

For a member of any kind of currency union, devising a sound fiscal policy is particularly valuable because fiscal policy tools only are available to its government. Since government expenditures and revenues data series are sketchy for all CEMAC countries, such a goal seems to have been mostly off the radar[5]. Because of missing data series, the identification of parameters related to a fiscal feedback policy rule fails when a Bayesian estimation is attempted. We use calibrated parameters to gain an insight into the effects of fiscal policy shocks[6].

Since its creation, the CFAF has been pegged to France's currency at a fixed exchange rate. In our model economy, the fixed exchange rate feature of the FZ arrangement is captured by assuming that base money is endogenous and that France's inflation rate is used as the target inflation when domestic producers set their prices with a Calvo-pricing procedure. In fact, pegging the CFAF exchange rate to the Euro or to whichever French currency is per se ensuring long run inflation rate convergence between the CEMAC countries and France. Moreover, the endogeneity of base money is germane to a fixed exchange rate unless perfect sterilization is put in place. During our estimation period, moderate inflation has been mostly achieved in CEMAC countries by setting a ceiling on monetary budget financing to twenty percent of the previous year's tax revenues[7].

The non-accumulation of external payment arrears has a safe place in the three iterations of multilateral surveillance. Over the forty years span between 1979 and 2018, the peak years for the ratio of external payments arrears to GDP were different from one country to another, leading one to infer that some country-specific factors might be at work[8]. In contrast, over that time span, external arrears accumulation occurred at least one in two years in CEMAC countries, suggesting that there may also be a common cause for external arrears accumulation in those countries[9]. We do not explore those two issues in depth in our model. However, we take the non-accumulation of external payment arrears seriously by using a risk adjustment term that translates into a higher effective foreign interest rate when net foreign assets, modelled as foreign debt, are above their non-stochastic steady state (NSS) level (Schmitt-Grohe and Uribe (2002), Christiano et al. (2011)).

The non-accumulation of domestic private and public payment arrears is the other pillar of the multilateral surveillance. In the model economy, we account for government arrears payments delays indirectly. We use a government flow budget constraint

[5] Amongst FZC, Chad and Gabon have no government revenue data while others have at best ten data points between 1979 and 2018 (World Development Indicator database).

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

[7] Obviously, the implementation of administered price in those countries dampens down nationwide inflationary pressure indicator but may also biases it. For instance, the prices of fuels, cement, and power are set by the Cameroon's government.

[8] The peak years for the ratio of external payments are as follows: Chad (6% in 1987), Gabon (15% in 1993), Cameroon (6% in 1996), Congo (73% and 75% in 1998 and 2003 respectively) and Central African Republic (18% in 2005) (Computed using data from World Development Indicators).

[9] The ratio is the number of times where there is a positive difference between two consecutive years of external arrears repayments divided by 40. The computed figures are as follows: Cameroon 65%, Central African Republic 50%, Chad 53%, Congo 58% and Gabon 58%. For instance, in Gabon, a positive difference has been computed 23 times (data extracted from World Development Indicators).

which binds at each period and where the monetary finance of budget deficit is set at the mid-range of the statutory bracket. Therefore, government debt increase is held in check given a lump-sum tax rate that is set at its average value.

The non-accumulation of domestic private payment arrears is dealt with by subjecting private borrowers to a borrowing collateral constraint that has a high cost of repossession in case of default. Moreover, the borrowing collateral constraint is always binding in the NSS as in Iacoviello (2005).

The financial sector is dominated by banks in the CEMAC. Yet, the long-standing excess liquidity in the banking sector shows that there is a pervasive fear of lending to the private sector among CEMAC's banks. For instance, the excess liquidity of the banking sector represented 12% of their balance sheet in 2016 and 2.2% of CEMAC Gross Domestic Product in 2019. Both figures are deemed to be too high by the IMF (2016, 2019b). In Cameroon, the causes of fear of lending include an improper accounting and bookkeeping practices in the corporate sector, a weak legal systems, and an expensive and cumbersome registration of collateral. Those factors are exacerbated by banks' foreseen fear to have difficulty refinancing at the BEAC because their eligible collateral are low and the quantity of outstanding government bonds limited (IMF (2005, 2016, 2019b)). Interestingly, Gerali et al. (2010) set forth a way to assess the role of credit-supply factors in business cycle fluctuations. Arguably, that framework is not meant to encompass all those fear of lending factors. However, since CEMAC banks' primary resources are deposits and their bottom line is shared almost equally between fees and interest rate spread (IMF (2016)), accounting for interest rate adjustment costs in an otherwise classic spread optimization problem helps to factor in other fees.

The inadequacy of financial inclusion is well established in the CEMAC. For example, in 2017, out of an average of the 31% of the population declaring having an account with a financial institution in the CEMAC, 5.8% succeeded in borrowing from those institutions or used a credit card, compared respectively to 43% and 8% for Sub-Saharan Africa. More importantly, 62.27% of the CEMAC population declared being unable to come up with emergency funds[10]. In our model, we accommodate for the inadequate financial inclusion by considering three types of private economic agents: - an optimizing household who has access to saving deposits, can trade in one physical asset (land or real estate) but cannot take out a loan from banks - an optimizing entrepreneur who can take out a loan to finance consumption or investment - an optimizing household who do not have access to and cannot trade in financial or physical assets. She/He can still smooth her/his consumption by adjusting her/his holdings of money as in Coenen et al (2007). For convenience only, the latter is dubbed the rule-of-thumb household[11].

For decades, FZ's monetary authorities have been relying on country-specific annual data to devise monetary policy because of the dearth of high frequency data and poor economic integration among its members (Masson and Patillo (2005)). We yield

[10] CEMAC's average computed from World Bank's FINDEX 2018 data (population age 16+ years).

[11] The rule-of-thumb household is perhaps a misnomer because the original Campbell-Mankiw (1989) rule-of-thumb household consumes all his/her disposable income (See the justification of our assumption below).

to that constraint and use Cameroon's annual data to estimate the model economy.

One of the findings of the paper is that fiscal policy does matter but through its effect on banks' balance sheet in a typical FZ model economy where the ratio of rule-of-thumb households, a bank supply side, and a binding collateral constraint are modelled.

The paper is organized as follows: The model is outlined in the second section and then estimated in the third section. Estimation results are commented in the fourth section. The fifth section concludes the paper.

2 The Model

The small country produces a homogenous good using intermediate goods purchased from monopolist producers[12]. The homogenous good is consumed at home or exported overseas at world prices after repackaging. Intermediate monopolist producers use labor, capital service and land to produce a variety of goods whose prices are set according to a Calvo-pricing mechanism[13]. 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 entrepreneurs. Entrepreneurs can take out loans from domestic and foreign banks to finance a fraction of their acquisition of land (or real estate), physical capital, and consumption goods.

2.1 The production of the final homogenous good

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

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

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, $Y_{j,t}$, and the domestic good's price

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

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

[12] The DSGE model of a small open economy has been described in numerous papers. See for example Christiano et al. (2011) and Adolfson et al. (2007) among others.

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

2.2 The production of intermediate goods

There is a continuum of j intermediate producers in the economy. The jth intermediate firm combines aggregate labor, $l_{j,t}$, capital service, $K_{j,t}$, and land (or real estate), $H^e_{j,t}$, to produce, $Y_{j,t}$.

$$Y_{j,t} = \varepsilon^y_t \left(K_{j,t}\right)^{\mu} \left(H^e_{j,t}\right)^{\vartheta} \left[z_t l_{j,t}\right]^{1-\mu-\vartheta} - \phi z_t \tag{4}$$

where z_t is the permanent technology shock whose rate of growth is $\mu_{z,t} = z_t/z_{t-1}$, ε^y_t a covariance stationary transitory technology shock and ϕ a fixed cost of production. The total cost of production of the intermediate good producer j is given by

$$W_t l_{j,t} + R^k_t K_{j,t} + r^h_t Q_{t-1} H^e_{j,t} \tag{5}$$

The stationarized first order conditions (FOCs) for the representative intermediate producer's cost minimization problem with respect to labor, capital and real estate services are given by

$$w_t = \varepsilon^y_t \left(1-\mu-\vartheta\right) mc_t \left(\frac{1}{\mu^z_t}\right)^{\mu+\vartheta} \left(\frac{w_t}{\overline{r}^k_t}\right)^{\mu} \left[\frac{\left(1-\mu-\vartheta\right)}{\left(\mu^z_t\right)\mu}\right]^{-\mu} \left(\frac{w_t}{q_{t-1}}\right)^{\vartheta} \left[\frac{\left(1-\mu-\vartheta\right)}{\vartheta}\frac{r^h_t}{\left(\pi_t \mu^z_t\right)}\right]^{-\vartheta} \tag{6}$$

$$\overline{r}^k_t = \mu\left(\mu^z_t mc_t\right)\frac{y_t}{k_t} \tag{7}$$

$$q_{t-1} = \frac{\vartheta\left(\pi_t \mu^z_t mc_t\right)}{r^h_t}\frac{y_t}{h^e_t} \tag{8}$$

where $\pi_t \equiv \frac{P_t}{P_{t-1}}, mc_t \equiv \frac{MC_t}{P_t}$, $\overline{r}^k_t \equiv \frac{R^k_t}{P_t}$, $q_t \equiv \frac{Q_t}{P_t}$ and r^h_t are the inflation rate of the domestic good, the real marginal cost, the real rental rate of capital services, the real price, and the rental rate of land (or real estate) respectively[14].

After choosing the optimal combination of labor, capital, and land services, intermediate firms set the price of their goods in a Calvo-type friction environment: Firms that receive the green light to change their price choose the optimum price with a probability $(1-\xi)$ and 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, $\overline{\pi}^c_t$, and the previous period's inflation, π_{t-1}.

$$P_t = \left(\pi_{t-1}\right)^{\kappa_d}\left(\overline{\pi}^c_t\right)^{1-\kappa_d} P_{t-1} \tag{9}$$

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

[14] Stationarized variables are obtain as follows: Nominal variables are divided by $z_t P_t$. Real flow and stock variables are scaled by z_t and z_{t-1} respectively.The low caps are used for stationarized variables.

2.3 Households

The economy is populated by a continuum of infinitely-lived households indexed by i on $[0,1]$. A proportion $(1-\lambda)$ of households can purchase real estate and make deposits at banks. The other fraction of households λ can only carry cash from one period to the other to smooth her/his consumption. The presence of two types of households was suggested by Mankiw (2000) in order to make theoretical models' predictions consistent with the observed strong dependence of consumption on current income, in contrast to the prediction of the permanent income hypothesis. Galí et al. (2007) pioneered the integration of both types of households with a calibrated DSGE model.

2.3.1 Household with access to land and bank deposits (Type I households)

The expected lifetime utility function of the ith household is

$$E_0 \sum_{t=0}^{t=\infty} (\beta_a)^t \left[\begin{array}{c} \varepsilon_t^c (1-\kappa_a) \log(C_{i,t}^a - \kappa_a C_{i,t-1}^a) - \frac{A_L^a}{1+\sigma_L} \left(l_{i,t}^a\right)^{1+\sigma_L} \\ +j_a \log\left(H_{t+1}^a\right) + \varepsilon_t^m \frac{A_q}{1-\sigma_q} \left(\frac{M_{i,t+1}^a}{z_t P_t}\right)^{1-\sigma_q} \end{array} \right]$$

where E_0 is the conditional expectation operator, $C_{j,t}^a$ an aggregate consumption index, $l_{i,t}^a$ the level of hours worked, H_{t+1}^a the stock of real estate, $M_{i,t}^a$ the nominal cash holdings, β_a 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, κ_a, is assumed. The demand for real money balances shock ε_t^m and the consumption preference shock , ε_t^c, follow AR(1) processes. There are three positive scaling parameters A_L^a, j_a, and A_q in the utility function.

The household's budget constraint is given by

$$\left(1+r_t^d\right) D_{i,t}^a + W_t l_{i,t}^a + M_{i,t}^a = P_t^c C_{i,t}^a + T_{i,t}^a + M_{i,t+1}^a + D_{i,t+1}^a + Q_t \left[1 - \widetilde{S}\left(\frac{H_{t+1}^a - H_t^a}{H_t^a - H_{t-1}^a}\right)\right] \left(H_{t+1}^a - H_t^a\right)$$

where r_t^d is the domestic deposit interest rate, $D_{i,t}^a$ the bank deposits and $T_{i,t}^a$ the lump tax. The last term on the right hand side of the equation is the new investment in land less transaction cost. The transaction cost functions are zero in the NSS i.e. $\widetilde{S}(\mu^z) = \widetilde{S}'(\mu^z) = 0$. The FOCs with respect to money, deposits, consumption, labor and land (or real estate) for the representative household are given by

$$-m_{t+1}^a + \frac{1}{\varepsilon_t^m} \left(\frac{1}{A_q}\right)^{\frac{-1}{\sigma_q}} \left(\psi_{z,t}^a - \beta_a \frac{\psi_{z,t+1}^a}{\pi_{t+1}\mu_{t+1}^z}\right)^{\frac{-1}{\sigma_q}} = 0 \tag{10}$$

$$-\psi_{z,t}^a + \beta_a \left(1 + r_{t+1}^d\right) \frac{\psi_{z,t+1}^a}{\pi_{t+1}\mu_{t+1}^z} = 0 \tag{11}$$

$$\varepsilon_t^c \left(\frac{1}{c_t^a - \kappa_a \frac{c_{t-1}^a}{\mu_{z,t}}}\right) - \beta_a \varepsilon_{t+1}^c \left(\frac{\kappa_a}{\mu_{z,t+1} c_{t+1}^a - \kappa_a c_t^a}\right) - \psi_{z,t}^a p_t^c = 0 \tag{12}$$

$$-A_L^a \left(l_t^a\right)^{\sigma_L} + \psi_{z,t}^a w_t = 0 \qquad (13) \tag{13}$$

$$\frac{j^a}{h^a_{t+1}} - \psi^a_{z,t} q_t \left[1 - \widetilde{S}_t - \Theta_1 \widetilde{S}'_t\right] + \beta_a \frac{\psi^a_{z,t+1}}{\mu^z_{t+1}} q_{t+1} \left[1 - \widetilde{S}_{t+1} + \Theta_2 \widetilde{S}'_{t+1}\right] = 0 \quad (14)$$

where

$$\Theta_1 \equiv \frac{\mu^z_{t-1}\left(\mu^z_t h^a_t - h^a_{t-1}\right)}{\mu^z_{t-1} h^a_{t-1} - h^a_{t-2}}$$

$$\Theta_2 \equiv \left[\frac{\mu^z_t\left(\mu^z_{t+1} h^a_{t+1} - h^a_t\right)}{\left(\mu^z_t h^a_t - h^a_{t-1}\right)} \frac{h^a_{t-1} - \mu^z_t \mu^z_{t+1} h^a_{t+1}}{\mu^z_t h^a_t - h^a_{t-1}}\right]$$

$\frac{\psi^a_{z,t}}{z_t} \equiv \nu^a_t P_t$ is the stationarized shadow value of one unit of the domestic homogenous good to the household and ν^a_t is the Lagrange multiplier.

2.3.2 Households with no access to real estate and bank deposits (Type II households)

In the theoretical literature, factors such as fear of saving, myopia or the ignorance of saving opportunities have been set forth as the rationale for non-optimizing behavior by rule-of-thumb households (Galí et al. (2007), Mankiw (2000)). Those factors may be invoked here too. However, we stress that the assumption that a fraction λ of households do not have access to financial and physical assets also results from poverty and the inadequacy of financial inclusion. Therefore, we are replacing the typical rule-of-thumb household by a cash optimizing household because we are going to estimate the model using Cameroon's data, a country where *Njanguis* offer a short term savings and loans "cash instruments.[15]"

The ith Type II household maximizes her/his lifetime utility

$$E_0 \sum_{t=0}^{t=\infty} (\beta_{na})^t \left[\varepsilon^c_t (1 - \kappa^{na}) \log(C^{na}_{i,t} - \kappa_{na} C^{na}_{i,t-1}) - \frac{A^{na}_L}{1+\sigma_L} \left(l^{na}_{i,t}\right)^{1+\sigma_L} + \varepsilon^m_t \frac{A_q}{1-\sigma_q} \left(\frac{M^{na}_{i,t+1}}{z_t P_t}\right)^{1-\sigma_q}\right]$$

subject to her/his budget constraint

$$W_t l^{na}_{i,t} - P^c_t C^{na}_{i,t} - T^{na}_{i,t} - M^{na}_{i,t+1} + M^{na}_{i,t} = 0$$

The representative Type II household's FOCs with respect to consumption, labor and cash are given by

$$\frac{\varepsilon^c_t}{c^{na}_t - \kappa_{na} \frac{c^{na}_{t-1}}{\mu^z_t}} - \frac{\kappa_{na} \beta_{na} \varepsilon^c_{t+1}}{\mu_{z,t+1} c^{na}_{t+1} - \kappa_{na} c^{na}_t} - \psi^{na}_{z,t} p^c_t = 0 \quad (15)$$

$$-A^{na}_L \left(l^{na}_t\right)^{\sigma_L} + \psi^{na}_{z,t} w_t = 0 \quad (16)$$

$$m^{na}_{t+1} - \frac{1}{\varepsilon^m_t} \left(\frac{1}{A_q}\right)^{\frac{1}{-\sigma_q}} \left[\psi^{na}_{z,t} - \beta_{na} \frac{\psi^{na}_{z,t+1}}{\pi_{t+1} \mu_{z,t+1}}\right]^{\frac{1}{-\sigma_q}} = 0 \quad (17)$$

where $\psi^{na}_{z,t} \equiv \nu^{na}_t P_t z_t$ and ν^{na}_t is the Lagrange multiplier.

[15] According to Cameroon's pidgin English, a Njangui describes a group of persons sharing common ties—region, tribe, friendship, colleagues—who decide to meet on a regular basis to assemble their savings to provide financial solutions to their members or community (IMF (2018)).

2.4 Entrepreneurs

The economy is populated by a continuum of infinitely-lived entrepreneurs indexed by j on $[0,1]$. Entrepreneurs own physical capital and a fraction of land (or real estate). They rent their stock of land to intermediate firms. They choose the level of capital service they rent to intermediate firms by choosing the utilization rate of capital for a given stock of capital or by increasing the stock of capital for a given utilization rate. They also choose the level of investment to increase the stock of physical capital. In addition to the wage and rents they receive from intermediate firms, entrepreneurs can borrow abroad or from local banks to purchase land, physical capital and consumption goods. Following, Bernanke et al. (1999), entrepreneur labor is inelastically supplied and set to one unit.

For the jth entrepreneur, what matters is the difference between his current and lagged consumption. His lifetime utility function is given by

$$E_0 \sum_{t=0}^{\infty} (\beta_e)^t \log(C^e_{j,t} - \kappa_e C^e_{j,t-1})$$

The jth entrepreneur's budget constraint is given by

$$R^k_t u_{j,t} \overline{K}_{j,t} + r^h_t Q_t H^e_{j,t} + B^e_{j,t+1} + R^*_{t-1} \Phi_{t-1} S_{t-1} B^{e*}_{j,t} + W^e l^e = P^c_t C^e_{j,t} + P^i_t I_{j,t} + P^i_t a\left(u_{j,t}\right) \overline{K}_{j,t} + P_t P^{k'}_t \Delta_t + \left(1 + \widetilde{S}_t\left(\cdot\right)\right) Q_t \left(H^e_{j,t+1} - H^e_{j,t}\right) + S_t B^{e*}_{j,t+1} + R^{be}_t B^e_{j,t} + T^{oil}_{j,t}$$

where R^{be}_t and R^*_{t-1} are the gross domestic and foreign borrowing interest rates respectively, $B^{e*}_{j,t}$ net foreign assets (NFA), $T^{oil}_{j,t}$ the lump-sum tax, S_{t-1} the nominal exchange rate, $u_{j,t}$ the level of capital utilization, R^k_t the rate of return on a unit of physical capital, and $P^{k'}_t$ the price of installed capital. The resource cost of capital utilization measured in units of physical capital is defined as in Schmitt-Grohe and Uribe (2004)

$$a\left(u_{j,t}\right) = \sigma_a\left(u_{j,t} - 1\right) + \frac{\sigma_b}{2}\left(u_{j,t} - 1\right)^2, \qquad \sigma_a,\ \sigma_b > 0 \tag{18}$$

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

$$\Phi_{j,t} = \exp\left(-\tilde{\phi}_b\left(B^*_{j,t} - B^*\right) - \tilde{\phi}_s\left(\left(R^*_t - R^d_t\right) - \left(R^* - R^d\right)\right) + \tilde{\phi}^u_t\right) \quad \tilde{\phi}_b,\ \tilde{\phi}_s > 0 \tag{19}$$

where $\tilde{\phi}^u_t$ is an AR(1) process, B^*, R^* and R^d the NSS values of the corresponding variables[16]. 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 of physical stock is given by

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

$$\overline{K}_{j,t+1}=(1-\delta)\,\overline{K}_{j,t}+\left(1-\widetilde{S}\left(\frac{I_{j,t}}{I_{j,t-1}}\right)\right)I_{j,t}+\Delta_{j,t}\qquad \widetilde{S}\,(1)=\widetilde{S}'\,(1)=0,\widetilde{S}"\,(1)>0 \tag{20}$$

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

Banks can repossess an entrepreneur's real estate if she/he defaults on her/his loan after paying a fraction $(1-\varpi_h)$ of the real estate's value. We do not deal with agency problem because real estate (or land) is used as collateral for domestic lending. Following Iacoviello (2005), we assume that the domestic borrowing constraint is always binding in NSS because entrepreneurs are more patient than Type I households ($\beta_e<\beta_a$) and the return on real estate is bigger than the nominal interest rate on loan.

$$R_t^{be}B_{j,t}^e-\varpi_h Q_{t+1}H_{j,t+1}^e=0 \tag{21}$$

Dropping the j's indexes to consider the representative entrepreneur, the FOCs with respect to investment, physical capital, capital utilization rate, domestic bank loan, foreign assets and land in stationarized form are given by

$$\frac{\mu_t^{\tilde{z}}}{\mu_t^{\tilde{z}}c_t^e-\kappa_e c_{t-1}^e}\frac{1}{p_t^c}\left[-p_t^i+P_t^{k'}\left(1-\widetilde{S}_t-\frac{\mu_t^{\tilde{z}}i_t}{i_{t-1}}\widetilde{S}_t'\right)\right]+\frac{\beta_e\left(\frac{\mu_{t+1}^{\tilde{z}}i_{t+1}}{i_t}\right)^2P_{t+1}^{k'}}{p_{t+1}^c\left(\mu_{t+1}^{\tilde{z}}c_{t+1}^e-\kappa_e c_t^e\right)}\widetilde{S}_{t+1}'=0 \tag{22}$$

$$\frac{\mu_{t+1}^{\tilde{z}}\beta_e}{\mu_{t+1}^{\tilde{z}}c_{t+1}^e-\kappa_e c_t^e}\frac{R_{t+1}^k}{p_{t+1}^c}\frac{\mu_{t+1}^{\tilde{z}}}{\pi_{t+1}}-\frac{1}{p_t^c}\left[\frac{\mu_t^{\tilde{z}}\mu_{t+1}^{\tilde{z}}}{\mu_t^{\tilde{z}}c_t^e-\kappa_e c_{t-1}^e}\right]=0 \tag{23}$$

$$\overline{r}_t^k=a'(u_t)\,p_t^i \tag{24}$$

$$\frac{\pi_{t+1}\mu_t^{\tilde{z}}\mu_{t+1}^{\tilde{z}}}{p_t^c\left(\mu_t^{\tilde{z}}c_t^e-\kappa_e c_{t-1}^e\right)}-\beta_e\left(1+r_{t+1}^e\right)\left[\frac{1}{p_{t+1}^c}\frac{\mu_{t+1}^{\tilde{z}}}{\mu_{t+1}^{\tilde{z}}c_{t+1}^e-\kappa_e c_t^e}+\psi_{z,t+1}^e\right]=0 \tag{25}$$

$$\psi_t^e-\beta_e\frac{\psi_{t+1}^e}{\pi_{t+1}}\frac{R_t^*\Phi_t}{\mu_{t+1}^{\tilde{z}}}=0 \tag{26}$$

$$\begin{aligned}&-\frac{q_t}{p_t^c}\frac{\mu_t^{\tilde{z}}}{\mu_t^{\tilde{z}}c_t^e-\kappa_e c_{t-1}^e}\left[1+\Theta_3\widetilde{S}_t{}'+\widetilde{S}_t\right]\\&+\beta_e\frac{q_{t+1}}{p_{t+1}^c}\frac{1}{\mu_{t+1}^{\tilde{z}}c_{t+1}^e-\kappa_e c_t^e}\left[1-\Theta_4\widetilde{S}'_{t+1}+\widetilde{S}_{t+1}+r_{t+1}^h\right]\\+\varpi_h\psi_{z,t}^e q_{t+1}\pi_{t+1}\quad&=\quad 0\end{aligned} \tag{27}$$

where

$$\Theta_3 = \frac{\mu_{t-1}^{z}\left(\mu_t^{z} h_{t+1}^{e} - h_t^{e}\right)}{\mu_{t-1}^{z} h_t^{e} - h_{t-1}^{e}}$$

$$\Theta_4 = \frac{\mu_t^{z}\left(\mu_{t+1}^{z} h_{t+2}^{e} - h_{t+1}^{e}\right)}{\left(\mu_t^{z} h_{t+1}^{e} - h_t^{e}\right)} \frac{h_t^{e} - \mu_t^{z}\mu_{t+1}^{z} h_{t+2}^{e}}{\mu_t^{z} h_{t+1}^{e} - h_t^{e}}$$

where $\psi_t^e \equiv (\upsilon_t^e P_t)\, z_t$ and υ_t^e is the shadow value of domestic currency in utility terms to the entrepreneur.

2.5 Banks

In order to account for credit-supply factors in business cycle dynamics, we choose the framework in Gerali et al. (2010). They conceive financial intermediation at banks as a three-step process involving at each step one branch of the bank, namely the wholesale branch, the loan branch, or the deposit branch. In a nutshell, once households place deposits with the deposit branch, it deposits them in the wholesale branch which transforms them into a loan to the lending branch. The latter transforms and lends that loan to firms and to the government. Profit maximization at each branch contributes to the aggregate profit of the bank[17].

2.5.1 The wholesale branch

The wholesale branch has a capital K_t^b whose law of motion is given by

$$K_t^b = (1 - \delta_{bk})\, K_t^b + \Pi_t^{bk} \tag{28}$$

where δ_{bk} is the rate of depreciation and Π_t^{bk} the amount of profits.

First, the wholesale branch combines (on the liability side) bank capital K_t^b and wholesale deposits received from the deposit branch D_t^a to issue a wholesale loan $B_t = B_t^e + B_t^g$ (on the asset side). Any deviation from its capital to asset ratio target ν^b entails a cost that is parametrized by κ_{Kb}. The wholesale branch chooses B_t and D_t^a to maximizes its profit

$$max_{\{B_t, D_t^a\}}\; r_t^b B_t - r_t\,(1 - \lambda_{res})\, D_t^a - \tfrac{\kappa_{Kb}}{2}\left(\tfrac{K_t^b}{B_t} - \nu^b\right)^2 K_t^b = 0$$

where r_t^b and r_t are the wholesale loan and deposit rate respectively and λ_{res} the reserves to deposit ratio. The deposit branch's reserves do not earn interest. The stationarized FOC with respect to B_t is given by

$$r_t^b = (1 - \lambda_{res})\, r_t - \kappa_{Kb}\left(\frac{k_t^b}{b_t} - \nu^b\right)\left(\frac{k_t^b}{b_t}\right)^2 \tag{29}$$

2.5.2 The loan branch

The loan branch gets a wholesale loan B_t from the wholesale branch that carries an interest rate r_t^b, differentiates it at no cost and then lends it to entrepreneurs and the

[17] Here, we only sketch the framework in Gerali et al (2016). The interested reader should see their paper for a discussion of the assumptions and the derivation of FOCs.

government. The loan branch faces a quadratic adjustment cost for changing loan interest rates. The problem for the jth loan branch is to

$$Max_{\left\{r^{be}_{j,t},r^{bg}_{j,t}\right\}} E_0 \sum_{t=0}^{\infty} (\beta_a)^t \left[\begin{array}{c} r^{be}_{j,t}B^e_{j,t} + r^{bg}_{j,t}B^g_{j,t} - r^b_{j,t}\left(B^e_{j,t}+B^g_{j,t}\right) \\ -\frac{\kappa_{be}}{2}\left(\frac{r^{be}_{j,t}}{r^{be}_{j,t-1}}-1\right)^2 r^{be}_{j,t}B^e_{j,t} - \frac{\kappa_{bg}}{2}\left(\frac{r^{bg}_{j,t}}{r^{bg}_{j,t-1}}-1\right)^2 r^{bg}_{j,t}B^g_{j,t} \end{array} \right]$$

subject to the demand for loans by entrepreneurs and the government, B^g_t.

$$B^e_{j,t} = \left(\frac{r^{be}_{j,t}}{r^{be}_t}\right)^{-\eta_{be}} B^e_t \qquad \text{and} \qquad B^g_{j,t} = \left(\frac{r^{bg}_{j,t}}{r^g_t}\right)^{-\eta_{bg}} B^g_t$$

where η_{be} and η_{bg} are the demand elasticities of entrepreneurs and government loans and B^e_t the aggregate loan to entrepreneurs.

The stationarized FOCs of the representative loan branch with respect to $r^{be}_{j,t}$ and $r^{bg}_{j,t}$ in a symmetric equilibrium are

$$1-\eta_{be}+\eta_{be}\frac{r^b_t}{r^{be}_t}-\kappa_{be}\left[\frac{r^{be}_t}{r^{be}_{t-1}}-1\right]\frac{r^{be}_t}{r^{be}_{t-1}}+\beta_a\frac{\psi^a_{z,t+1}}{\psi^a_{z,t}}\kappa_{be}\left[\frac{r^{be}_{t+1}}{r^{be}_t}-1\right]\left(\frac{r^{be}_{t+1}}{r^{be}_t}\right)^2\frac{b^e_{t+1}}{b^e_t}\frac{\mu^z_t\pi_t}{\mu^z_{t+1}\pi_{t+1}}=0 \tag{30}$$

$$1-\eta_{bg}+\eta_{bg}\frac{r^b_t}{r^{be}_t}-\kappa_{bg}\left[\frac{r^{bg}_t}{r^{bg}_{t-1}}-1\right]\frac{r^{bg}_t}{r^{bg}_{t-1}}+\beta_a\frac{\psi^a_{z,t+1}}{\psi^a_{z,t}}\kappa_{bg}\left[\frac{r^{bg}_{t+1}}{r^{bg}_t}-1\right]\left(\frac{r^{bg}_{t+1}}{r^{bg}_t}\right)^2\frac{b^g_{t+1}}{b^g_t}\frac{\mu^z_t\pi_t}{\mu^z_{t+1}\pi_{t+1}}=0 \tag{31}$$

2.5.3 The deposit branch

The jth deposit branch collects deposits, $D^a_{j,t}$, from households with access to financial assets (Type I) and then deposits them in the wholesale unit. The wholesale unit pays an interest rate, r_t, on those deposits while the deposit branch pays $r^d_{j,t}$ on households' deposits. It is costly to change the interest rate on households' deposits. The deposit branch problem is to choose, $r^d_{j,t}$, to maximize its profit by solving

$$Max_{\left\{r^d_{j,t}\right\}} E_0 \sum_{t=0}^{\infty} (\beta_a)^t \left[r_t\left(1-\lambda_{res}\right)D^a_{j,t} - r^d_{j,t}D^a_{j,t} - \frac{\kappa_d}{2}\left(\frac{r^d_{j,t}}{r^d_{j,t-1}}-1\right)^2 r^d_t D_t\right]$$

subject to

$$D^a_{j,t} = \left(\frac{r^d_{j,t}}{r^d_t}\right)^{-\eta_d} D_t$$

In a symmetric equilibrium, the stationarized FOC for the representative deposit branch is

$$\eta_d-\frac{\eta_d\left(1-\lambda_{res}\right)r_t}{r^d_t}-1-\kappa_d\left[\frac{r^d_t}{r^d_{t-1}}-1\right]\frac{r^d_t}{r^d_{t-1}}+\beta_a\frac{\psi^a_{t+1}}{\psi^a_t}\frac{\pi_t\mu^z_t}{\mu^z_{t+1}\pi_{t+1}}\kappa_d\left[\frac{r^d_{t+1}}{r^d_t}-1\right]\left(\frac{r^d_{t+1}}{r^d_t}\right)^2\frac{d_{t+1}}{d_t}=0 \tag{32}$$

2.6 The government

According to the FZ Agreement (up to end-2017), for any given year, each government is entitled to obtain from the BEAC up to 20% of taxes collected in the previous year as a monetary finance of its budget deficit[18]. Here, we keep that monetary financing rule because it applies in our estimation period and also because the new rule is still to be successfully implemented[19].

By the way, it would be straightforward to adapt the present model to accommodate the substitution of a statutory monetary finance of government's deficit by the BEAC with a monetary finance of that deficit through market auction.

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

$$B_{g,t+1}^{bk} = G_t + \left(1 + r_t^{bg}\right) B_{g,t}^{bk} - \lambda T_{i,t}^{na} - (1-\lambda)\, T_{i,t}^{a} - T_{i,t}^{e} - \lambda^{FZ} T_{t-1} \tag{33}$$

where λ^{FZ} the CEMAC's monetary finance of budget deficit parameter. Public spending and lump-sum tax are AR(1) processes.

$$T_t^{\tau} = \xi_t^{T} \left(\lambda_\tau Y\right)^{1-\rho_T} \left(T_{t-1}^{\tau}\right)^{\rho_T} \tag{34}$$

$$G_t = \xi_t^{T} \left(\lambda_g Y\right)^{1-\rho_G} \left(G_{t-1}\right)^{\rho_G} \tag{35}$$

where $\lambda_\tau = \lambda_a, \lambda_{na}$, or λ_e are lump-sum tax ratios (Type I, II households and entrepreneurs respectively) and λ_g the expenditures ratio.

2.7 The Central Bank

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. 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 foreign exchange reserves in our model because data are unavailable.

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

[18] In the new monetary framework, member States must seek liquidity on a competitive market where the minimum rate is equal to the BEAC's policy rate and the maximum amount raised consistent with the regional international reserves targets. Monetary programming would be abandoned (IMF (2017b)).

[19] One of the long-standing problems with CEMAC governments is the squandering and embezzlement of taxes, natural resources rents and foreign aid. For instance, the IMF (2018) points out "Access to finance" as the second most problematic factor to doing business after "Corruption" in Cameroon.

$$S_t^{CBK} = S_t \Delta CBXR_{t+1} - \Delta MB_{t+1} \tag{36}$$

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 households, M_t, 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

$$S_t CBXR_{t+1} - S_{t-1} CBXR_t - \Delta MB_{t+1} = i_{t-1}^{*FZ} S_{t-1} CBXR_t - \lambda^{FZ} \left(\lambda T_{i,t-1}^{na} - (1-\lambda) T_{i,t-1}^{a} - T_{i,t-1}^{e} \right) \tag{37}$$

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)[20].

2.8 Aggregation

The aggregate consumption bundle is a CES function of domestic (C_t^d) and imported consumption goods (C_t^m).

$$C_t = \left[(1-\omega_c)^{\frac{1}{\eta_c}} \left(C_t^d \right)^{\frac{(\eta_c - 1)}{\eta_c}} + \omega_c^{\frac{1}{\eta_c}} \left(C_t^m \right)^{\frac{(\eta_c - 1)}{\eta_c}} \right]^{\frac{\eta_c}{(\eta_c - 1)}} \tag{38}$$

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_t^c, P_t and P_t^m, are given to the households, 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 $P_t^m = S_t P_t^*$, where P_t^* is the foreign currency price of the homogenous good. The FOCs give the stationarized demand for the domestically produced and imported consumption goods (c_t^d and c_t^m)

$$c_t^m = \omega_c \left(q_t^e \right)^{-\eta_c} c_t \tag{39}$$

$$c_t^d = (1-\omega_c) \left[\frac{1}{p_t^c} \right]^{-\eta_c} c_t \tag{40}$$

where $q_t^e \equiv \frac{S_t P_t^*}{P_t^c}$ is the real exchange rate, S_t the nominal exchange rate. The relative price of the consumption good is given by

$$p_t^c = \left[(1-\omega_c) + \omega_c * \left(p_t^m \right)^{1-\eta_c} \right]^{\frac{1}{1-\eta_c}} \tag{41}$$

where the relative price of the imported consumption good is defined by $p_t^m \equiv q_t^e p_t^c$. The consumer inflation index computed from (41) is

[20] A sample of interest rates applicable to different deposit brackets is provided in Veyrune (2007)

$$\pi_t^c \equiv \pi_t \left[\frac{(1-\omega_c) + \omega_c * (p_t^m)^{1-\eta_c}}{(1-\omega_c) + \omega_c * \left(p_{t-1}^m\right)^{1-\eta_c}} \right]^{\frac{1}{1-\eta_c}} \tag{42}$$

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

Likewise, the FOCs for a CES investment bundle given P_t^i, P_t and P_t^m gives the demand for the stationarized domestically produced and imported investment goods (i_t^d and i_t^m)

$$i_t^m = \omega_i \left(q_t^e\right)^{-\eta_i} i_t \tag{43}$$

$$i_t^d = (1-\omega_i) \left[\frac{1}{p_t^i} \right]^{-\eta_i} i_t \tag{44}$$

where the investment price index p_t^i is given by

$$p_t^i = \left[(1-\omega_i) + \omega_i * \left(q_t^e p_t^c\right)^{1-\eta_i} \right]^{\frac{1}{1-\eta_i}} \tag{45}$$

and the investment inflation index by

$$\pi_t^i \equiv \pi_t \left[\frac{(1-\omega_i) + \omega_i * \left(q_t^e p_t^c\right)^{1-\eta_i}}{(1-\omega_i) + \omega_i * \left(q_{t-1}^e p_{t-1}^c\right)^{1-\eta_i}} \right]^{\frac{1}{1-\eta_i}} \tag{46}$$

2.9 Resource constraints

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

Land stock, $\overline{h}$, is fixed and normalized to 1. Each period, the sum of land holdings of the entrepreneurs and Type I households is equal to $\overline{h}$ in equilibrium.

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

$$\begin{aligned} y_t \quad = \quad & (1-\omega_c) \left[\frac{1}{p_t^c} \right]^{-\eta_c} \left[(1-\lambda) c_t^a + \lambda c_t^{na} + c_t^e \right] \\ & + g_t + (1-\omega_i) \left[\frac{1}{p_t^i} \right]^{-\eta_i} i_t + a\left(u_{j,t}\right) \frac{\overline{k}_{j,t}}{\mu_t^z} + \left(\frac{1}{p_t^c q_t} \right)^{-\eta_x} y_t^* \end{aligned} \tag{47}$$

where y_t^* is the foreign output, η_x the export elasticity with respect to the relative price of exports.

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

$$S_t \Delta CBXR_{t+1} = \left[q_t^e p_t^c C_t^m + q_t^e p_t^c I_t^m + S_t B_{t+1}^*\right] - \left[\left(\frac{1}{q_t^e p_t^c}\right)^{-\eta_x} Y_t^* + i_{t-1}^{*FZ} S_{t-1} CBXR_t + \left(1 + r_{t-1}^*\right) \Phi_{t-1} S_{t-1} B_t^*\right] \quad (48)$$

2.10 Shocks

Seventeen stochastic exogenous variables are included in the model. There are two technology shocks: a neutral technology stationary shock, ε_t^y, and a labor neutral technology shock, z_t, whose growth rate shock, $\varepsilon_t^{\mu_z}$, is a first order autoregression process, AR(1). Land supply shock, $\varepsilon_t^{\overline{h}}$, and bank profit shock, $\varepsilon_t^{\Pi^{bk}}$, also affect the supply side of the model economy. Since entrepreneurs' labor is exogenous and normalized to one, their wage rate shock is added for convenience. On the demand side, there is a consumption preference shock, ε_t^c, and a demand for real money balances shock, ε_t^m. A government spending shock, ε_t^G, and three lump-sum tax shocks are included -one on each type of household, $\varepsilon_t^{T^a}$ and $\varepsilon_t^{T^{na}}$, and one on the entrepreneurs, $\varepsilon_t^{T^{oil}}$. Shocks related to monetary policy include the inflation target shock, $\varepsilon_t^{\overline{\pi}^c}$, the interest rate on foreign reserves shock, $\varepsilon_t^{R^{*FZ}}$, the nominal exchange rate shock, ε_t^s, and the bank reserves shock, ε_t^{bkr}. A foreign inflation shock, $\varepsilon_t^{\pi^*}$, and a risk term shock, $\varepsilon_t^{\widetilde{\phi}^u}$, complete the set of exogenous stochastic variables. In the model, all shocks are defined by AR(1) processes

$$\varepsilon_t^\iota = \xi_t^\iota \left(\overline{\varepsilon^\iota}\right)^{1-\rho_{\varepsilon^\iota}} \left(\varepsilon_{t-1}^\iota\right)^{\rho_{\varepsilon^\iota}} \quad (49)$$

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

3 Estimation of the model

The model is estimated using 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 non-stochastic steady state's neighborhood.

3.1 Data

We estimate the model economy using Cameroon's annual data over 1979-2016. The observable time series are the Gross Domestic Product (GDP), foreign exchange reserves, claims on the private sector by banks, physical capital stock, bank deposits, consumer price inflation, deposit interest rate, investment in physical capital, forest rent as a proxy for lump-sum tax on rule-of-thumb households, oil rents as a proxy for lump-sum tax on entrepreneur, West Texas Intermediate price change as a proxy for foreign inflation and a proxy for risk free international interest rate[21].

[21] WTI prices are extracted from Macrotrends.net. The stock of capital is extracted from Penn World Tables (Feenstra et al. (2015). Claims on the private sector comes from the World Bank (2018). Money

The change in oil price is used as a proxy for foreign inflation because the share of oil and petroleum products imports is sizeable and the country is a price-taker on international markets of those goods.

For the proxy for lump-tax on entrepreneurs, we note that all companies file and pay taxes. However, extractive industries in general - and oil exploitation companies in particular - are both the main taxpayers and capital intensive producers in the country. They operate throughout the production chain and sell their output in world markets. The government collects a fraction of the sales. Therefore, we use the oil rents as a proxy for lump-sum tax on entrepreneurs because its amount is sizeable and affects the tax levied on other smaller companies.

The proxy for the lump-sum tax on rule-of-thumb consumers is perhaps less obvious and needs to be put into context. The ONCPB(*Office National de Commercialisation des Produits de Base*) was created in 1978 and dismantled in 1994/95 after three consecutive reforms (1989/90, 1991 and 1994/95). During its existence, that state-owned Marketing Board of cash crops indirectly levied export taxes on crop producers by taxing sales made by authorized private traders and by pocketing the revenue of sales made directly by ONCPB's agents[22]. Since 1995, licensed exporters have been tasked with buying crops from local producers for exportation. Because of the long-standing monopolistic structure of the cash crops local market, licensed exporters have been able to pass on taxes to local producers[23]. Therefore, the gap between local and world market price of one of the main cash crops could be used as a proxy for lump-tax on rule-of-thumb households since farming is the main activity of low-income households[24] and is still the principal source of revenue for 56.1% of the population in 2017[25]. Unfortunately, local crops price data are missing between 2001 and 2004, and after 2010 in the dataset provided by the Food and Agriculture Organization (FAO (2020)). Therefore, we use forest rent data as the proxy.

3.2 Fixed parameters

Parameters that cannot be identified are fixed (Table 1). The adjustment cost on deposit interest rate κ_d is high to reflect the extremely low variability of deposit interest rate in the data. The demand elasticity of exports, η_x, the reserves to deposits ratio, λ_{res}, the rate of depreciation of capital, δ, the parameter controlling the deviation of net foreign assets from its equilibrium value, $\tilde{\phi}_b$, the capital utilization cost parameters, σ_a, and σ_b, are from Nana-Davies (2018). The land and capital service shares in output are respectively set to $\vartheta = 0.04$ and $\mu = 0.42$, implying a labor share of 0.54. The inverse of the Frisch elasticity σ_L is set to 1. The demand elasticity of deposit, η_d, the adjustment cost parameter of banks' wholesale branch, κ_{Kb}, and lending branch, κ_{be}, are from Gerali et al. (2010). Given the average growth and the average consumer

is extracted from International Financial Statistics. All other series are retrieved from the World Development Indicators database (The World Bank).

[22] See World Bank (1986), Shepherd and Farolfi (1999), and Konings (2010).

[23] For example, it is still true that 6 of 193 licensed cocoa exporters provide 80% of exports as noted in Shepherd and Farolfi (1999).

[24] Lynch (1991) finds that the majority of Cameroon's poor households, approximately 80 percent of the lowest quintiles, live in the rural areas.

[25] See World Food Programme (2017).

price inflation found in the in the data, the subjective discount factors, β_a, and β_e, are set to match the domestic and foreign interest rates averages found in the data. The monetary finance of government deficit as a percentage of tax revenues of the previous year, λ^{FZ}, is set to the median value of its statutory range. The fraction of asset that can be recovered in case of default, ϖ_h, is low because of the long-standing difficulty to collect debt and enforce mortgages as noted for example by the IMF (2009). The government expenditure to GDP ratio λ_g is set to the average value computed from available years of data.

The share of households who do not have access to deposits and land market λ cannot be identified with our observed data. Interestingly, Galí et al. (2007) found that the existence of a unique equilibrium (or an indeterminacy) is linked to the degree of price stickiness and the weight of rule-of-thumb households in a calibrated model economy. Having successfully identified the degree of price stickiness in our model, we take our cue from one piece of information to start the search for a sensible value of λ. First, from 1996 to 2014, the World Bank (2019) estimates that the poverty headcount ratio range is between 44.7% and 73.8% of the population. Second, using a few years of available data, the computed average government revenues to GDP ratio is equal to 0.11. Third, setting an equal value for λ_a and λ_e, and a lower value for λ_{na}, we test different combinations to find the rule-of-thumb households ratio that is included in the World Bank's range of 0.44 - 0.74, that guarantees the revenues ratio of 0.11, and that ensures the existence of a unique NSS of the model economy. We find that given an average government revenues to GDP ratio of 0.11, a unique NSS exist for the combination of a rule-of-thumb ratio $\lambda = 0.48$ and fiscal parameters $\lambda_a = \lambda_e = 0.06$ and $\lambda_{na} = 0.04$. Interestingly, the IMF (2018) reports that 47% of respondent do not have a bank account by lack of money in the 2014 Findex survey. Because the value of λ that ensures the existence of a NSS is in the World Bank's range and is very close to the Findex survey's value, we gain some confidence about all our fixed parameters and our priors before turning to the estimation of identified parameters.

Table 1: Fixed parameters

Parameter	Value	Description
A_L^a	2	Scaling of disutility of work (Type I household)
A_L^{na}	2.5	Scaling of disutility of work (Type II household)
A_q	0.75	Scaling of utility of cash
β_a	0.97	Subjective discount factor (Type I household)
β_e	0.9	Entrepreneur's subjective discount factor
β_{na}	0.98	Subjective discount factor (Type II household)
δ	0.05	Depreciation rate of physical capital
η_{bg}	2.79	Demand elasticity of public loan
η_d	-1.5	Demand elasticity of deposits
η_x	1.5	Demand elasticity of exports
j_a	0.01	Scaling of disutility of land (Type I household)
κ_{be}	3	Adjustment cost parameter interest rate for entrepreneur loan
κ_{bg}	5	Adjustment cost parameter interest rate for government loan
κ_{Kb}	10	Adjustment cost parameter capital to asset ratio
κ_d	50	Adjustment cost parameter interest rate on deposits
λ	0.48	Share of Type II households
λ^{FZ}	0.1	Monetary finance of government parameter
μ	0.42	Capital service share in production
ϖ_h	0.01	Fraction of land recovered in case of default
λ_{res}	0.1	Reserves to deposits ratio
σ_L	1	Inverse of the Frisch elasticity
σ_a	0.058	Capital utilization cost parameter
σ_b	0.009	Capital utilization cost parameter
ϑ	0.04	Land service share in production
$\tilde{\phi}_b$	0.01	Parameter on NFA in Risk adjustment term
λ_a	0.06	Lump-sum tax ratio (Type I households)
λ_g	0.12	Gov. expenditure to GDP ratio
λ_{na}	0.04	Lump-sum tax ratio (Type II households)
λ_e	0.06	Lump-sum tax ratio (Entrepreneurs)

3.3 Empirical results

Table 2a and 2b show the priors and posteriors of estimated parameters. The distributions of our priors rely on theory. The Inverse Gamma distribution is used for the law of motion of positive parameters. Parameters whose values are expected to fall in range between 0 and 1 are assumed to follow a Beta distribution. A Gamma distribution is used for positive or nil parameters[26].

The values of autocorrelation coefficients and standard deviations priors are standard in the literature. The priors of deep parameters that are related to the supply side of banks are from Gerali et al. (2010). The values of other priors are from Nana-Davies (2018).

The model is estimated using the Metropolis-Hasting algorithm consisting of two

[26] Del Negro and Schorfheide (2006) provide a discussion on priors.

separate chains with 1,000,000 draws each (Adjemian et al. (2011)). Along with the posterior mean and standard deviation, the highest posterior density interval (HPDI), computed between 10% and 90%, is shown in the last two columns in Table 2a and 2b[27].

The price indexation parameter κ_d is 0.512. It implies that non-optimizing firms give a slight weight to previous year's inflation when they set their current price. The Calvo proportion of firms that do not re-optimize, ξ, is 0.195, suggesting and expected lifetime of price of 1.25 years. The elasticities of substitution η_c and η_i between domestic and imported consumption goods and between domestic and imported investment goods are 2.92 and 0.05 respectively. Domestic substitutes of imported investment goods either do not exist or are mostly poor while imported consumption goods can be more easily replaced. The posterior shares of imported goods in consumption - $\omega_c = 0.10$ - and in investment - $\omega_i = 0.55$ - corroborate the different degrees of substitutability in both type of goods highlighted by estimated demand elasticities.

The habit in consumption of entrepreneurs - $\kappa_e = 0.72$ - is bigger than that of type I households - $\kappa_a = 0.57$ - because the former has more financing options than the latter. The posterior elasticity of substitution between varieties of domestic goods (θ) implies a 3.1% 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 1.72, implying a lower premium on net foreign assets 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 elasticity of loan demand by entrepreneurs - $\eta_{be} = 3.18$ - is close to 3.12 calibrated by Gerali et al. (2010). The resource used up in the management of bank capital (or bank capital depreciation rate) $\delta_{bk} = 0.01$ is much lower than the calibrated value of 0.1049 obtained in Gerali et al. A lower number of extended loans and the amount involved may explain such a low value. The persistence of AR(1) shocks ranges between 0.49 and 0.95. It is noteworthy that none is close to one, implying that the demeaned growth rates of most observed data is matched (Christiano et al (2011)).

From the posteriors plots (not shown), data appear to be a little less informative for the shock parameters $\rho_{\overline{\pi}^c}$, $\rho_{\varepsilon^{bkr}}$, and the deep parameters ω_c, ξ and κ_d. However, their posteriors are close to those estimated in Nana-Davies (2018). Overall, the posteriors are credible. Therefore, the model provides a sensible representation of the data. We proceed with the economic implications of the estimation.

[27] Priors-posteriors plots and convergence statistics are available upon request.

Table 2a: Prior and posterior distribution of parameters.

		Prior			Posterior			
Parameter	Description	Density	Mean	Std.Dev	Mean	Std.Dev	10%	90%
δ_{bk}	Bank capital depreciation rate	B	0.005	0.0005	0.005	0.000	0.005	0.006
η_{be}	Elasticity of loan demand by entrepreneur	IG	3	0.3	3.181	0.356	2.626	3.741
η_c	Elasticity of subst. between imported and domestic cons. good	G	3.2	0.3	2.921	0.245	2.539	3.344
η_i	Elasticity of subst. between imported and domestic inv. good	G	0.05	0.005	0.051	0.005	0.043	0.059
θ	Elasticity of substitution between varieties of domestic goods	G	31	3.1	33.20	3.102	28.24	38.48
ξ	Calvo probability of no price reoptimization	B	0.2	0.02	0.195	0.019	0.163	0.227
κ_d	Price indexation parameter	B	0.51	0.05	0.512	0.049	0.432	0.595
κ_a	Habit in consumption (Type I households)	B	0.6	0.06	0.575	0.057	0.481	0.671
κ_e	Habit in consumption (Entrepreneur)	B	0.8	0.08	0.723	0.082	0.598	0.861
σ_q	Demand for money curvature parameter	G	10	1	8.096	0.903	6.610	9.567
$\tilde{\phi}_s$	Risk adjustment parameter	G	1.25	1	1.716	0.095	1.551	1.867
ω_c	Share of imported consumption	B	0.1	0.01	0.099	0.01	0.083	0.116
ω_i	Share of imported capital investment	B	0.6	0.06	0.55	0.035	0.493	0.608
$\rho_{\varepsilon^{\pi*}}$	Persistence, foreign inflation	B	0.85	0.075	0.726	0.084	0.597	0.873
$\rho_{\varepsilon^{y}}$	Persistence, stationary output	B	0.85	0.075	0.868	0.06	0.780	0.958
$\rho_{\overline{\pi}^c}$	Persistence, target inflation	B	0.85	0.075	0.844	0.078	0.727	0.968
$\rho_{\tilde{\phi}^u}$	Persistence, country risk premium shock	B	0.85	0.075	0.955	0.022	0.921	0.988
ρ_{μ^z}	Persistence, trend growth shock	B	0.85	0.075	0.489	0.02	0.457	0.521
$\rho_{\varepsilon^{R*FZ}}$	Persistence, interest rate on reserves	B	0.85	0.075	0.812	0.077	0.697	0.947
$\rho_{\varepsilon^{S}}$	Persistence, nominal exchange rate	B	0.85	0.075	0.903	0.049	0.828	0.98
$\rho_{\varepsilon^{m}}$	Persistence, money shock	B	0.85	0.075	0.784	0.08	0.655	0.917
$\rho_{\varepsilon^{c}}$	Persistence, consumption shock	B	0.85	0.075	0.789	0.072	0.67	0.905
$\rho_{\varepsilon^{bkr}}$	Persistence, banks' reserves	B	0.85	0.075	0.842	0.081	0.713	0.964
$\rho_{T^{a}}$	Persistence, tax revenue (Type I household)	B	0.85	0.075	0.868	0.06	0.773	0.963
$\rho_{T^{na}}$	Persistence, tax revenue (Type II household)	B	0.85	0.075	0.868	0.06	0.773	0.963
$\rho_{T^{oil}}$	Persistence, tax revenue (Entrepreneur)	B	0.85	0.075	0.868	0.06	0.773	0.963
ρ_G	Persistence, government expenditure persistence	B	0.85	0.075	0.871	0.061	0.776	0.964
$\rho_{\Pi^{bk}}$	Persistence, banks' profit persistence	B	0.85	0.075	0.842	0.081	0.719	0.968
$\rho_{\overline{h}}$	Persistence, land	B	0.85	0.075	0.934	0.033	0.883	0.986

Density: B: Beta; G: Gamma; IG: Inverse Gamma. Based on two separate metropolis chains with 1,000,000 draws each.. Scale factor set to obtain an acceptance rate in the 0.30 neighborhood. HPDI: 90%. Univariate convergence diagnostic: Brooks and Gelman (1998).

Table 2b: Prior and posterior standard deviation of shock.

		Prior			Posterior			
Parameter	Description	Density	Mean	Std.Dev	Mean	Std.Dev	10%	90%
$\sigma_{\varepsilon^{\pi^*}}$	Size of foreign inflation shock	IG	0.5	∞	0.086	0.01	0.069	0.103
$\sigma_{\varepsilon^{y}}$	Size of Stationary output shock	IG	0.5	∞	0.127	0.021	0.091	0.16
$\sigma_{\varepsilon^{\overline{\pi}^c}}$	Size of Target inflation shock	IG	0.5	∞	0.406	0.249	0.119	0.763
$\sigma_{\varepsilon^{\tilde{\phi}^u}}$	Size of country risk premium shock	IG	0.5	∞	2.417	0.512	1.566	3.45
$\sigma_{\varepsilon^{\mu^z}}$	Size of the trend growth shock	IG	0.5	∞	0.101	0.014	0.079	0.123
$\sigma_{\varepsilon^{R*FZ}}$	Size of the interest rate on reserves shock	IG	0.5	∞	0.089	0.012	0.070	0.108
$\sigma_{\varepsilon^{S}}$	Size of the nominal exchange rate shock	IG	0.5	∞	0.101	0.013	0.079	0.122
$\sigma_{\varepsilon^{m}}$	Size of money shock	IG	0.5	∞	0.156	0.035	0.101	0.207
$\sigma_{\varepsilon^{c}}$	Size of Consumption shock	IG	0.5	∞	1.072	0.384	0.419	1.705
$\sigma_{\varepsilon^{bkr}}$	Size of Bank reserves shock	IG	0.5	∞	0.374	0.199	0.123	0.667
$\sigma_{\varepsilon^{T^a}}$	Size of tax shock (Type I household)	IG	0.5	∞	0.409	0.222	0.125	0.744
$\sigma_{\varepsilon^{T^{na}}}$	Size of tax shock (Type II household)	IG	0.5	∞	0.214	0.029	0.167	0.261
$\sigma_{\varepsilon^{T^{oil}}}$	Size of tax shock (Entrepreneur)	IG	0.5	∞	0.530	0.063	0.430	0.630
$\sigma_{\varepsilon^{G}}$	Size of the government expenditure shock	IG	0.5	∞	0.264	0.057	0.172	0.354
$\sigma_{\varepsilon^{\Pi^{bk}}}$	Size of banks' profit shock	IG	0.5	∞	0.067	0.006	0.059	0.075
$\sigma_{\varepsilon^{\overline{h}}}$	Size of stock of land shock	IG	0.5	∞	0.071	0.007	0.059	0.081

Density: B: Beta; G: Gamma; IG: Inverse Gamma. Based on two separate metropolis chains with 1,000,000 draws each.. Scale factor set to obtain an acceptance rate in the 0.30 neighborhood. HPDI: 90%. Univariate convergence diagnostic: Brooks and Gelman (1998).

4 Economic implications

The economic analysis of the estimation is done in two steps. First, we explore the posterior variance decompositions to spot shocks that have a sizeable contribution to the variations of output, investment, consumption and foreign exchange reserves. Second, we describe the impulse response functions of those shocks on variables.

4.1 Variance decomposition

The posterior conditional variance decomposition is shown for the first and the eight period to cover the business cycle fluctuations span that runs from 6 to 32 quarters.

Figure 1 exhibits the mean conditional variance decomposition one year after a shock. The gamut of colors shows that variables are quite spread over the shocks. For instance, if we consider a 75%-threshold, we note that the price of land, q, needs four shocks (or 4 colors) to reach that threshold. In that respect, 47% of variables need more than four shocks, 41.2% between 3 and 4 shocks, and 11.8% between 1 to 2 shocks.[28].

[28] The 16 variables of the 47%-group include: lAC, lNA, rb, r, nx, pkpr, cAC, cNA, y, rh, q, Rk, l, rbg, rd, and rbe. The 14 variables of the 41.2%-group include: rkbar, u, pinv, bstr, eq, inv, hE, hAC, k w, d, be, bg, and mon (See Table 3 for the meaning of variables).

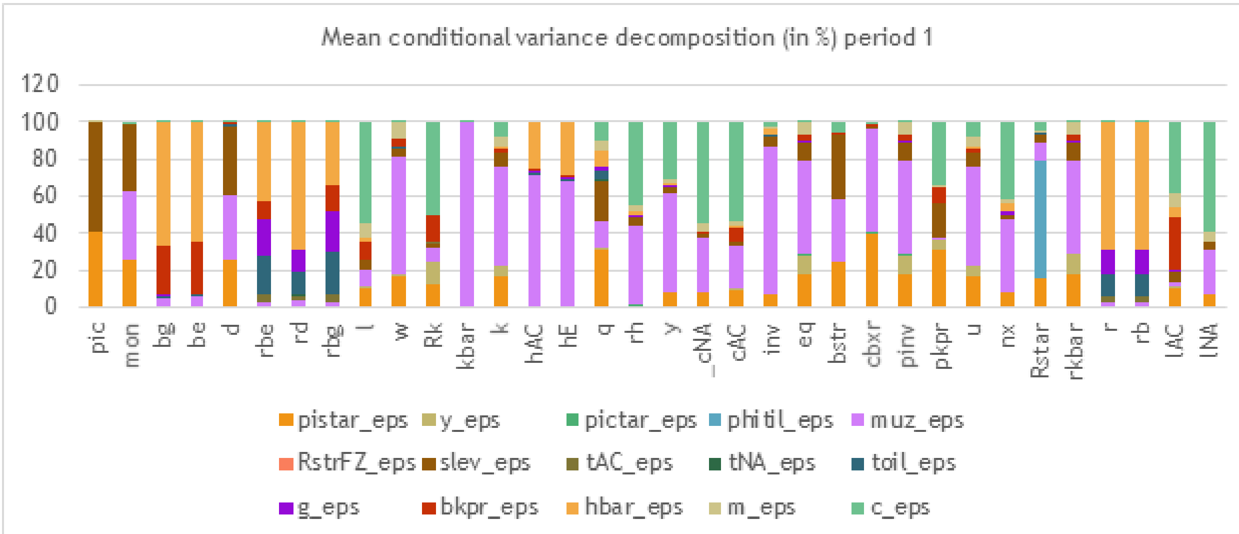


Figure 1:

Figure 1: Posterior mean conditional variance decomposition one period after a shock.

Note: Variables are on the X-axis; Contribution of each shock on a given variable on the Y-axis. See text and tables for symbols' meaning.

From the standpoint of the effect of shocks, there are broadly four categories: six shocks explain less than 20% of any variable, three shocks between 20 and 50%, five shocks between 50 and 70% , and one shock more than 75% of at least one variable. For instance, a risk adjustment shock (phitil_eps) belongs to the third category because it contributes 62.48% of the foreign interest rate on net foreign assets [29]. Foreign inflation, permanent technology and consumption shocks stand out for their massive effect on a few variables in the first period. Except for the foreign interest rate, whose variations mainly stem from the risk adjustment shock, it is reassuring that there are many shocks contributing to open economy variables (eq, cbxr, bstr, and nx).

We turn to a quantitative assessment to comment the mean conditional variance decomposition in the 8th period (Table 3). There is a surge in the contribution of permanent technology and land shocks. For instance, between the first and the eight

[29] The shocks' categories are as follows: Category 1 shocks (less than 20%): transitory output (y_eps), inflation target (pictar_eps), interest rate on foreign exchange reserves (RstrFZ_eps), lump-sum tax on Type I household (tAC_eps), money (m_eps), lump-sum tax on Type II household (tNA_eps) Category 2 shocks (20%-50%): Lump-sum tax on entrepreneurs (toil_eps), government spending (g_eps), bank profit (bkpr_eps). Category 3 shocks (50%-75%): foreign inflation (pistar_eps), nominal exchange rate (slev_eps), land stock (hbar_eps), consumption (c_eps), risk adjustment (phitil_eps). Category 4 shock: (more than 75%) permanent technology (muz_eps).

period, the contribution of technology and land service shocks to the variation of output jump from 53.27% and 1.53% to 71.58% and 13.43% respectively. That outcome is expected for technology shock which is a unit root shock. The surge in the contribution land shock is due to its services being used as an input by intermediate good producers. Bank related variables have a different story though. Instead of land shock continuing to be one of the main sources of their variations, variables such as the amount of loan, interest rates and deposits are now mainly driven by bank profit shock. Interestingly, the contribution of few shocks to the variation of variables has vanished. Moreover, some variables such as cash holdings are spread over more shocks than they did in the first period. Those outcomes testify to the strength of the model's dynamics in the business cycle time horizon. We now turn to the posterior mean variance decomposition to look at the long run linkages.

Table 4 shows the posterior mean variance. Aside from the prominent role of technology and land shocks, it can be noted that fiscal policy shocks matter through their effects on bank and land variables even at an infinite horizon.

Lump-sum tax on entrepreneurs and government spending shocks (toil_eps and g_eps) have a low but highly persistent contribution on the variations of output, land price and its rental rate.

Those shocks also contribute to the variations of bank variables - be, rbe, rd and rbg. Therefore, our estimation corroborates the importance of government's transactions on banks' balance sheet and its effects on financial intermediation (World Bank (1986) and lately IMF (2018)).

We regard that corroboration as a further validation of our model being a good description of the data because the "sovereign-banks" nexus in the CEMAC have been highlighted elsewhere (IMF (2017b)).

Table 3: Posterior mean conditional variance decomposition (in %) Period 8

	pistar_eps	phitil_eps	muz_eps	slev_eps	tAC_eps	toil_eps	g_eps	bkpr_eps	hbar_eps	m_eps	c_eps
Inflation (pic)	60.16	0	0.4	38.98	0	0	0.01	0.03	0.25	0.06	0.01
Money (mon)	38	0	32.92	7.04	0.08	0.01	0.09	10.6	0.41	2.27	8.06
Government's loan (bg)	0.01	0	0.72	0	0.02	0.1	0.07	97.8	1.28	0	0
Entrepreneurs' loan (be)	0.01	0	24.87	0.02	0.63	3.14	2.42	26.92	41.92	0	0.01
Households' deposits (d)	0.01	0	0	0	0	0	0	99.99	0	0	0
Loan rate entrepreneurs (rbe)	0.02	0	1.36	0	3.86	19	17.11	33.14	25.17	0	0.01
Deposit rate (rd)	2.43	0	34.17	0.55	1.33	6.59	6.53	2.37	43.66	1.72	0.5
Loan rate government (rbg)	0.01	0	0.95	0	4.69	22.96	20.37	35.34	15.27	0	0
Aggregate labor (l)	27.25	0	7.16	2.47	0.42	0.26	0.38	11.61	8.41	3.34	38.41
Wage (w)	11.58	0	75.08	1	0.04	0.08	0.12	3.6	2.75	1.71	2.06
Capital return (Rk)	6.98	0	10.18	3.35	0.26	1.25	1.8	0.7	71.17	1.16	2.66
Capital stock (kbar)	0.06	0	99.82	0.01	0	0.02	0.01	0.03	0.04	0	0.01
Capital. service. (k)	5.24	0	81.53	0.92	0.03	0.26	0.17	1.11	8.02	0.82	1.06
Households' land. (hAC)	0.02	0	70.73	0.01	0.26	1.32	1.19	0.53	25.91	0	0
Entrepreneurs' land.(hE)	0.02	0	70.52	0.01	0.26	1.31	1.19	0.53	26.14	0	0
Land price(q)	4.98	0	18.65	3.46	1.41	6.87	6.21	3.53	51.9	0.86	1.67
Land rental (rh)	5.87	0	11.27	4.01	1.56	7.57	6.9	3.78	55.67	1	1.82
Output (y)	1.41	0	71.58	0.58	0.08	0.41	0.3	0.32	13.43	0.31	9.87
Hshld II cons. (cNA)	14.52	0	51.69	1.17	0.02	0.02	0.02	1.52	0.49	1.74	28.22
Hshld I cons. (cAC)	17.62	0	31.85	0.72	0.37	0.05	0.27	12.54	0.99	1.04	33.2
Investment (inv)	3.61	0	65.58	1.46	0.25	1.34	1.23	1.03	23.69	0.5	1.06
Real exchange rate (eq)	9.12	0	76.54	1.58	0.02	0.15	0.1	2.33	4.35	1.21	1.16
Net foreign assets (bstr)	13.47	0	12.89	2.94	0.25	1.22	1.67	1.46	61.11	1.5	2.91
Foreign exchange reserves (cbxr)	17.37	0	14.41	0.71	0.04	0.01	0.03	4.01	0.15	0.87	3.08
Price new capital (pinv)	9.12	0	76.54	1.58	0.02	0.15	0.1	2.33	4.35	1.21	1.16
Price installed capital (pkpr)	7.43	0	28.12	2.78	0.22	1.04	1.44	1.1	53.28	1.12	2.27
Capital utilization rate (u)	6.91	0	75.85	1.2	0.03	0.35	0.23	1.44	10.44	1.07	1.38
Net export ratio (nx)	2.48	0	55.54	0.45	0.019	1.1	0.58	0.88	16.93	0.41	18.94
Foreign rate (Rstar)*	3.63	49.34	4.74	1.59	0.15	0.72	0.88	0.33	36.41	0.75	1.22
Capital rental rate (rkbar)	9.14	0	76.05	1.59	0.02	0.15	0.1	2.34	4.29	1.21	1.18
Wholesale loan rate (r)	0.02	0	3.21	0.05	2.55	12.46	12.49	0.92	67.87	0.19	0.02
Wholesale deposit rate (rb)	0.02	0	2.29	0.01	1.73	8.42	8.28	13.15	65.92	0.01	0.02
Labor Hshld I (lAC)	19.08	0	7.05	1.88	0.93	0.49	0.63	27.4	13.01	2.68	26.61
Labor Hshld II (lNA)	24.43	0	29.36	1.96	0.02	0.1	0.14	0.19	4.67	2.49	36.42

Note:(*) Contribution of the shock on Rstar_FZ (not shown to save space): 59.11%

Table 4 : Posterior mean variance decomposition (in %)

	pistar_eps $\varepsilon_t^{\pi^*}$	phitil_eps $\varepsilon_t^{\tilde{\phi}^u}$	muz_eps $\varepsilon_t^{\mu^z}$	slev_eps ε_t^{S}	tAC_eps $\varepsilon_t^{T^a}$	toil_eps $\varepsilon_t^{T^{oil}}$	g_eps ε_t^{g}	bkpr_eps ε_t^{bkr}	hbar_eps $\varepsilon_t^{\overline{h}}$	m_eps ε_t^{m}	c_eps ε_t^{c}
pic	60.22	0	0.54	38.73	0	0.01	0.01	0.03	0.29	0.06	0.01
mon	0.03	0	70.56	0.01	0.27	1.32	1.2	0.53	26.05	0	0
bg	0.02	0	54.08	0.01	0.2	0.97	0.88	24.76	19.08	0	0
be	0.02	0	70.39	0.01	0.26	1.31	1.19	0.95	25.84	0	0
d	0.01	0	0	0	0	0	0	99.99	0	0	0
rbe	0.02	0	44.97	0.01	0.8	3.88	3.38	28.15	18.73	0	0
rd	2.43	0	34.17	0.55	1.33	6.59	6.53	2.37	43.66	1.72	0.5
rbg	0.02	0	47.89	0.01	0.66	3.24	2.79	27.63	17.71	0	0
l	0.03	0	70.53	0.01	0.27	1.33	1.2	0.53	26.01	0	0.01
w	0.02	0	70.57	0.01	0.27	1.32	1.2	0.53	26.06	0	0
Rk	6.96	0	10.41	3.33	0.26	1.25	1.8	0.7	70.99	1.16	2.65
kbar	0.02	0	70.56	0.01	0.27	1.33	1.2	0.53	26.06	0	0
k	0.02	0	70.77	0.01	0.26	1.31	1.19	0.53	25.88	0	0
hAC	0.02	0	70.66	0.01	0.26	1.32	1.19	0.53	25.98	0	0
hE	0.02	0	70.66	0.01	0.26	1.32	1.19	0.53	25.98	0	0
q	0.02	0	70.66	0.01	0.26	1.32	1.19	0.53	25.98	0	0
rh	0.03	0	70.58	0.01	0.27	1.33	1.2	0.54	26.01	0	0
y	0.02	0	70.58	0.01	0.26	1.32	1.2	0.53	26.05	0	0
cNA	0.02	0	70.56	0.01	0.27	1.32	1.2	0.53	26.06	0	0
cAC	0.02	0	70.56	0.01	0.27	1.33	1.2	0.53	26.06	0	0
inv	0.02	0	70.56	0.01	0.27	1.33	1.2	0.53	26.07	0	0
eq	0.02	0	71.13	0.01	0.26	1.29	1.17	0.53	26.07	0	0
bstr	0.09	0	70.29	0.01	0.27	1.33	1.2	0.53	25.56	0	0
cbxr	0.03	0	70.39	0.01	0.26	1.32	1.19	0.53	26.22	0.01	0.02
pinv	0.02	0	71.13	0.01	0.26	1.29	1.17	0.53	25.56	0	0
pkpr	0.03	0	71.09	0.01	0.26	1.29	1.17	0.53	25.59	0	0
u	0.02	0	71.12	0.01	0.26	1.29	1.17	0.53	25.56	0	0
nx	0.04	0	70.66	0.01	0.26	1.31	1.18	0.54	25.76	0	0.18
Rstar	2.4	65.9	3.7	1.04	0.1	0.48	0.58	0.26	24.08	0.49	0.81
rkbar	0.02	0	71.13	0.01	0.26	1.29	1.17	0.53	25.56	0	0
r	0.02	0	3.24	0.05	2.55	12.45	12.49	0.92	67.85	0.19	0.02
rb	0.02	0	23.69	0.01	1.09	5.34	5.14	20.05	44.54	0.01	0.01
lAC	0.03	0	70.51	0.01	0.27	1.33	1.2	0.54	26.08	0	0.01
lNA	0.03	0	70.56	0.01	0.26	1.32	1.2	0.53	26.05	0	0.01

Note:(*) Contribution of the shock Rstar_FZ (not shown): 59.11%. Otherwise, shocks contributing less than 1% for all variables are omitted. See Table 3 for variable definitions.

4.2 Bayesian impulse response functions

In order to shed light on the propagation mechanism in the economy, we look at the Bayesian impulse response functions (IRFs) of a permanent technology shock, a consumption shock, a foreign inflation shock and a shock in banks' profit (Figure 2a, 2b, 2c, and 2d).

4.2.1 Permanent technology shock

Figure 2a shows that a standard deviation shock to permanent technology brings about a rise in aggregate employment for the first two periods, followed by a steady fall below its NSS level throughout the adjustment process. However, the IRFs of labor of both types of households show that even though they overshoot their respective NSS levels in the first two years and keep on falling thereafter, they do so in quite different contexts. Labor from households who have access to land market and bank deposits are declining while they are lower than their NSS levels whereas for the Type II household, that decline is occurring from above its NSS level.

From the consumption IRFs, we notice that constrained households are hit harder than unconstrained households at the outset and so are willing to work more to restore their consumption. Interestingly, intermediated good producers know that and they substitute labor from constrained households for labor from Type I households. Type I households are forced to draw down their assets, aggressively as far as land is concerned, to bring back their equilibrium consumption.

Intermediate good producers must also adjust their demand for land and capital service after a shock to permanent technology. The aggressive selling of land by households brings about a sharp fall of their price that benefit entrepreneurs both at acquiring and lending it to firms. Firms reduce capital service as their rental rate increases while their flat rate of return over the adjustment process prompts entrepreneurs to reduce the investment in physical capital. Therefore, the available stock of physical capital takes a long time to crawl towards in NSS value. Overall, output falls at the outset and remains below its NSS level following the changes in consumption, inputs and their prices.

Considering the external dimension, net export and foreign exchange reserves fall while net foreign assets do not change at the outset. In the following periods, net exports keep on deteriorating leading to continuous accumulation of foreign debt (modelled as capital inflows) and loss of foreign exchange reserves. The loss in foreign exchange reserves bottoms in the second period where the risk adjustment term must be lower because the domestic interest comes close to its NSS level and the lagged foreign interest rate on current NFA is below its NSS value. Comparing U-shaped IRF of foreign exchange reserves in the one hand and the shapes of the IRFs of net foreign assets, foreign and domestic interest rates on the other hand, it can be inferred that the risk adjustment term, which controls the law of motion of foreign debt service, is the key driver of the pace of foreign exchange reserves' adjustment.

4.2.2 Consumption shock

A standard deviation shock to aggregate consumption translates into an initial increase in output and consumption of both types of households (Figure 2b). Subsequently, output and Type II households' consumption steadily decrease towards their respective NSS levels while Type I household's consumption follows a hump-shaped pattern because of habit in consumption. To meet the increased demand, firms increase the demand for labor and capital service but decrease the demand for land service. The decrease in land service is caused by an initial jump in the price of land and a subsequent decrease that stabilizes above its NSS level. Thus, the reduced return to entrepreneurs prompts them to provide less land service to firms. In contrast, entrepreneurs increase the capital service they rent to firms and the utilization rate of physical capital they provide them with. The physical cost of increasing the utilization rate of capital is low enough to enable entrepreneurs reap a hump-shaped above NSS renting rate of capital. However, the return in physical capital is on average flat over the first four periods preceding its return to equilibrium. The flat return on physical capital brings about a fall of investment and a flat price of installed capital.

Bank variables show that a steep fall in interest rates occurs at the outset and leads to a jump in loan extended to entrepreneurs after a consumption shock. The inverse happens in the next period from where interest rates stabilize near their NSS level while loan decreases gradually towards its NSS level. Entrepreneurs are gradually reducing their loan demand because they are facing a gradual decline of new investment's price.

Turning to the open economy dimension, it can be noted that the consumption of imported goods increases while the imported investment good decreases but the latter must be decreasing more because the net export ratio is positive throughout the process. Foreign debt moves sideways from the first to the fifth period before stabilizing a little above its NSS from where it slowly moves towards that level. Foreign exchange reserves decrease at the beginning of the adjustment process, reach their lowest level in sixth period then move towards its NSS level. The U-shaped IRF of foreign exchange reserves implies that the net export surplus is not high enough to compensate for the servicing of foreign debt. The effective interest rate on foreign debt is bigger than the risk-free international rate throughout the adjustment process because the domestic interest rate and the foreign debt are above their NSS levels.

4.2.3 Foreign inflation shock

Figure 2c shows the IRFs for a standard deviation shock to foreign inflation ($\sigma_{\varepsilon^{\pi^*}} = 0.086$). Domestic consumer price inflation and the real exchange rate jump because importers pass on the increase in foreign price to the domestic consumers and entrepreneurs. Consumption of both types of households fall and gradually revert to their respective NSS levels. The consumption path of households that have access to the land market and bank deposits is U-shaped since they can use both assets to smooth their consumption. Domestic output recovers swiftly even though the consumption recovery process is slower, implying a swift adjustment in the inputs side.

It can be seen from the IRFs of labor, capital utilization rate, capital service and land service that domestic intermediate good firms prioritize land service and labor to swiftly cope with a foreign inflation shock. That input choice is sensible because wage is climbing to its NSS value after its initial fall and the rental rate of land is already at its NSS value starting from the third period while the rental rate of capital is moving towards its NSS level after having overshot that level at the outset.

Entrepreneurs, who acquire land and physical capital to be rented to firms, are adding to their land stock but not to their capital stock as the return on capital is on average flat after the foreign inflation shock. They are adding to their stock of land because the initial sharp fall of their price have prompted households to sell immediately and they keep on selling to restore their consumption level. Entrepreneurs are taking loans from domestic banks but in very small amount because even if the lending rate is back to its NSS after its initial fall their collateral constraint must be binding in the process.

From the external dimension standpoint, net exports fall at the outset then improves to return to its equilibrium. The capital outflow induce by the negative net export ratio is financed by an increase capital inflow because net foreign assets are above their NSS level. The country is losing reserves because outflows are bigger than inflows. However, that foreign exchange reserves process bottoms in the fourth period where the foreign interest rate, after having moving sideways, returns to its NSS level and so induces a lower value for the risk adjustment term. At that period, the domestic interest rate also peaks. Thereafter, the risk adjustment term, which is not yet equal to one, starts to decrease along with the domestic interest rate and net foreign assets bringing about the gradual improvement of foreign exchange reserves holdings.

4.2.4 Bank profit shock

Figure 2d shows the IRFs for a standard deviation shock banks' profits. That shock stems from a decrease in the interbank rate -assumed to be equal to the net wholesale deposit rate paid to deposit branch- which brings about a decrease in the net wholesale loan rate charged by wholesale bank to loan branch. Those wholesale interest rate decreases spark a fall in the interest rate on households' deposits and a dramatic fall in the nominal interest rate on loan to entrepreneurs. A spike in entrepreneurs' loan demand ensues along with a sharp fall of households' deposits who are grappling to keep up with their consumption as their wage revenues are also declining. To cope with that adverse situation, they flood the land market by massive selling causing the land price to drop. Entrepreneurs snap the land up thanks to an increase in bank loans and a looser collateral constraint. Besides their acquisitions of land, entrepreneurs increase their investment in physical capital taking advantage of their lower price.

Intermediate good producers, who rent capital and land services from the entrepreneurs and hire households, adapt their input choice to the new economic landscape. The IRFs of Type I and Type II households' labor show that firms are restoring their labor input by skewing their payroll in favor of the latter. Therefore, aggregate labor is improving along with Type II households' labor.

The IRFs of wage, bank deposits and labor show that Type I households bear the brunt of a bank profit's shock because they cannot take out loans from banks. At this point, it is worth recalling that households' poor collateral, stemming from the land tenure system and law enforcement problems, is one of the biggest impediments to an adequate financial inclusion in Cameroon (IMF (2009, 2018)).

Output undershoots then overshoots its NSS value during the first four periods preceding the initiation of a U-shaped adjustment path. Interestingly, consumption of both types of households jumps initially then decreases to revert to equilibrium. Constrained households gradually decrease their consumption by optimizing their cash holdings. Unconstrained household smooth their consumption overtime by using an optimal combination of cash holdings, land sale and reduced savings at the banks that is consistent with their consumption habit. Therefore, their consumption adjustment path is hump-shaped.

Net export increases in the first period then steadily falls below its NSS level until the ninth period from where it starts moving towards that level. After the first three periods where the country swings from net foreign creditor to net foreign debtor, the country achieves a maximum accumulation of foreign claims in the fourth period. Thereafter, claims accumulation on non-residents steadily reverts (from below) towards its NSS level. The NFA's favorable outcome induces foreign reserves accumulation. It can be seen that the hump-shaped IRF of the latter is located above its NSS throughout the adjustment process. Foreign exchange accumulation reaches its peak in the sixth period where the gap between the domestic interest rate and its NSS value is minimum.

At this stage, it is worthwhile to recall that a bank profit shock is associated with a sharp fall of wholesale interest rates, interest rates on loan to entrepreneurs and government bonds. Moreover, government bonds demand is lower throughout the adjustment process. Overall, the favorable effects of this shock suggests that high interest rates, which is one of the symptom of the fear of lending, are among the impediments to economic expansion in the country.

4.2.5 Other low-effect shocks

To save space, we have not commented on the IRF of a government spending shock. However, it should be noted that a government spending shock does increase households' consumption because of the presence of two types of households and price stickiness in the model as suggested in Galí et al. (2007). The consumption of both types of households overshoot their respective NSS levels at the outset then revert to those values, steadily for Type II households and following a hump-shaped path for Type I households.

The effects of a selected shocks on a selected set of variables are given in Table 5. Most of the shocks are expansionary but the posterior variance decompositions have shown that their contribution is lower than those of the shocks described above.

Table 5: Cumulative variation over 8 periods (increase : +; decrease: -; little change: $\simeq$)

	Variables					
Shocks	Output	Foreign Reserves	Investment	Consumption. Type I	Consumption. Type II	Inflation
y_eps	+	+	+	+	+	small +
slev_eps	$\simeq$	+	short + (3 years)	-	-	+
m_eps	small +	-	$\simeq$	+	+	small +
tAC_eps	+	small -	-	-	small -	small +
tNA_eps	small +	small -	-	-	-	small -
toil_eps	short + (4 years)	small -	-	-	+	small -
g_eps	+	small +	+	+	+	small +

Note: short + (3 years) means NSS value after 3 years.;(increase : +; decrease: -; little change: $\simeq$);y_eps: stationary output shock; slev_eps: nominal exchange rate shock; m_eps: money demand shock; tAC_eps: Lump-sum tax on Type I households; tNA_eps: Lump-sum tax on Type II households; toil_eps: Lump-sum tax on Entrepreneurs; g_eps: Government expenditures shock.

5 Conclusion

We model the supply side of the banking sector, two types of households and a land asset collateral in a small open economy model that accounts for some of the most enduring features and provisions of the Franc Zone. The model is estimated using the Metropolis-Hasting algorithm consisting of two separate chains with 1,000,000 draws each and Cameroon's data over the sample period 1979-2016. Among our findings, four stand out.

First, we find that sensible posteriors of some deep parameters are obtained when the proportion of rule-of-thumb households is set to forty-eight percent, which is in the range of the World Bank's (2019) estimates of the poverty headcount ratio and close to the percentage of respondent not having a bank account by lack of money in its Findex survey (IMF (2018), World Bank (2018)).

Second, the posterior variance decomposition at business cycle frequencies and the mean variance decomposition show that permanent technology, bank profit, consumption and foreign inflation shocks are the key drivers of macroeconomic fluctuations in that country.

Third, among those shocks, only bank profit shock brings about an output expansion. That shock is associated with a sharp drop of wholesale interest rates, leading us to infer that high interest rates, which is one of the symptom of the fear of lending, are among the main impediments to economic expansion.

Fourth, fiscal policy shocks matter but through their effects on banks' balance sheet because they contribute to the deviations of interest rates even at the infinite horizon as shown by the posterior mean variance decomposition.

Two more general findings are worth noting to conclude the paper.

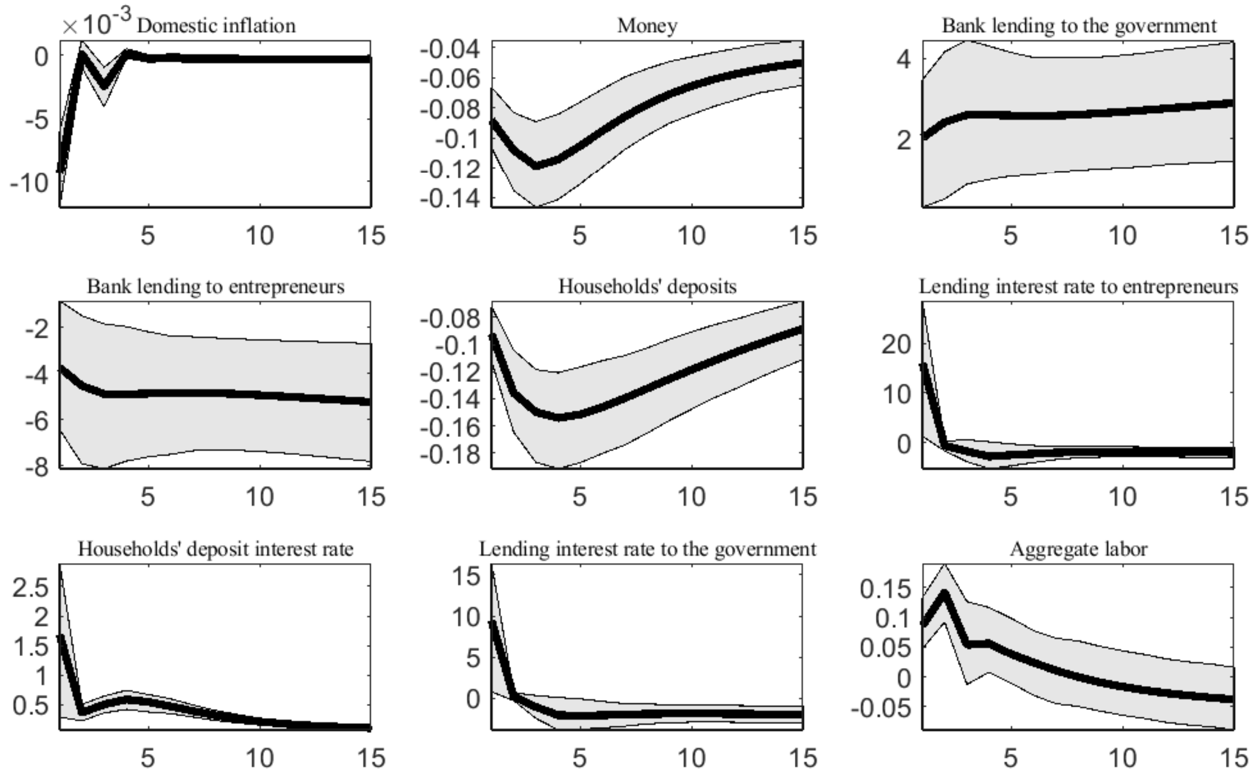
Franc Zone's monetary authorities recognize that the fiscal balance criterion used until 2017 had significant weaknesses, both in terms of design and implementation. As they are considering a change in the workings of their monetary union by moving to a market based monetary financing of budget deficit in member countries, the supply side of the banking sector modelled here can be easily adapted to suit that fix if it materializes.

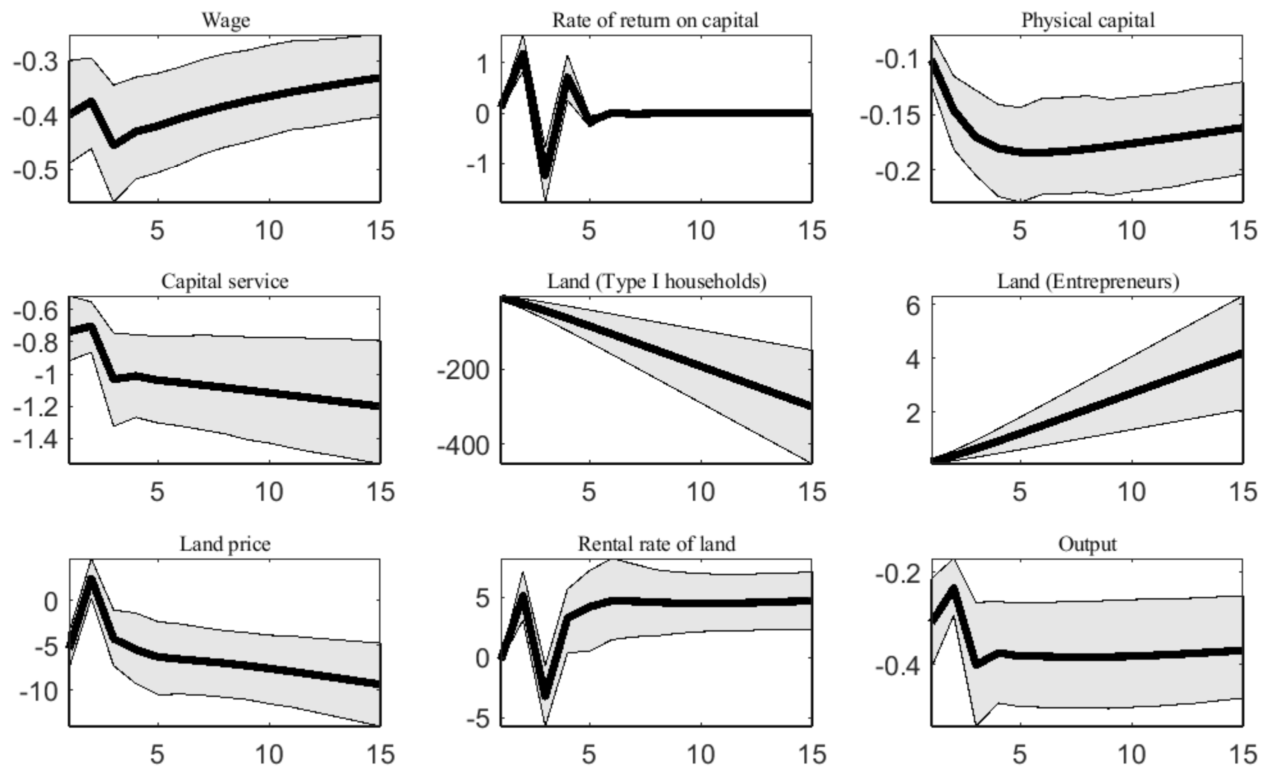
Cameroon's average real growth per capita is barely positive during our estimation period. It follows that notwithstanding any architecture fix of the Franc Zone, the country needs a brand new range of structural policies to deal with mostly contractionary shocks that are buffeting its economy.

Figure 2: Bayesian impulse response functions (IRFs)

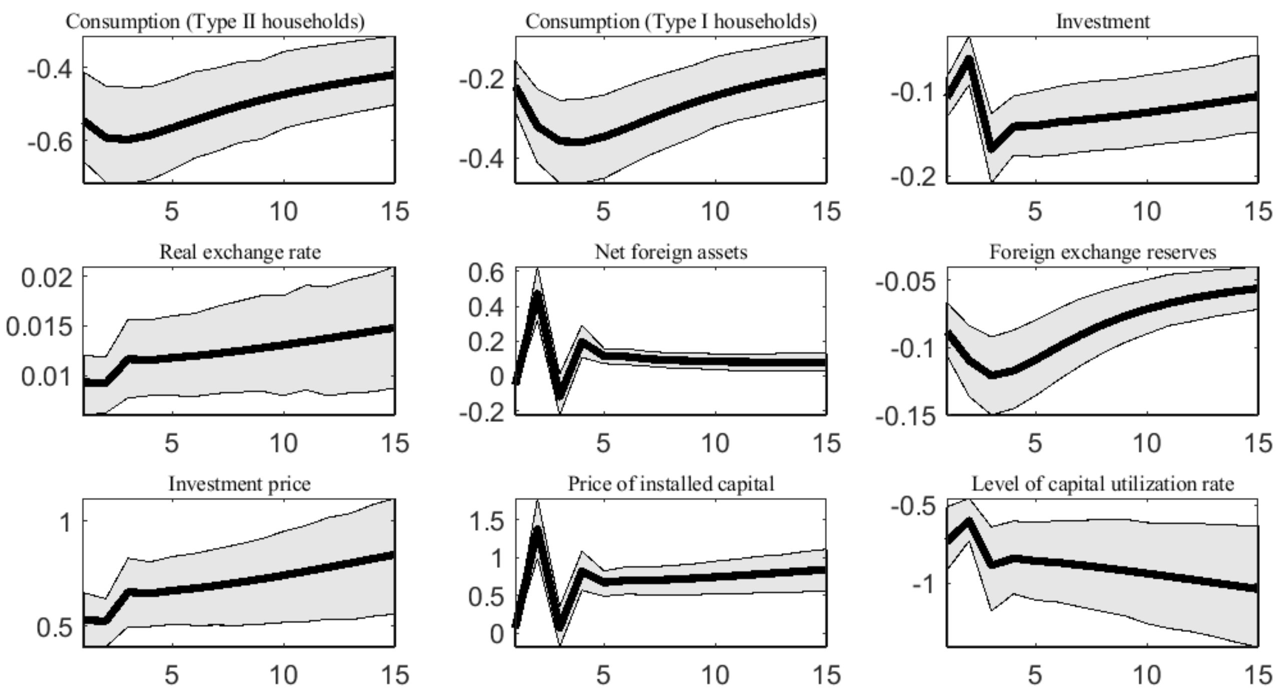
Bayesian IRFs are the mean impulse responses. The gray shaded areas provide highest posterior density intervals. Also note that first order IRFs are scale invariant. So, variation on the y-axis can be interpreted as percent or basis points.

Graph 2a: Bayesian impulse responses to a permanent technology shock

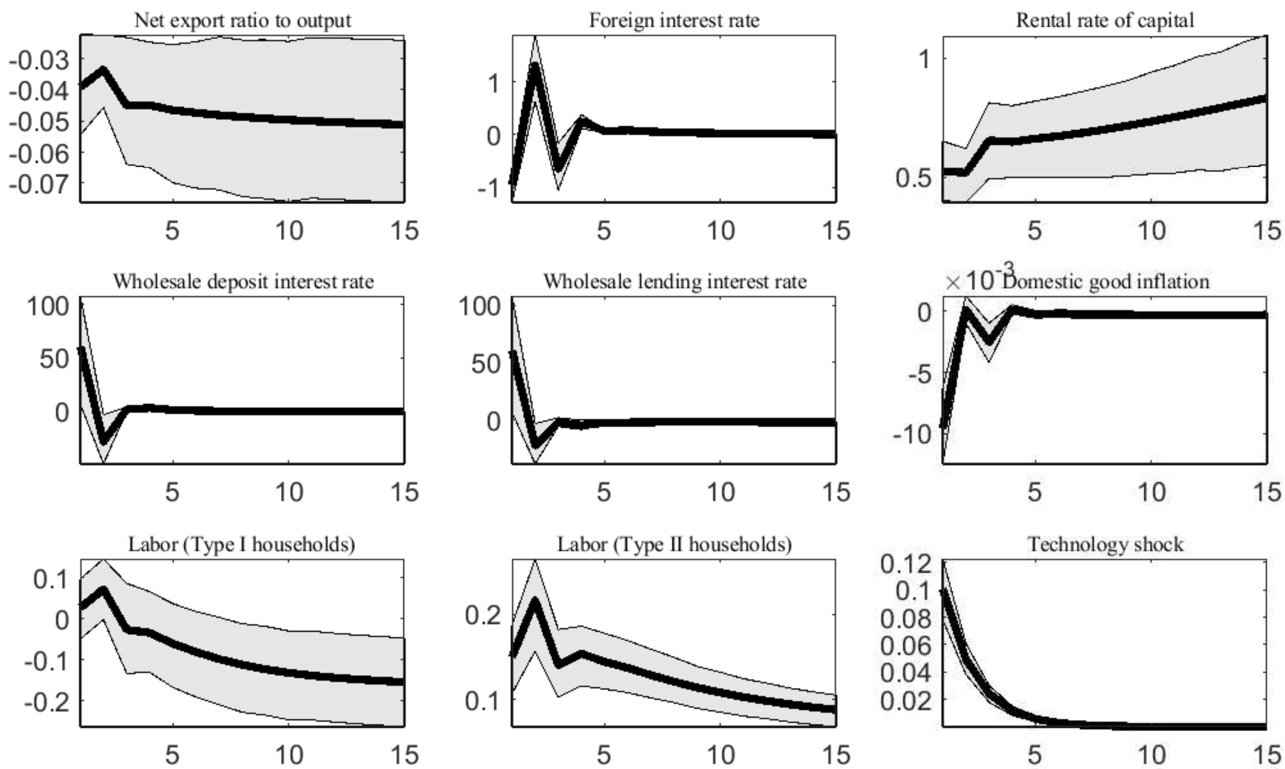




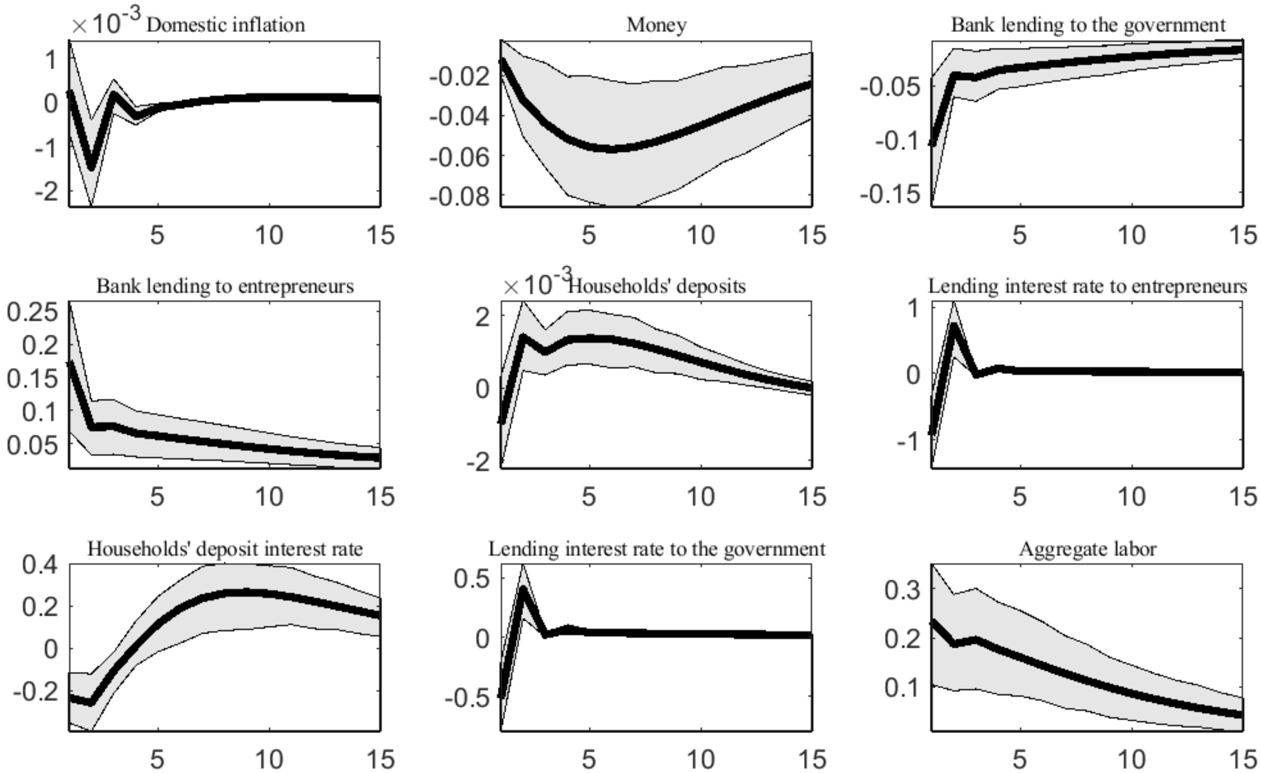
Wage
-0.3
-0.4
-0.5
5
10
15
Rate of return on capital
1
0
-1
5
10
15
Physical capital
-0.1
-0.15
-0.2
5
10
15
Capital service
-0.6
-0.8
-1
-1.2
-1.4
5
10
15
Land (Type I households)
-200
-400
5
10
15
Land (Entrepreneurs)
6
4
2
5
10
15
Land price
0
-5
-10
5
10
15
Rental rate of land
5
0
-5
5
10
15
Output
-0.2
-0.4
5
10
15

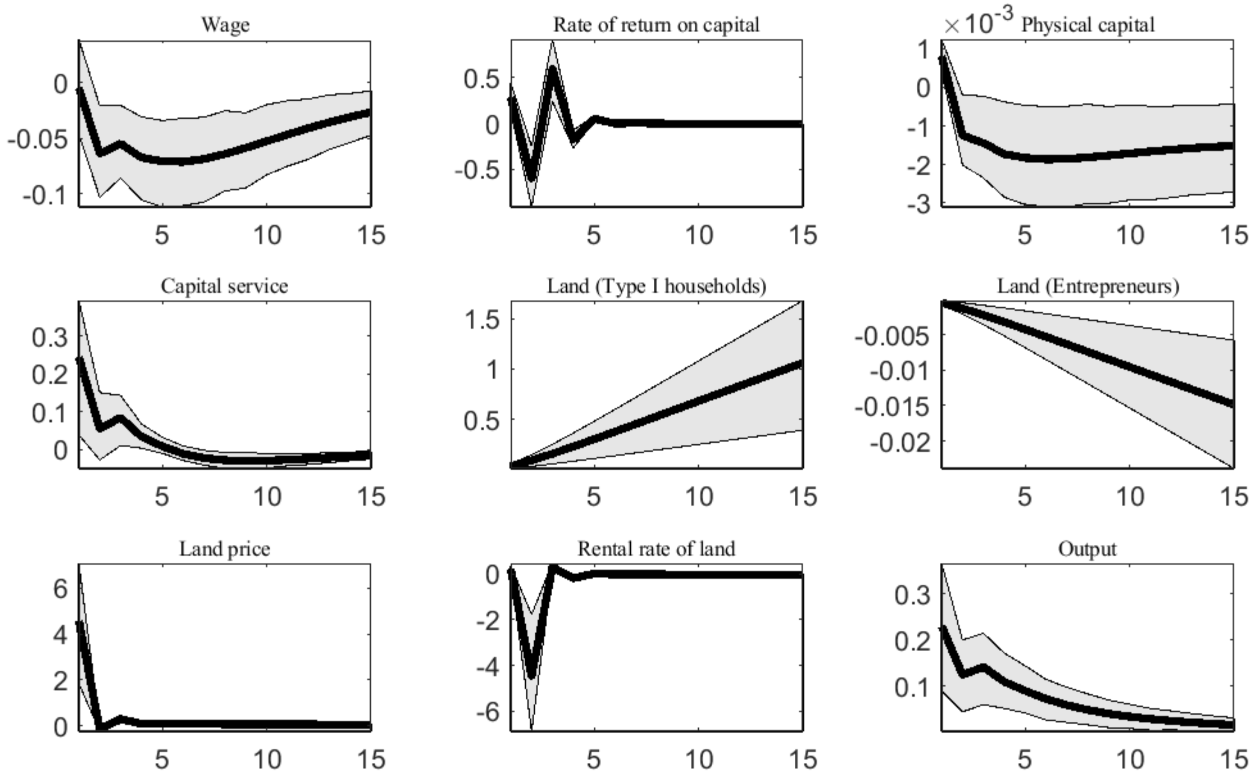


Consumption (Type II households)
Consumption (Type I households)
Investment
Real exchange rate
Net foreign assets
Foreign exchange reserves
Investment price
Price of installed capital
Level of capital utilization rate

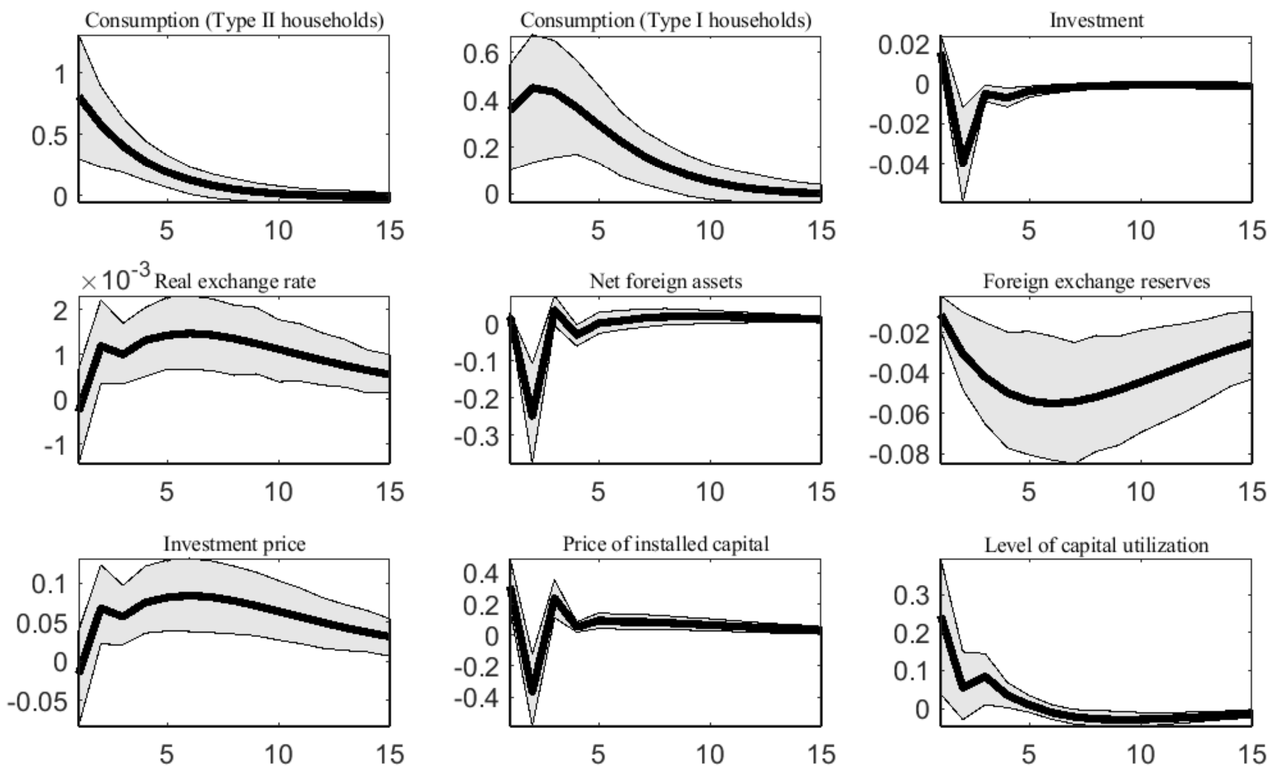

Net export ratio to output
Foreign interest rate
Rental rate of capital
Wholesale deposit interest rate
Wholesale lending interest rate
×10^-3 Domestic good inflation
Labor (Type I households)
Labor (Type II households)
Technology shock

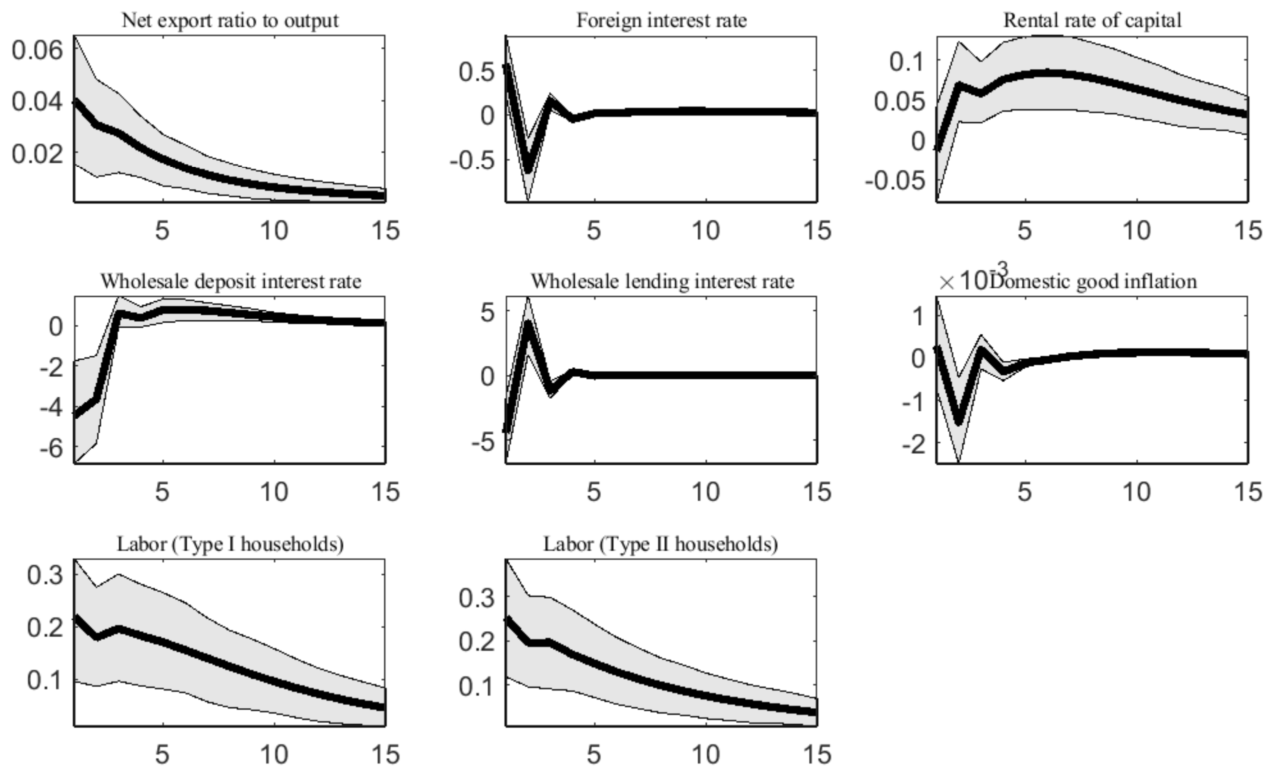
Graph 2b: Bayesian IRFs to a consumption shock





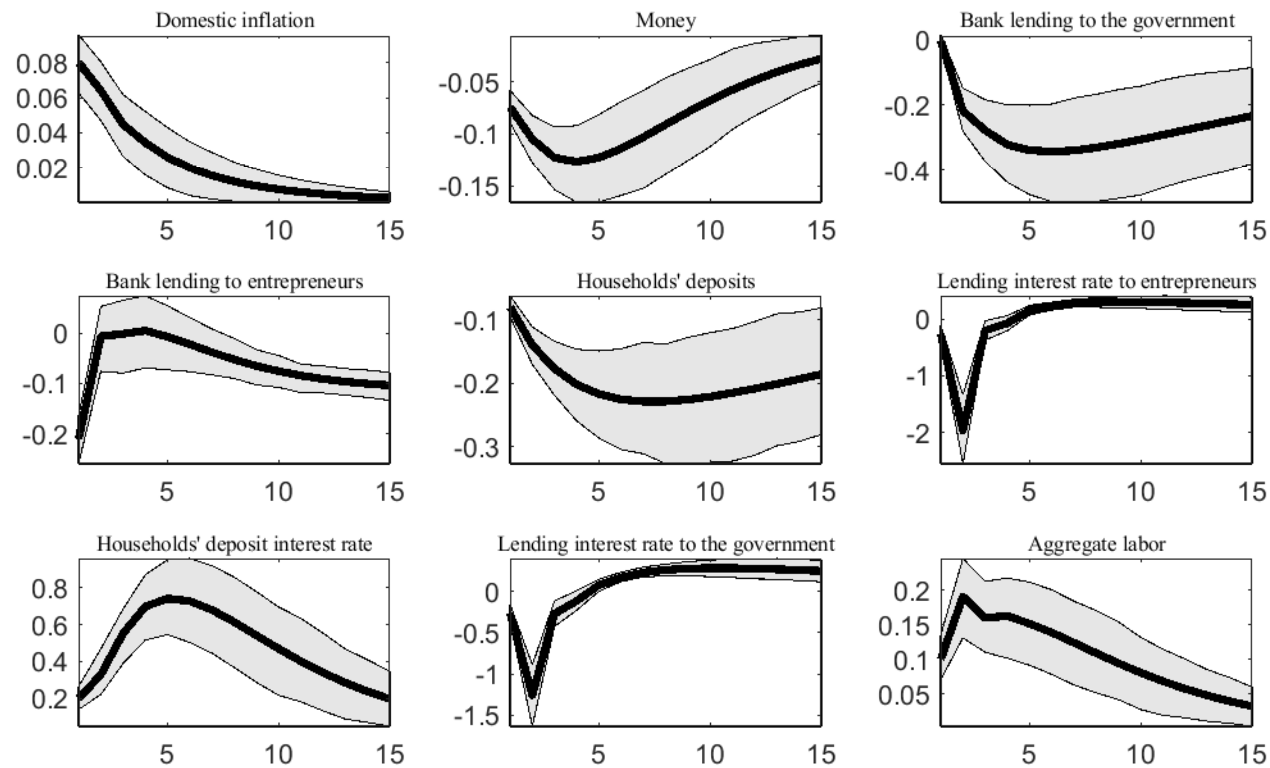
Wage
Rate of return on capital
$\times 10^{-3}$ Physical capital
Capital service
Land (Type I households)
Land (Entrepreneurs)
Land price
Rental rate of land
Output

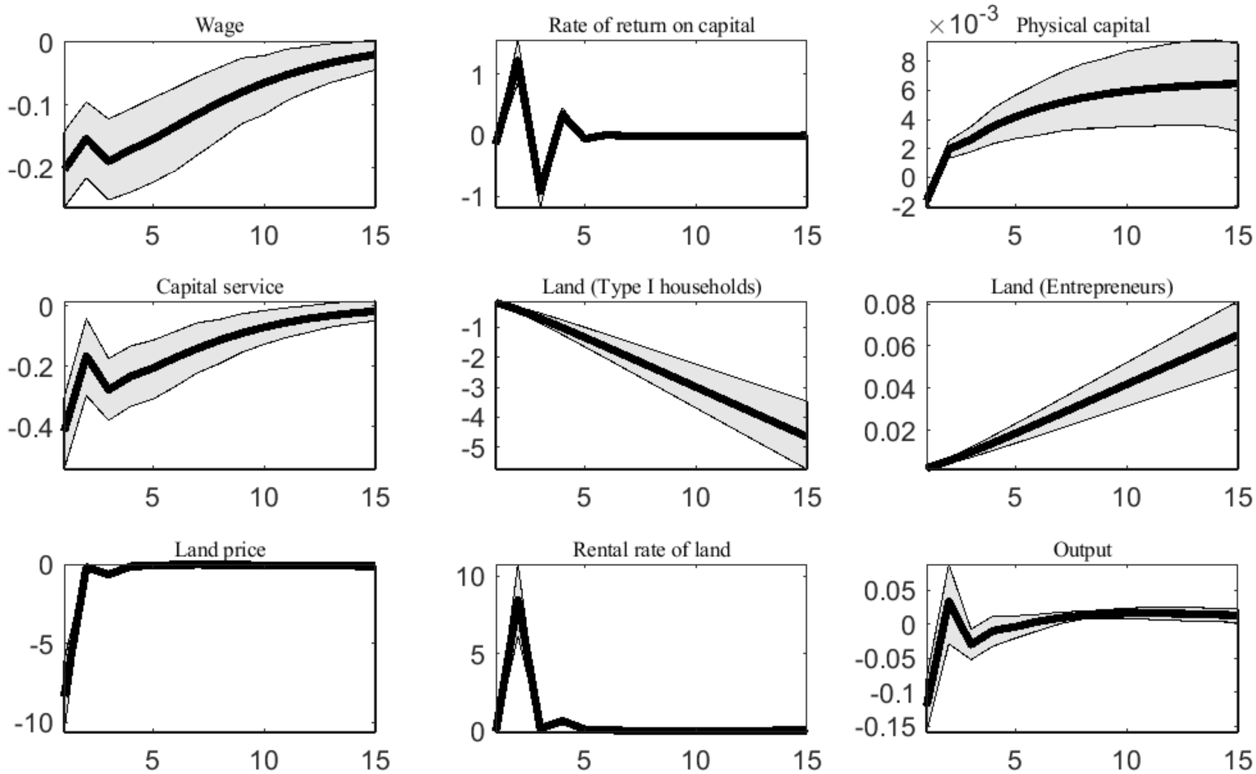

Consumption (Type II households)
Consumption (Type I households)
Investment
$\times 10^{-3}$ Real exchange rate
Net foreign assets
Foreign exchange reserves
Investment price
Price of installed capital
Level of capital utilization



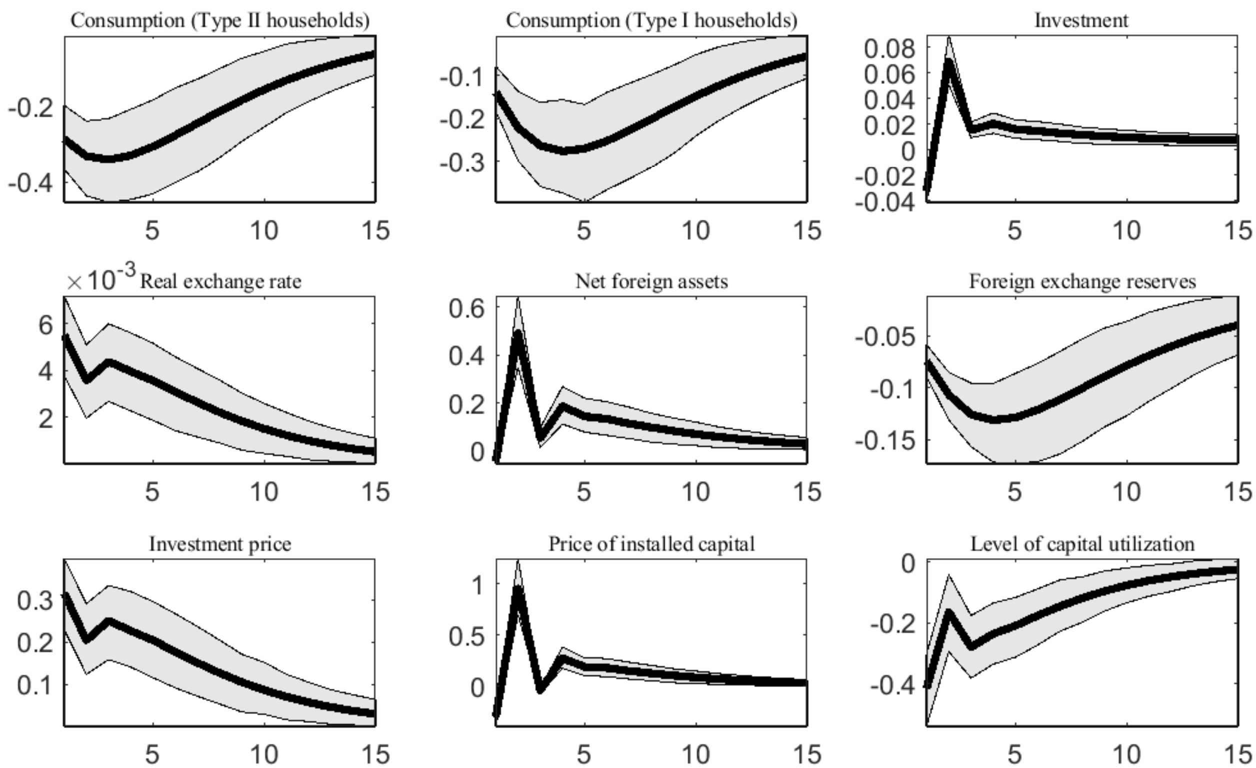
Net export ratio to output
0.06
0.04
0.02
5
10
15
Foreign interest rate
0.5
0
-0.5
Rental rate of capital
0.1
0.05
0
-0.05
Wholesale deposit interest rate
0
-2
-4
-6
Wholesale lending interest rate
5
0
-5
$\times 10^{-3}$
Domestic good inflation
1
0
-1
-2
Labor (Type I households)
0.3
0.2
0.1
Labor (Type II households)

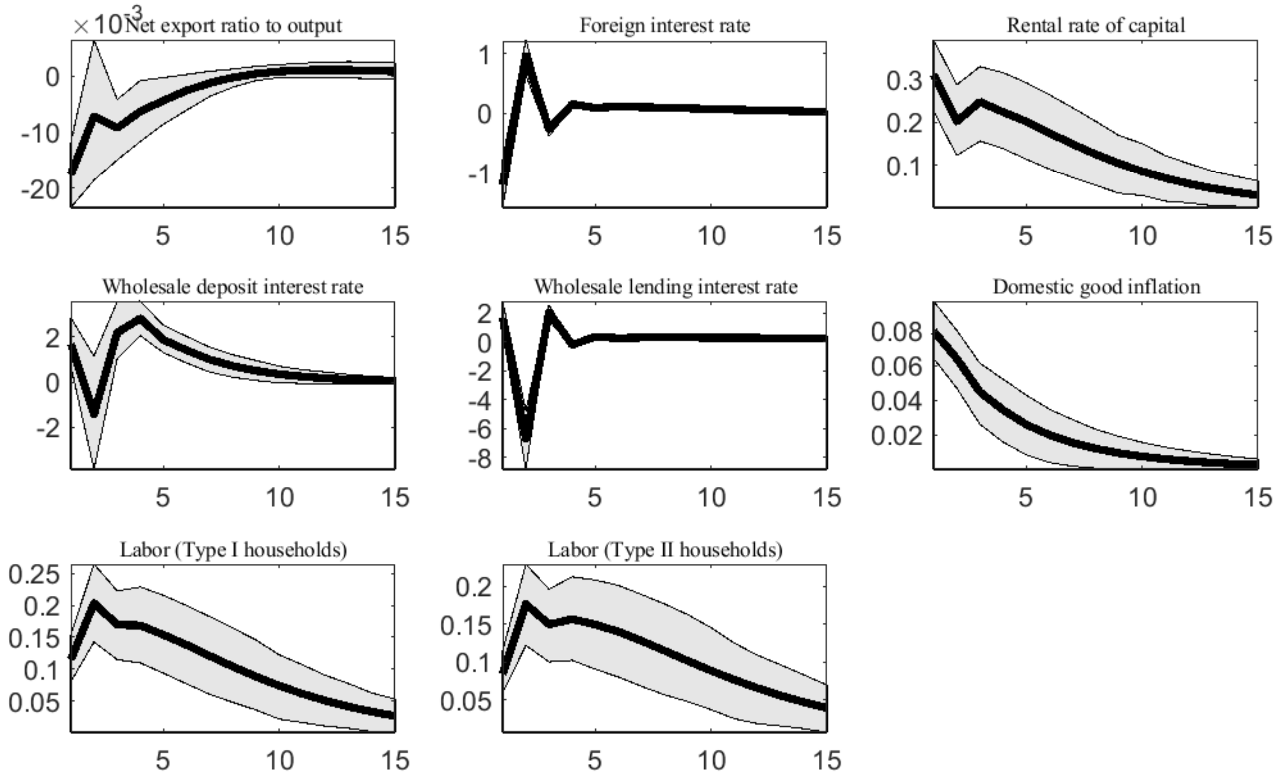
Graph 2c: Bayesian impulse responses to a foreign inflation shock





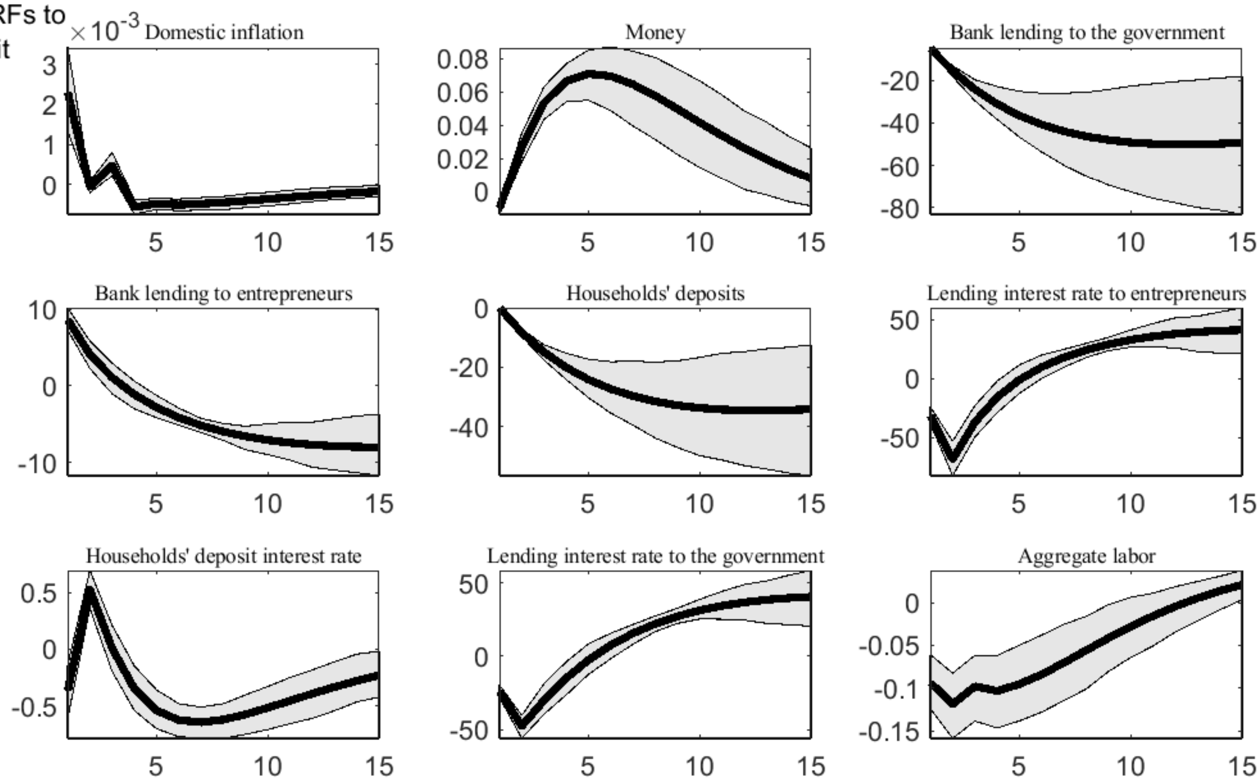
Wage
Rate of return on capital
×10^-3 Physical capital
Capital service
Land (Type I households)
Land (Entrepreneurs)
Land price
Rental rate of land
Output

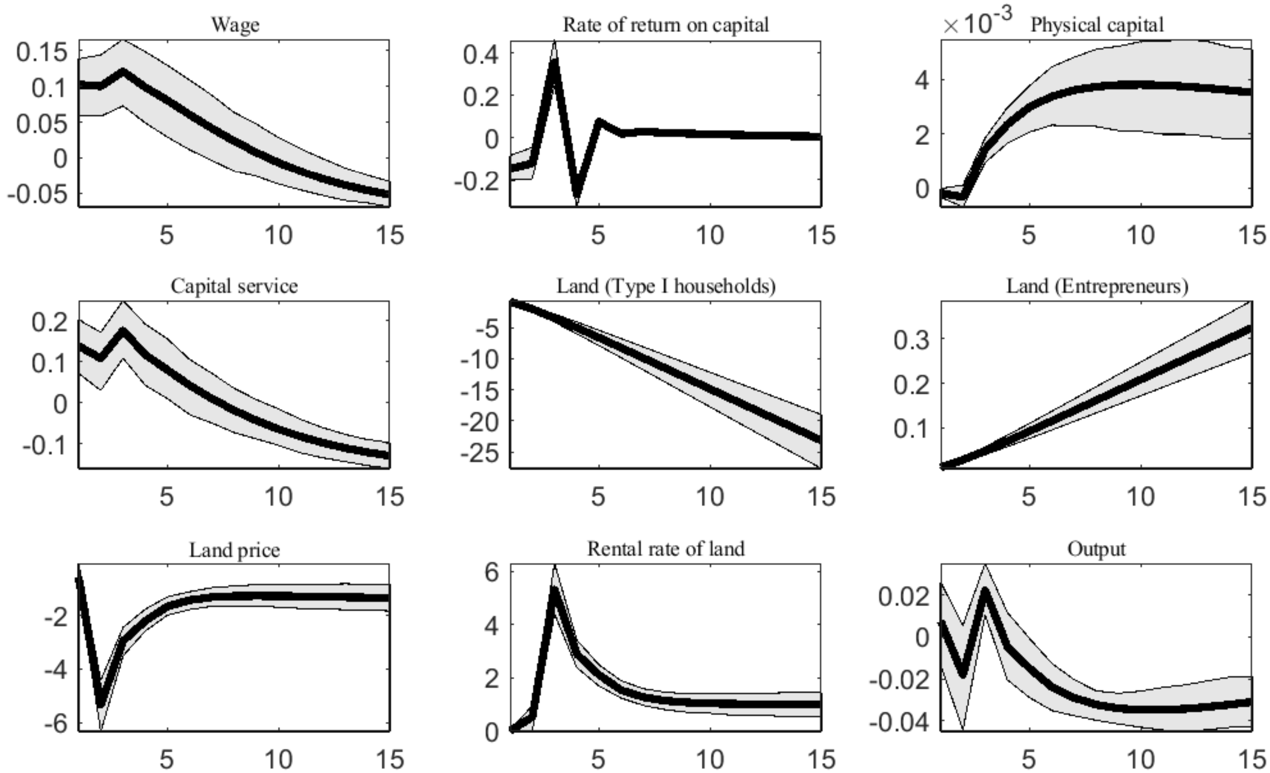

Consumption (Type II households)
Consumption (Type I households)
Investment
$\times 10^{-3}$ Real exchange rate
Net foreign assets
Foreign exchange reserves
Investment price
Price of installed capital
Level of capital utilization



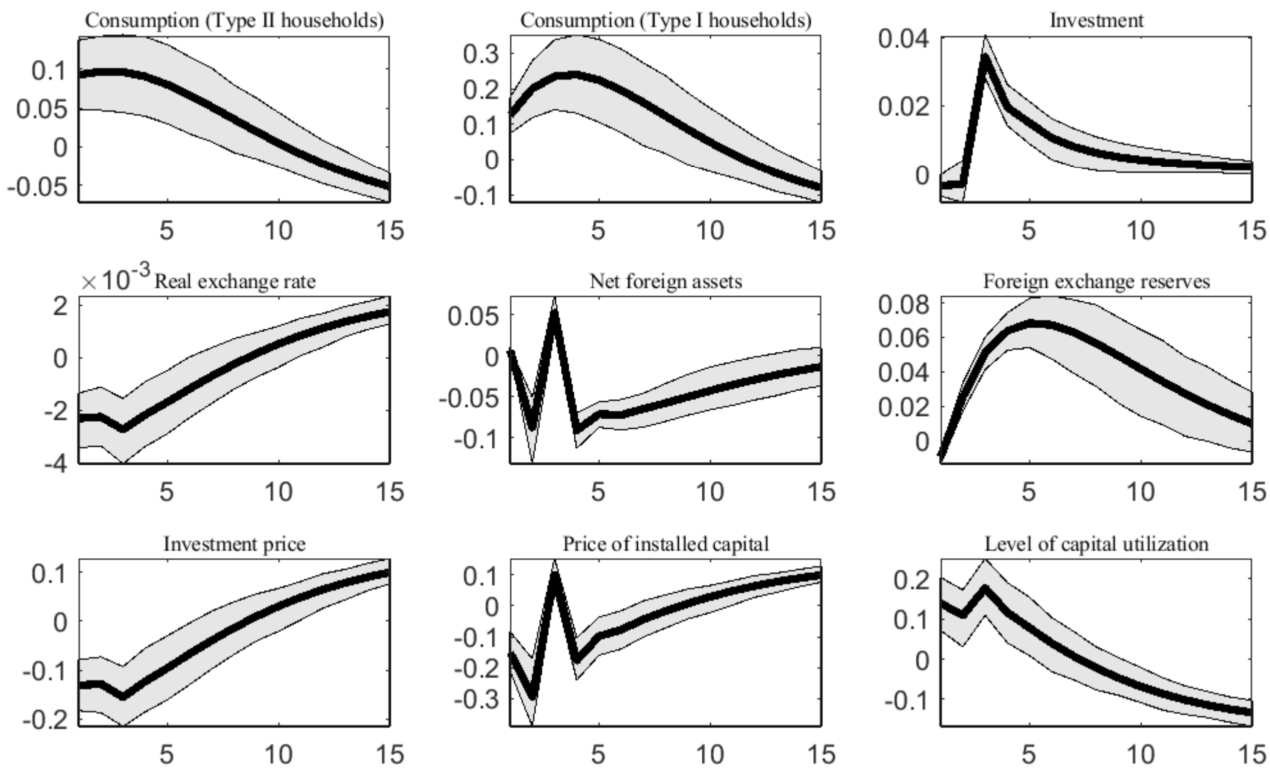
×10-3 Net export ratio to output
Foreign interest rate
Rental rate of capital
Wholesale deposit interest rate
Wholesale lending interest rate
Domestic good inflation
Labor (Type I households)
Labor (Type II households)

Graph 2d:
Bayesian IRFs to
a bank profit
shock

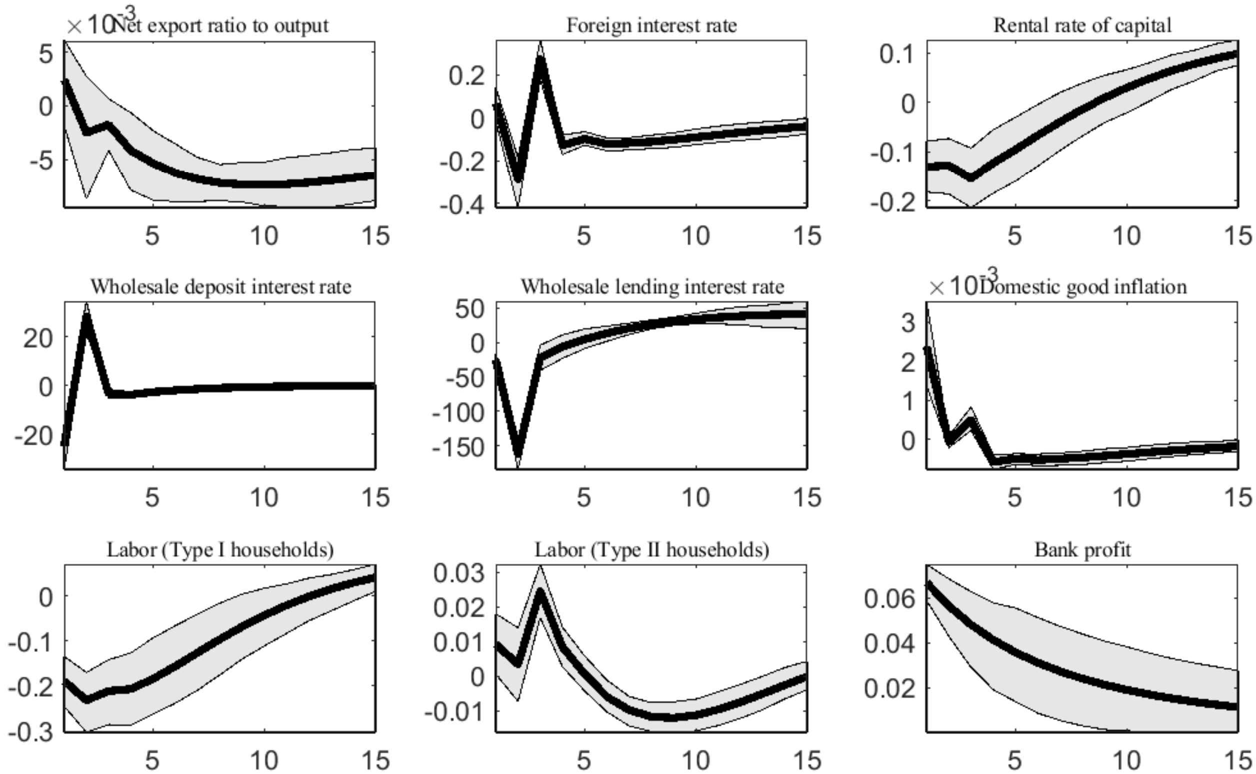




Wage
0.15
0.1
0.05
0
-0.05
5
10
15
Rate of return on capital
0.4
0.2
0
-0.2
$\times 10^{-3}$
Physical capital
4
2
0
Capital service
0.2
0.1
0
-0.1
Land (Type I households)
-5
-10
-15
-20
-25
Land (Entrepreneurs)
0.3
0.2
0.1
Land price
-2
-4
-6
Rental rate of land
6
4
2
0
Output
0.02
0
-0.02
-0.04



Consumption (Type II households)
Consumption (Type I households)
Investment
Real exchange rate
$\times 10^{-3}$
Net foreign assets
Foreign exchange reserves
Investment price
Price of installed capital
Level of capital utilization



×10^-3 Net export ratio to output
Foreign interest rate
Rental rate of capital
Wholesale deposit interest rate
Wholesale lending interest rate
×10^-3 Domestic good inflation
Labor (Type I households)
Labor (Type II households)
Bank profit