Macroeconomic Effects of Sovereign Deficits: Evidence from An Estimated DSGE Model for the Philippines

Aris Zoleta[1]
[1] *DLSU Graduate School of Economics*
aris.c.zoleta@gmail.com

Abstract

This study used the Bayesian methodology to estimate and calibrate a small-scale DSGE model of the Philippines. The goal of this study was to review the risk associated with increases in sovereign deficits. The main results of the study are as follows: Estimates of fiscal rules show that fiscal authority provides more emphasis on debt to GDP than output and deficits. In addition, the stochastic simulation shows that increases in public investment don't limit increases in private investment. And both public and private investment exhibit procyclical behaviors in presence of government spending shock. Lastly, the output is more persistent during episodes of technology shocks than on an increase in government spending. The paper also shows that there is no significant difference in result between the fiscal authority's alternative fiscal rules of responding on levels of deficits and debt or levels of deficits and debt from its target

Research Objective

In this study, we want to answer the following research question: (1) What are the macroeconomic effects on the increase of government spending on public infrastructure investment? (2) What are the benefits of alternative fiscal rules? I introduce two rules. The first rule, in which the government spending responds to changes in output, deficit to GDP, and Debt to GDP. The second rule is similar to the first rule except that now government responds by accounting changes in Deficit to GDP and Debt to GDP from its target level. (3) Does government investment have positive effects on private investment? And (4) How the levels of deficits and debt respond to the increase of government spending?

Theoretical Model

Model

A continuum of households that derive utility by consumption C_t lives the model, relative to the stock of habits h and disutility in providing labor hours L_t. The household stock of habit is given by the fraction of household previous consumption in the form, hC_{t-1} where $h \in [0,1]$ is the habit parameter. The habit parameter measures the relative desires of households to smoothen consumption in the presence of shock. Also, the persistence of habits explains the nominal rigidities in consumption. Furthermore, the household utility maximization problem can be written as

$$E_t \sum_{s=0}^{\infty} \beta^{t+s} \chi_{t+s}^{u} \left[\frac{1}{1-\gamma} (C_{t+s} - hC_{t+s-1})^{1-\gamma} - \chi_{t+s}^{l} \frac{L_{t+s}^{1+\kappa}}{1+\kappa} \right]$$

The household budget constraint can be written as;

$$(1+\varphi_t^c)P_t C_t + I_t + B_t = (1-\varphi_t^l)W_t L_t + (1+\varphi_t^k)R_t^k K_t^P + R_t^b B_{t-1} + \phi_t$$

And private capital follows a simple law of motion

$$K_t^P = (1-\delta)K_{t-1}^P + I_t^P$$

Household chooses the sequences of consumption, labor, capital, and debt consecutively$\{c_t, l_t, k_t, b_t\}$ .Solving the household first-order condition yields the following:

$$(1+\varphi^c)\lambda_t = (c_t - hc_{t-1})^{-\gamma} - h\beta E_t (c_{t+1} - hc_t)^{-\gamma}$$

$$\lambda_t = \frac{\chi^l l_t^{\kappa}}{(1+\varphi^l) w_t}$$

$$\frac{1}{(1+R_t^B)} = \beta^t \frac{\lambda_{t+1}}{\lambda_t}$$

$$1 = \beta^t \frac{\lambda_{t+1}}{\lambda_t} \left[1 - \delta + \frac{(1+\varphi^k)R_t^P}{P_t} \right]$$

I divided the firm sector between perfectly competitive final goods firms and monopolistic competitive intermediate goods firms. There is a continuum of intermediate goods index by j which is distributed over an interval of [0,1] that is being sold by the monopolistic competitive firm to the final goods firm.The final good firms used Dixit- Stiglitz (1977) technology in aggregating intermediates good. The interediate goods demand the price index.

$$y_t^j = \left(\frac{P_t^j}{P_t} \right)^{-\varepsilon} Y_t ;$$

$$P_t = \left[\int_0^1 (P_t^j)^{1-\varepsilon} dj \right]^{\frac{1}{1-\varepsilon}}$$

The monopolistic intermediate goods firm purchases labor and capital from the household sector and also uses government capital k_t^G to produce intermediate goods using Cobb-Douglas production technology.

$$y_t^j = A_t (k_{jt}^P)^{\alpha} l_{jt}^{1-\alpha} (k_{t-1}^G)^{\alpha_G}$$

I follow Villaverde and Ramirez (2006) on the exposition of firms' cost minimization problem.

$$\min_{k_{jt-1}^P, l_{jt}} r_t^P k_{jt}^j + w_t l_{jt}'$$

Solving the cost minimization yields the intermediate firms' demand for labor and capital.

$$r_t^P = \frac{\alpha w_t}{(1-\alpha)} \frac{l_{jt}}{k_{jt}^P}$$

$$l_{jt} = \frac{\left[\frac{\alpha w_t}{(1-\alpha) r_t^P} \right]^{-\alpha} (k_t^G)^{-\alpha_G}}{A_t}$$

Fiscal Authority

The government purchase of consumption and investment, interest payment for bond and transfer shall match by the revenue from taxes in consumption, capital, and labor.

$$\frac{B_{t+1}}{P_{t+1}} = G_t^C + G_t^I + \frac{R_t^G}{\pi_t} \frac{B_t}{P_t} + \phi_t - (\varphi_t^c P_t C_t + \varphi_t^k R_t^P K_t^P + \varphi_t^l W_t L_t)$$

The law of the motion that governed the government capital accumulation

$$K_t^g = (1-\delta_G) K_{t-1}^g + G_t^I$$

In this study, the fiscal agents target a certain level of debt to GDP and primary deficit as a fiscal stabilizer. Also, consumption, labor earnings, and capital earnings respond exogenously to government spending shocks

$$G_{1,t} = \gamma_{1,y}(y_t) + \gamma_{1,\tau} \left(\frac{\tau_t}{y_t} \right) + \gamma_{1,b} \left(\frac{b_{t-1}}{y_t} \right) + \psi_{1,t}^G$$

$$G_{2,t} = \gamma_{3,y}(y_t) + \gamma_{3,\tau} \left(\frac{\tau_t / y_t}{\bar{\tau} / \bar{y}} \right) + \gamma_{3,b} \left(\frac{b_{t-1}/y_t}{\bar{b}/\bar{y}} \right) + \psi_{2,t}^G$$

Monetary Authority

There is a central bank that conducts monetary policy. The monetary authority sets the interest rate as a policy instrument. I assume that the central bank uses a simple Taylor Rule in the below form

$$i_t = \phi_i i_{t-1} + \phi_y (\bar{y} - y_t) + \phi_\pi (\bar{\pi} - \pi_t) + \psi_t^i$$

Results and Discussion

As shown in Table 1, the estimates of the coefficient of fiscal rules suggest that the national government is more sensitive on Debt to GDP than Output and Deficits to GDP. This estimate is consistent with the different institutional arrangements and legislated rules to stabilize debt growth in the Philippines. As for rules, the general appropriation act apportions and prioritize debt servicing. In addition, the institutional arrangement between fiscal and monetary authority is crucial in Philippine debt management. There is coordination between the national government and BSP on matters of foreign borrowing. This arrangement may contribute to the significant sensitivity of the fiscal rules to the level of debt to GDP

Notation	Parameter	prior mean	posterior mean	90% HPD	Interval	Prior	Posterior Deviation
γ_Y	Output	0.5	0.1851	0.0334	0.323	beta	0.2
γ_τ	Deficit to GDP	0.5	0.1316	0.0264	0.2438	beta	0.2
γ_b	Debt to GDP	0.5	0.9197	0.859	0.988	beta	0.2

Table 1 Estimated Coefficient of Fiscal Rule

The changes in BSP monetary framework from targeting monetary aggregate into inflation targeting are evident in the estimation result shown in Table 2. In the presence of exogenous shock on output and inflation, BSP response almost twice as aggressively on inflation compared to persistence on policy rate and output. This may characterize the BSP policy as leaning against the wind during the recent decades of inflation targeting. Also, the inertial behavior of BSP as shown by the interest smoothing parameter is relatively high compare to the coefficient of the output gap.

Notation	Parameter	prior mean	posterior mean	90% HPD	Interval	Prior	Posterior Deviation
ϕ_π	Inflation	2	2.2061	1.8859	2.5562	norm	0.25
ϕ_i	Interest smoothing	0.75	0.6712	0.5251	0.8147	beta	0.10
ϕ_Y	Output gap	0.125	0.0847	0.031	0.1445	norm	0.05

Table 2 Estimated Coefficient of Taylor Rule

Figure1 and 2 show the effects of technology and government spending shocks consecutively. Increases in government spending have positive effects on output, consumption, private investment, and public investment. As shown in Figure 2, output expanded for 2 quarters and sharply decline up to its steady-state. This shows that output is more persistent during episodes of technology shocks than on an increase in government spending. Similarly, consumption and hours peak then sharply decreases on the next quarter. Both private and public investment increases as the government increase its expenditure. This result replicates the prediction of literature. Public investment doesn't crowd out private investment during positive shock on government spending. BSP responded by reducing the interest rate and inflation. The increase in the deficit is much muted during the shock on government spending than on technology shock. Government borrowing decreases then continues to increase until 10 quarter then die down.

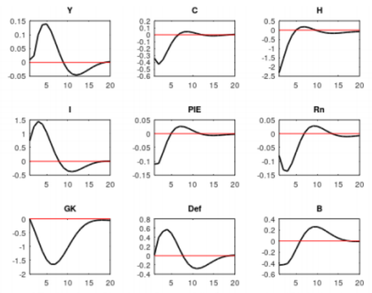

Figure 1 The Effects of Technology Shock on Output (Y), Consumption (C), Labor hours (H), Investment (I), inflation (PIE), BSP rate (Rn), Govt. Capital (GK), Deficit (Def), and Gov.t Debt (B)

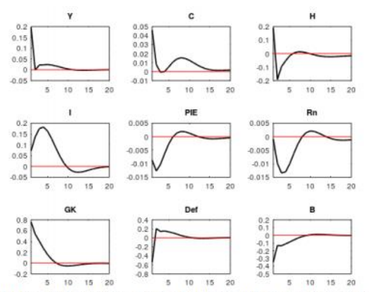

Figure 2 The Effects of Govt. Spending Shock on Output (Y), Consumption (C), Labor hours (H), Investment (I), inflation (PIE), BSP rate (Rn), Govt. Capital (GK), Deficit (Def), and Govt. Debt (B)

Conclusion

Using DSGE models the simulation provides evidence on the ability of government public investment on infrastructure to influence private capital investment. The simulation results suggest that during episodes of increasing government spending private capital responded positively. In addition, both public and private investment exhibits procyclical behaviors in presence of government spending shock. Lastly, the output is more persistent during episodes of technology shocks than on an increase in government spending. The estimates also show that the national government is more sensitive on debt to GDP than on output or deficits to GDP in presence of government spending shock.