Is Debt Finance Deficit Better than Tax Revenue?

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July 17, 2020

Abstract

One realization of containment measures imposed against Covid-19 is that these measures not only impact consumer and firm sentiment but induce revenue lost in taxes and increase spending on the government's social safety net program

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Key Words: Fiscal Rule, Government Spending, Fiscal Deficit, DSGE

1 Introduction

The recent Covid-19 is the most expensive health crisis that the Philippines ever experienced. This pandemic resulted in broad measures such as social distancing and prohibitions of discretionary activities to contain the spread of the disease. To avoid the collapse of the current health system, measures are undertaken to control the outbreak. Strict adherence to community quarantine and lockdown protocol is implemented to limit the mobility of people and to further slow the contagion of the disease. One realization of containment measures impose is that these measures not only impact consumer and firm sentiment but also induce revenue lost in taxes and increase spending on government's social safety net programs and further need to invest in research and health facilities to address the similar future health crisis.

The natural question we want to ask, does policy to reduce interaction among people, will positively correlate with an economic recession? Or does this policy only induce a temporary shock on employment, consumption, and investment? We may conjecture that the current pandemic will have long-run and short-run effects not only on output but also on welfare. And that forecasted recovery will not only be conditional on the magnitude of the shock attributed to pandemic but also its persistence. If a solution such as a vaccine will be available for a while the persistence of shock will be longer and have severe long run effects.

In addressing such a scenario, swift coordination between fiscal and monetary are needed. Bangko Sentral ng Pilipinas (BSP) introduces several measures to protect the financial market and banking system from the vagaries of the pandemic. On the onset of the pandemic, the monetary authority reduces the policy rate and reserve requirement significantly to ease liquidity constraints and encourage flows of credit from the banking system to the real sector of the economy. Other none monetary measures such as the 300 billion pesos worth of repo agreement between the BSP and Bureau of Treasury (BTr) are undertaken. Foreseeing bankruptcy among many firms, the BSP also proposes the legislation of Financial Institution Strategic Transfer (FIST), which authorizes banks to transfer its trouble assets to special purposes vehicles, which act as asset managers for debt structuring and recovery. This is similar to the Trouble Asset Relief Program (TARP) in the United States. The goal of the proposed legislation is to ensure that the banking system will not be overwhelmed with non-performing assets (NPAs) if the pandemic continues to persist. This ensures that credit is available to firms and households ensued prolong crisis

Similar efforts are undertaken by the Philippine fiscal authority to limit the long-run effects of the pandemic on the economy. However, the scale and breadth of the cost of this program put a strain on public spending. One key step is the passage of the "Bayanihan Act to Heal as One" in April 2020. The legislation is to authorize the President to realign and supplement the General Appropriation Act of 2020 to fund various efforts to fight the pandemic. Such programs are expanding the coverage of the Pantawid Pamilya Pilipino Program (4Ps) to a larger segment of the population for social amelioration. Other relief measures are also in place; for example, the Department of Health extended bereavement benefits among surviving beneficiaries of doctors and other health professionals who died due to the Covid-19. The Social Security Services (SSS) and the Department of Labor (DOLE) provide cash assistance among displaced workers to ease the financial burden caused by the pandemic.

On similar ways studies on accurate measurement on the impact of pandemic is prerequisite in designing policy that reduces its effects on consumer spending, investment and welfare Eichenbaum et al. (2020) show that the current pandemic has both supply and demand effects. The supply effect is due to reduced productivity in employment and an increased risk of mortality that resulted in the decline of labor supply. This effects on demand arise from the limited ability of consumers to traditional access to goods and services such as retail establishments that slowly moving to e-commerce channels. Another negative effect is the increasing uncertainty on the soonest availability of vaccines, which discourages capital investment which most needed for economic recovery.

The literature on public finance recognizes the distortionary effects of taxes on consumer welfare and firm behavior. Bhattaraia and Trzeciakiewiczb (2017) show that in an environment with a low-interest rate, consumption taxes are the most effective and labor income tax is least effective among different policy horizons. Dacuycuy (2019); shows a different result using the Philippine data and shows that decreases in labor taxes stimulate the economy due to a higher level of output and private consumption. Also, he added that his result is sensitive to the preference structures of the household in the economy. This results are in presence of deep habits and habit formation that provides insight into the relative effects of taxes on consumption and labor supply. As the degree of habit is stronger, a shock on labor income due to taxes tends to have less influence on consumption.

This is in conjunction on theoretical model of the fiscal policy. In thought experiment on the influence of a fiscal shock on different endogenous variables. Household expectation of current debt increases will likely determined equilibrium dynamics. In addition, it is important to understand how future tax burden exogenously affects household budget constraint. In most cases in general equilibrium models, it is implied that public debt holding must be equal to the expected present value of government surpluses. For example, on paper of Leeper et al. (2009), they show that fiscal shocks that are financed by debt have long-lasting dynamics that satisfy the present value condition of the government budget constraint. However, under this environment, the fiscal authority follows a Ricardian policy, and that debt could be finance entirely by future surpluses (Chung & Leeper, 2007). This is different on Woodford (2001), he further views that assumption of Ricardian equivalence may run counter to the different experiences of many countries such as in their history follows the Non-Ricardian policy and resulted in a significant increase in the price level

One notable effect of the current pandemic is a large positive shock on government spending. For example, in the Philippines, it is expected to have deficits equivalent to 8.7 percent of GDP, and growth is expected to contract around 3 percent this year. In combating this, different legislation is proposed for stimulus packages and to enhance tax revenue. Revenue proposals such as additional taxes on sin products, oil and sweeten beverages are deliberated in the congress as revenue measures to catch the shortfall from the tax and fund various stimulus program. The goal of this study is to provide context on the current policy debates on different fiscal measures notably on debt finance and tax amendments.

2 Model

The model in this study is similar to Leeper et. al. (2009) and Uribe (2019) extended to include New Keynesian nominal rigidities in the firm's pricing decision. I assume that households buy the product from the goods market and provide labor and capital to the inputs market. The government raises taxes to households to finance its spending and sell government bonds to finance its deficit.

2.1 Household

The model is lived by a continuum of households that derive utility by consumption C_t , relative to the stock of habits 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 household to smoothen consumption in presence of shock. Also, the persistence of habits explain the nominal rigidities in consumption. Furthermore, the household utility maximization problem can be written as

$$E_t \ \sum_{t=0}^{\infty} \beta^t \ \chi_t^u \left[\frac{1}{1-\gamma} \left(C_t - hC_{t-1} \right)^{1-\gamma} - \chi_t^l \ \frac{L_t^{1+\kappa}}{1+\kappa} \right]$$

where

$\gamma,\ \kappa \in (0,1)$ are parameters that represent the inverse relative aversion of households and the inverse of the Frisch substitution elasticity of labor consecutively; $\beta \in (0,1)$ is the household discount factor. And χ_t^u and χ_t^l are shocks on preference and labor, that follow AR (1) process. The household budget constraint can be written as;

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

I assume that private capital follows a simple law of motion

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

where $\delta \in (0,1)$ is the capital depreciation rate. Dividing the budget constraint by the price level P_t , we can denote in the small letter all real variables in the model. The representative agent purchases consumption, investment, i_t and lend to the government by purchasing government bonds b_t . Household wealth is derived from labor income $w_l l_t$, dividends from renting private capital to the firm $r_t^k k_t^p$, returns from holding government bonds $R_t^b b_{t-1}$, and lastly, by receiving government transfer ϕ_t . The parameter φ_t^c , φ_t^l and φ_t^k are the rate the government levied to household's consumption, labor, and capital earnings respectively. We can summarize the household financial wealth by Equation (3) and nonfinancial wealth by Equation (4);

$$w_t \equiv r_t^b b_{t-1}$$

$$z_t \equiv \left(1+\varphi_t^l\right) w_t l_t + \left(1+\varphi_t^k\right) r_t^k k_t^p + \phi_t$$

where $r_t^b \equiv R_t^b - \pi_t$ the real interest rate on government bonds and $\pi_t \equiv \frac{P_t}{P_{t+1}}$ is the gross inflation. In equation (4), the government can influence household financial wealth by changing the value of government debt or by influencing the real rates it pays to the household. This strategy is independent of the distortionary taxes that the government levied on the household. On a different note, Equation (5) tells a different story where the household's nonfinancial wealth is mainly driven by the distortionary tax rate that households have to pay. Furthermore, I assume that household is subject to borrowing constraints that prevent them from engaging in Ponzi schemes.

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:

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

where λ_t is the langrage multiplier associated with the household optimization problem. The household allocated labor hours given by (7) and portfolio of government bond (8). Lastly Equation (9) describes the household Euler equation. Collectively Equation (6) to (9) describes the decision rules of household's optimal resources allocation.

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

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

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

2.2 Firm

The firm sector is divided 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 constant return technology:

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

where y_t^j is the quantity of intermediate goods j used at time t and ε is the elasticity of substitution between different goods. In every period the final good firms maximize their profit by

$$\max \left[P_t Y_t - \int_0^1 P_t^j Y_t^j \ \ dj\right]$$

Solving Equation (8) given (7) yields the demand for intermediate goods and the price index

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

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

The monopolistically 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. Government capital is available to all intermediate firms in the economy and is used symmetrically owed to its production technology.

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

where α is the parameter that shows the share of private capital production process, and $A_t = \rho_A + (1-\rho_A) A_{t-1} + \varepsilon_{At}$ are the firm's technical productivity available to all intermediate firms that follow AR(1) process and ε_{At} is a stochastic shock on productivity that has zero mean and constant variance. Based on Leeper et al. (2010), α_G is defined as the efficiency parameter of government spending. Lim (2019), have different interpretations of this which I follow in this paper. In his study, he defined this as the measure of the influence of government capital on an intermediate good production. Or simply we can say the share of government capital in the intermediate goods production function. Dacuycuy et al. (n.d.)in their paper on the Disbursement Acceleration Program (DAP) allowed the accumulation of government capital to have effects on the firm's marginal production, similar to the paper modelling strategy. Following Villaverde and Ramirez (2006), in the intermediate firm's minimization.

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

Solving (11) given (10) yields the intermediate firms' demand for labor and capital.

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

Rewriting (13) as $r_t^P k_{jt}^P = \frac{\alpha l_{jt} w_t}{(1-\alpha)}$ and substituting into (18) yields the real cost of the intermediate firms.

$$w_t l_{jt} + \frac{\alpha w_t l_{jt}}{(1-\alpha)} = \frac{w_t l_{jt}}{(1-\alpha)}$$

Substituting (14) to (11) and letting it equal to 1, exploiting the fact that each intermediate firm uses constant return to scale (CRS) technology, similar to Fernandez-Villaverde and Ramirez (2006), yields

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

Again, substituting (15) into (14) gives the intermediate firm's marginal cost.

$$mc_t = \left(\frac{1}{(1-\alpha)}\right)^{1-\alpha} \left(\frac{1}{\alpha}\right)^{\alpha} \frac{w_t^{1-\alpha} r_t^{\alpha}}{A_t \left(k_t^G\right)^{\alpha_G}}$$

My exposition in this section usually follows Dacuycuy et al. (2019). Based on the above result, the level of government capital affects the firm's marginal cost, which indirectly affects pricing decisions. I depart on some assumption by Dacuycuy et al. (2019), which is I will state in the next section in detail. In their model similar to Lim (2019), they assume that the government purchases both consumption and investment. Needing to simplify my exposition, I assume that the government does not purchase consumption and only produces government capital. This modeling strategy allows me to further link the dynamics of debt and taxes on firms' marginal costs.

Continuing the exposition of Dacuycuy et al. (2019) and Fernandez-Villaverde and Ramirez (2006). The second stage of the intermediate firm's problem is maximizing the discounted present value of its profit. Using Calvo pricing, $(1-\theta)$ a fraction of the firms will optimize their price and the remainder of the firms will index their price from past inflation. The indexation parameter $\chi \in [0,1]$ governs the relative desire of a non-optimizing firm to index its price. Given the optimal demand for intermediate goods,

$$y_{jt+\omega} = \left(\prod_{s=1}^{\omega} \pi_{t+s-1}^{\chi} \frac{P_{jt}}{P_{t+\omega}}\right)^{-\varepsilon} y_{t+\omega}$$

The firm's problem is to maximize (18), subject to (17)

$$\max_{P_{jt}} E_t \sum_{\omega=0}^{\infty} (\beta\theta)^{\omega} \frac{\lambda_{t+\omega}}{\lambda_t} \left(\prod_{s=1}^{\omega} \pi_{t+s-1}^{\chi} \frac{p_{jt}}{p_{t+\omega}} - mc_{t+\omega}\right) y_{jt+\omega}$$

Taking the first-order condition of the firm's problem leads to

Considering the result of the firms pricing decision, the price index evolves according to the following rule:

$$p_t^{1-\varrho} = \theta \left(\pi_{t-1}^{\chi}\right)^{1-\varrho} p_{t-1}^{1-\varrho} + (1-\theta)\, p_t^{*(1-\varrho)}$$

Rearranging (20) implies that

$$1 = \theta \left[\frac{\pi_t^{\chi}}{\pi_{t+1}} \right]^{-\varepsilon} + (1-\theta)\, \pi_t^{*(1-\varepsilon)}$$

2.3 Fiscal Authority

The government sells bonds to households and levied taxes on consumption labor income and capital earnings. In describing the government budget flow, as I mentioned before, the government purchases resources to produce capital. This allows us to fully appreciate the dynamics of the effects of the different fiscal regimes. The only caveat is that this may not be observable, but I believe it is a good approximation of the current fiscal policy of the government.

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

Government capital accumulation is governed by the law of the motion

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

We can rearrange (25) and define the government budget constraints as

$$\frac{B_{t+1}}{P_{t+1}} = \tau_t + \frac{R_t^G}{\pi_t} \frac{B_t}{P_t} + \phi_t$$

where τ_t is the fiscal authority primary deficit, which is tax revenue deducting expenditure less interest payment on a government bond. I allow government expenditure to contemporaneously respond to output and debt level by following the rules below, similar to Leeper et al. (2009). I also assume that fiscal agents target a certain level of debt to GDP and primary deficit as a fiscal stabilizer. Also, I allow consumption, labor earnings, and capital earning to respond exogenously.

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

$$G_{2,t}^I = \gamma_{2,y}\,(y_t) + \gamma_{2,\tau} \left(\frac{\Delta \tau_t}{y_t} \right) + \gamma_{2,b} \left(\frac{\Delta b_t}{y_t} \right) + \psi_{2,t}^G$$

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

$$G_{4,t} = \gamma_{4,y}(y_t) + \gamma_{4,\tau}\left(\frac{\tau_t}{y_t}\right) + \gamma_{4,b}\left(\frac{\Delta\left(\frac{b_{t-1}}{y_t}\right)}{b/y}\right) + \psi^G_{4,t}$$

I propose four different rules. The first rule (25), says that the financial instrument of the government responds conditionally on output, deficit-to-output, debt-to-GDP, and some exogenous shocks that follow AR(1) processes. The second rule (26) is the same as the first rule but now instead of the level of deficits and debt, the fiscal authority's instrument responds to economic shock conditional in changes in deficit and debt. The third rule (26) states that the fiscal instrument responds to the shock in the economy considering output, deficit-to-output, similar to the first rule but now it will also consider the debt-to-GDP given a certain debt-to-GDP target. The last rule (27) is similar to rule number three (26) but instead of level, the fiscal instrument responds on the shock conditional on changes in debt-to-GDP given the fiscal authority debt-to-GDP target.

2.4 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

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

The monetary authority reaction function (28) conditionally respond on current inflation π_t and output y_t from its target level; and past policy rate i_{t-1} . In the context of the current monetary policy framework, the BSP respond on the deviation of current output from $\overline{y}$ which is the natural level of output without distortion and the deviations of current inflation from $\overline{\pi}$ which is the target inflation set by the Development Budget Coordinating Committee (DBCC). The parameter ϕ_i , ϕ_y and ϕ_π measure the relative degree of efforts of the monetary authority in its policy variables.

2.5 Market Clearing

3 Estimation Methodology

3.1 Bayesian Estimation

There are several formal estimations and econometric procedures in the literature that evaluate the empirical fit of DSGE models. Christiano and Eichenbaum (1992) use generalize methods of moments to estimate the equilibrium relationship in the model. Other works, like Rotemberg and Woodford (1998) and Christiano, Eichenbaum, and Evans (1998) exploit the difference between the impulse response function between DSGE and VAR.

In this study, Bayesian estimation is used, which is the standard procedure for estimating DSGE models. The Bayesian procedure combines the advantages of calibration and maximum likelihood function. It can be accomplish by exploiting measurement equations that link observable variables into models endogenous variables. Additionally, this strategy allows the mapping of endogenous parameters of the model to those of the time series observed. In following the same line of thinking, Bayesian estimation allows researchers to see the true underlying data generating mechanism of the models. In this context, Bayesian provides a richer set of prior beliefs to the parameter's real value in model estimation that prohibits the parameters estimated to assume unrealistic value which is common to maximum likelihood estimation.

This section briefly discussed the mechanics of Bayesian estimation. However, the interest readers refer to An and Schorfheide (2007) and Fernandez-Villaverde (2010) for the detailed treatment of this subject. The estimation is implemented using DYNARE, free software that specializes in handling simulation and estimation of DSGE models.

Assume that we want to estimate the vector of parameters θ . Let the probability density be $p(\theta)$. In addition, we can observe the vector of endogenous variables $Y^T = \{y_1, \ y_2, , , y_T$. We can write the likelihood density of Y^T conditional on our vector of parameters θ . In the Bayesian approach prior belief of the parameter's value is incorporated into the likelihood function. This estimation procedure as discussed earlier maps the likelihood function generated by the models to the observed time series.

$$p\left(Y^T|\theta\right) = p\left(y_1|\theta\right)\prod_{t=2}^{T} p\left(y_t|Y^{T-1},\theta\right)$$

Given the above likelihood density, we can write the likelihood function as

$$L\left(\theta; Y^T\right) \equiv p\left(Y^T|\theta\right)$$

The goal of maximum likelihood estimation is to search a parameter that maximizes the likelihood function (30). Using Bayesian rules we can write the posterior

$$p\left(\theta|Y^T\right) = \frac{p\left(Y^T,\theta\right)}{p\left(Y^T\right)} = \frac{p\left(Y^T|\theta\right)p(\theta)}{\int p\left(Y^T|\theta\right)p(\theta)d\theta}$$

And define the posterior kernel $K\left(\theta|Y^T\right)$

$$p\left(\theta|Y^T\right)\left(Y^T|\theta\right) \equiv K\left(\theta|Y^T\right)$$

The Bayesian method chooses a parameter value that maximizes the posterior density $p\left(\theta|Y^T\right)$ or the posterior kernel density $K\left(\theta|Y^T\right)$.

The caveat in using Bayesian estimation is the computational challenge it faces. For example, even in DSGE model with small parameter space, the only way to overcome the curse of dimensionality is by using the Bayesian approach with a sophisticated filtering methodology like Kalman filter in estimating the likelihood function. In addition, advanced Markov chain Monte Carlo (MCMC) method such as the Metropolis-Hasting algorithm is employed to simulate posterior kernel density.

3.2 Data

I used different time series

4 Result and Discussion

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