Large-Scale Asset Purchase and Sovereign Debt Market During the Pandemic

Aris Zoleta

Graduate Student
De La Salle University Manila

BSP Research Conference, June 13-14, 2023

Disclaimer

The view in this paper is mine and not of the others.

Outline

Introduction

- Large Scale Asset Purchase (LSAP), also known as Quantitative Easing (QE), is a policy tool employed by central banks (CB) in developed economies when conventional monetary policy measures are constrained by the zero lower bound (ZLB).
- During normal times, CBs can lower the policy rate to stimulate demand. But there is a limit to this, CBs can only lower the policy rates till the policy rate hit the ZLB, where further lowering the policy rate is *ineffective*.
- During the COVID-19 pandemic, Bangko Sentral ng Pilipinas (BSP) initiated a P300 billion (approximately USD 5.9 billion) repurchase agreement of GS in the primary market.

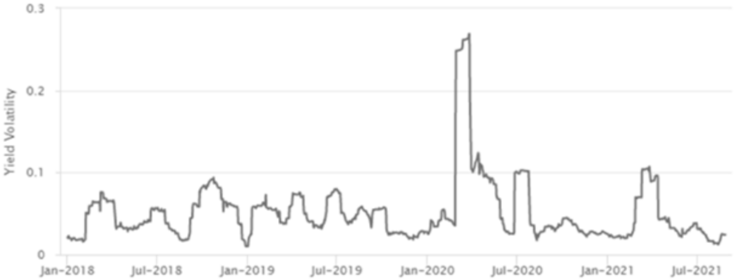
Emerging Market Experiment

- During the COVID-19 pandemic, emerging market economies (EMEs) like the Philippines have started to use LSAP as part of the central bank's emergency monetary policy tool.
- CB in EMEs intervene by purchasing large quantities of sovereign debt either or both in the primary and secondary market. In often cases, the maturity (mostly long dated GS) and duration of the purchase are predetermined and announced.
- Does many of these EMEs experience ZLB problems during the pandemic? There is still limited literature on this topic. Need more empirical validation.
- Potentially, CB overcompensates to counter the demand shocks of the COVID-19 pandemic. The hope is that LSAP can complement or catch up the slack of existing policy rate reductions.

Some Stlyzed Facts: Sovereign Debt Market

- Figure 1, illustrates that in the early stage of the pandemic, government bond yield volatility had risen the most in the last three years.

Figure 1: Yield volatility



Source: `https://asianbondsonline.adb.org//`

Some Stylized Facts: Sovereign Debt Market

- Figure 2 indicates a period of yield curve flattening between February and June 2020, which suggests that bond investors were exhibiting risk-off behavior due to the uncertainty caused by the pandemic.

Figure 2: Yield spread between 2 and 10 Yrs. Local Currency Govt. Bond

Source: https://asianbondsonline.adb.org//

What This Paper Trying to Accomplish

- This paper examines the role of LSAP in restoring the function of the sovereign debt market during the pandemic.
- The paper also wishes to understand the effectiveness of conventional monetary policy when unconventional tools like LSAP are at work.

Model Description

- When the ZLB is a binding constraint, the conventional monetary policy rate cut diminishes its influence along the yield curve.
- The standard assumption in the NK model is the use of single financial assets and asset prices which is the short-term interest rate.
- This paper introduced simple financial friction, where households have access to heterogeneous assets and purchased deposits from financial intermediaries
- Financial intermediaries invested the deposits in a portfolio of short and long-term government securities.
- The model in this paper follows the chassis of the NK models with sticky prices. In particular, the paper borrows from Harrison's (2012) specification of the financial friction in the economy. The model is calibrated using the Philippine data.

Household

- Households gain utility by holding a real money balance M_t and consumption C_t. And disutility by providing labor N_t.
- The household utility maximization problem can be written

$$E_t \sum_{s=0}^{\infty} \beta^{t+s} \psi_{t+s} \left[\frac{C_{t+s}^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} - \frac{N_{t+s}^{1+\kappa_n}}{1+\kappa_n} + \frac{\chi_m^{-1}}{1-\sigma_m} \left(\frac{M_{t+s}}{P_{t+s}} \right)^{1-\frac{1}{\sigma_m}} \right] \quad (1)$$

- Where $\sigma,\ \kappa_n, \sigma_m \ \in (0,1)$ are parameters that represent the household relative risk aversion, the inverse of the Frisch substitution elasticity of labor, and the real money balance parameter consecutively; $\beta \ \in \ (0,1)$ is the household discount factor; ψ is the shock on the household utility function.

Household Budget Constraint

- The household budget constraint can be written as

$$A_t + M_t = R^A_{t-1}A_{t-1} + M_{t-1} + W_tN_t + T_t + D_t - C_tP_t \qquad (2)$$

- The left-hand side of Equation (2) represents the household's asset holdings. This consists of the interest-bearing asset A_t and money balance M_t. The household net asset holding can be liquated at the value of $R^A_{t-1}A_{t-1} + M_{t-1}$, where R^A_{t-1} is the rate of return on the household asset portfolio from the previous period.

Household Behavioral Equation

- Solving the Household utility maximization problem given the constraint yields the household Euler Equation

$$\widetilde{c}_t = E_t \widetilde{c}_{t+1} - \sigma \left[\widetilde{R^A}_t - E_t \widetilde{\pi}_{t+1} - r_t^* \right] \tag{3}$$

Firm

- 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 technology in aggregating intermediate goods.

$$Y_t = \left[\int_0^1 (y_{j,t})^{\frac{\varepsilon-1}{\varepsilon}} \, \mathrm{dj}\right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{4}$$

- In every period the Final good firms maximize its profit by

$$\max \left[P_t Y_t - \int_0^1 p_{j,t} y_{j,t} \, \mathrm{dj}\right] \tag{5}$$

Final Goods Firms Maximization Problem

- Solving Equation (5) given (4) yields the demand for intermediate goods and the price index

$$y_{j,t} = \left(\frac{p_{j,t}}{P_t}\right)^{-\varepsilon} Y_t \ ; \tag{6}$$

$$P_t = \left[\int_0^1 (p_{j,t})^{1-\varepsilon} \ \mathrm{dj}\right]^{\frac{1}{1-\varepsilon}} \tag{7}$$

Intermediate Goods Firm

- The intermediate goods firm purchases differentiated labor $n_{j,t}$ from the household sector and produces intermediate goods using Cobb-Douglas production technology.

$$y_{j,t} = A_t n_{j,t} \tag{8}$$

- Where A_t is the productivity shock that follows an autoregressive process.

Intermediate Goods Firm Quadratic Cost Adjustment

- The intermediate firm faces quadratic cost adjustments similar to Rotermberg (1982).

$$\text{Max } E_0 \sum_{t=0}^{\infty} \beta_t \left[p_{j,t} y_{j,t} - W_t n_{j,t} - \frac{\chi_p}{2} \left(\frac{p_{j,t}}{p_{j,t-1}} - 1 \right)^2 P_t Y_t \right] \tag{9}$$

- Subject to

$$y_{j,t} = \left(\frac{p_{j,t}}{P_t} \right)^{-\varepsilon} Y_t \ ; \tag{10}$$

$$y_{j,t} = A_t n_{j,t}; \tag{11}$$

Intermediate Goods Firm Profit Maximization

- The intermediate firm profit maximization can be written as,

$$\text{Max } E_0 \sum_{t=0}^{\infty} \beta_t \left[\left(p_{j,t} - \frac{W_t}{A} \right) \left(\frac{p_{j,t}}{P_t} \right)^{-\varepsilon} - \frac{\chi_p}{2} \left[\frac{p_{j,t}}{p_{j,t-1}} - 1 \right]^2 P_t \right] Y_t \quad (12)$$

- Taking the first order condition and linearizing in symmetric equilibrium

$$\widetilde{\pi}_t = \beta E_t \widetilde{\pi}_{t+1} + \frac{\varepsilon - 1}{\chi_p} \widetilde{w}_t \quad (13)$$

New Keynesian Philip's Curve

- Equation 13 can be written in much familiarize form

$$\widetilde{\pi}_t = \beta E_t \widetilde{\pi}_{t+1} + \kappa \widetilde{x}_t \tag{14}$$

- Where $\widetilde{x}_t = Y_t - Y_t^{\text{Pot}}$ is the output gap, the difference between actual the potential output and $\kappa = \frac{\varepsilon - 1}{\chi_p}$.

Gov't Consolidated Budget Constraint

- Fiscal policy does not play a critical role in the allocation of resources in the economy. Hence there is no government spending and distortionary taxes in the model.

$$\frac{T_t}{P_t} = \frac{B_{L,t}}{P_t} + \frac{B_t}{P_t} - \frac{R_{L,t}B_{L,t-1}}{P_t} - \frac{R_{t-1}B_{t-1}}{P_t} + \frac{\Delta}{P_t} \tag{15}$$

- In Equation (15), the government finances the lump-sum transfers $\frac{T_t}{P_t}$ with net issuance of government debt, which is issued in two types, short-term debt B_t and long-term bond $B_{L,t}$.

CB Balance Sheet and LSAP

- The change in central banks' balance sheets or the central bank's dividend Δ can be describe as

$$\frac{\Delta}{P_t} = \frac{M_t - M_{t-1}}{P_t} - \left[\frac{Q_t}{P_t} - \frac{R_{L,t} Q_{t-1}}{P_t}\right] \tag{16}$$

- The LSAP policy is executed by varying the central bank's holding of long-term government debt in its balance sheet

$$Q_t = q_t B_{L,t} \tag{17}$$

Financial Intermediary

- The financial intermediary accepts one-period deposits from the household and pays at the rate R_t^A. The fund raised from the deposit is used to finance the purchase of short term B_t and long term $B_{L,t}$ government debt.
- The maximization problem of the financial intermediary is

$$\max E_t \left[R_t B_t + R_{L,t+1} B_{L,t} - \left(R_t^A A_t + \frac{\upsilon}{2} \left(\delta \frac{B_t}{B_{L,t}} - 1 \right)^2 P_t \right) \right] \quad (18)$$

- subject to

$$A_t = B_t + B_{L,t} \quad (19)$$

- The relative importance of cost adjustment is driven by the parameters υ.The parameter δ which is the inverse steady state of the intermediary's portfolio of government bond $\frac{B_t}{B_{L,t}}$

Financial Intermediary Profit Maximization

- The financial intermediaries maximize profit by having a positive difference between the returns it earns from its asset portfolio holding and the deposit return paid to the customers.
- The model assumes that the intermediaries bear the quadratic cost of rebalancing their portfolio of short and long-term government debt.

$$\widetilde{R}_t = E_t \widetilde{R}_{L,t+1} + \nu \left(\widetilde{b}_t - \widetilde{b}_{L,t} \right) \tag{20}$$

- Where $\nu \equiv \beta \frac{\delta \upsilon}{b_L}$. Notice that the parameter ν dictates the cost of adjusting the household portfolio between short and long-term government bonds

Monetary Authority

- The monetary the authority conducts conventional monetary policy by reducing the interest rate $\widetilde{R}_t$.
- Performs LSAP by manipulating the fraction of long-term government bonds in central bank's balance sheet q.

$$\widetilde{R}_t = \rho_R \widetilde{R}_{t-1} + (1 - \rho_R)\left(\alpha_\pi \widetilde{\pi}_t + \alpha_x \widetilde{x}_t\right) + \epsilon_t^R \tag{21}$$

- Where $\widetilde{x}_t \equiv Y_t - Y_t^{\text{pot}}$ is the output gap
- The parameter ρ_R is the autoregressive coefficient for interest rate smoothing. ϵ_t^R is the Taylor rule shock that follows an autoregressive process.
- α_π and α_x are coefficients for inflation and the output gap.

LSAP Policy

- The asset purchase policy follows a simple autoregressive process.

$$q_t = \rho_q q_{t-1} + \epsilon_t^q \tag{22}$$

- Where ρ_q is the autoregressive coefficient for the LSAP policy.

Estimation Procedure

- This paper follows the Bayesian procedure for the estimation of the model.
- The equations in the model form a nonlinear rational expectation system equation driven by a vector of innovations in the model.
- The solution for the model of a rational system of equations takes the form of

$$s_t = \Phi \left(s_{t-1}, \epsilon_t, \theta\right) \tag{23}$$

Measurement Equations

- Measurement Equations link the likelihood the function of the endogenous variables in the model to the observable variables
- In constructing the measurement equation, I obtained quarterly time series 2001:Q1 to 2022:Q2 from the Philippine Statistic Authority, BSP, and Bureau of Treasury.
- The measurement equation is constructed and written as:

$$y_t^{\mathrm{Obs}} = \mu_Y + 100\left(\widehat{y}_t - \widehat{y}_{t-1}\right) \tag{24}$$

$$R_t^{\mathrm{Obs}} = \mu_R + 100\left(\widehat{r}_t\right) \tag{25}$$

$$\pi_t^{\mathrm{Obs}} = \mu_\pi + 100\left(\widehat{\pi}_t\right) \tag{26}$$

Estimation Results

- Table 1 presents the prior and the posterior mean used in the simulation

Table 1: Estimated Parameters Value

Parameter	Prior Type	Prior Mean	Post Mean	90% HPD Interval		Std Dev
Structural Parameters						
Risk Aversion (σ)	Normal	1.0000	1.0239	1.0144	1.0376	0.3800
Philips Curve (κ)	Beta	0.2900	0.7162	0.7020	0.7312	0.1500
Money Demand (σ_m)	Beta	0.8800	0.8747	0.8743	0.8752	0.0030
Monetary Policy Rule						
Inflation Coeffient (α_π)	Normal	1.7000	1.5246	1.5201	1.5288	0.2500
Output Gap Coefficient (α_x)	Normal	1.0000	0.8605	0.8461	0.8738	0.0500
Asset Portfolio						
Long-Short Bond Ratio (δ)	Normal	0.5000	0.5590	0.5540	0.5629	0.0500
Asset Portfolio Elasticity (ν)	Normal	0.1000	0.3137	0.3075	0.3200	0.2000

Estimation Results

Table 2: Estimated Parameters Value

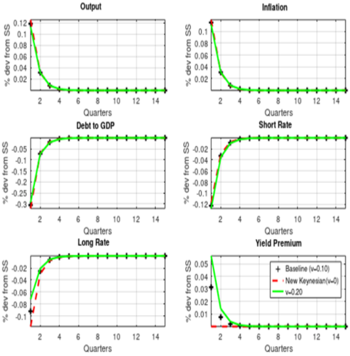
	Prior Type	Prior Mean	Post Mean	90% HPD Interval	Std Dev
Parameter					
Observable Constant					
Output Trend	Normal	0.3000	0.4599	0.4424 0.4779	0.0900
T-Bill Growth Rate	Gamma	1.0000	0.0052	0.0000 0.0120	1.000
Inflation Constant	Gamma	1.0000	0.6971	0.6694 0.7264	0.2000
Shock Persistence					
Monetary Policy (ρ_R)	Uniform	0.5000	0.5414	0.5365 0.5450	0.2887
Output (ρ_x)	Uniform	0.5000	0.4881	0.4852 0.4910	0.2887
Asset Purchase Policy (ρ_q)	Uniform	0.5000	0.9998	0.9997 1.0000	0.2887

Interest Rate Policy

- The larger the market imperfection, the greater the reduction of interest rate is needed but a weaker response of output and inflation.

Figure 3: IRF to the Interest Policy Shock (

$$\epsilon_t^R = -\ 0.05)$$

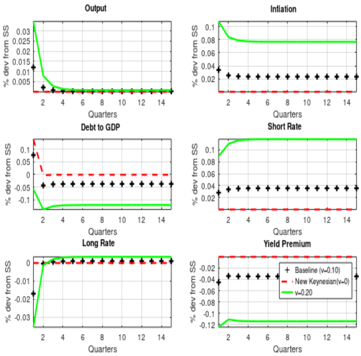


Asset Purchase

- LSAP complements existing reductions in monetary by inducing higher output and inflation with fewer reductions in nominal interest rates.

Figure 4: IRF to the Asset Purchase Shock (

$\epsilon_t^q = 0.25$)

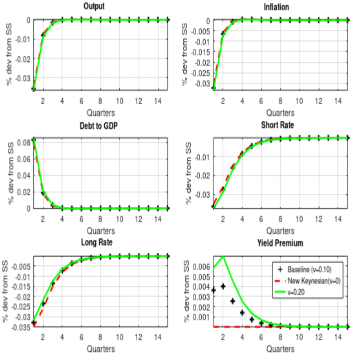


Effect of Demand Shock

- The reduction in nominal interest rates translated to less reduction in long-term yield and less output compared to other parametrizations of market imperfection.

Figure 5: IRF to the Negative Demand Shock (

$$\epsilon_t^* = -\ 0.25)$$



Conclusion

- The paper shows evidence that asset purchase policies can effectively ease liquidity conditions in the sovereign debt market.
- The study shows that large-scale asset purchases can complement conventional monetary policy by generating higher output and inflation with smaller reductions in nominal interest rates, particularly in the presence of market imperfections during negative demand shocks.
- The simulations also indicate that the BSP's asset purchase program could serve as an alternative tool even when conventional monetary policy is limited or unavailable.