Effects of Monetary Policy on Philippine Sovereign Bond Yield

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Abstract

Accurate measurement on the effects of monetary policy on sovereign bond yield is important in many ways, one of which is that suboptimal policy choice of monetary authority may have distortionary effects on the risk premia of government bond and other credit instruments. In this paper, I look at the impact of monetary policy both on short term and long term government bond yield using small scale VAR. I also introduce a basic New Keynesian model to endogenize the interest rate dynamics and investigate the transmission mechanism of a policy shock to bond yields. The main finding is that monetary policy has larger effects on real long term yield than on real short term yield. The model exhibits "price puzzle" where inflation shock is being preceded by policy expansion instead of tightening. I sought an alternative method and found that Bayesian VAR produced a result that doesn't suffer on price puzzle conundrum. The NK model I proposed was able to match the impulse response of our VAR model. In which both the VAR and NK model recorded a 6 basis point rise in real short term yield response to a 1 percent standard deviation on policy rate shock.

Key Words: Yield Curve, Price Puzzle, Taylor Rule, Monetary Shock, Monetary Policy
JEL Classification: E6, E4, E5

1. Introduction

The main mechanism in which central bank influence real aggregate in the economy is through the policy rates which influences the cost of credit in the economy. Under discretionary inflation targeting regime central bank (CB) control inflation to its desired path using the interest rate as a policy instrument. An inflation shock usually is being preceded by a tight monetary policy. However the model in this paper exhibit a conundrum known as price puzzle in the literature, in which an increase in policy rate resulted in much larger inflation. Since the paper don't seek to resolve such estimation challenge the reader is referred to other authors who may offer valuable insight (Bernanke & Mihov, 1998; Castelnuovo & Surico, 2010; McMillin, 2001). I sought an alternative method and found that Bayesian VAR produced a result that doesn't suffer on price puzzle conundrum.

Accurate measurement on the effects of monetary policy on the yield of a government bond is important in many ways, one of which is that suboptimal policy choice of monetary authority may have distortionary effects on the risk premia in government bond and other instruments. Secondly, government bond yield serves as benchmark instrument in determining the cost of capital on long term investment in the economy and other credit instruments, which is the main channel on how central banks influence real aggregate by expanding or contracting credit. The challenge in measuring the impact of monetary policy on the yield curve is not only to its accuracy due to many factors that may affect the yield curve but as well the appropriate policy rule in the way the central bank operates and communicate its policy action. Lastly, the variation on the slope and level of the yield curve allow the monetary authority to assess its policy interaction and expectation of market participant. In addition, the yield curve can also be affected by the desire of fiscal authority on different configurations of debt maturity.

In this paper, I seek to provide an alternative narrative on the transmission mechanism by providing evidence on the effects of monetary policy on both ends of the yield curve using Philippine data. To preview my results, the paper shows that monetary policy has larger effects on real long term yield than on real short term yield. This is in contrast with the expectation hypothesis in which holds that long term yield is the average of short term rates and what matter for monetary authority is its influence in the short yields through its policy rates to indirectly affect the long end of the yield curve. In defense of the result, the effects of the monetary authority in the market participant's expectation of future inflation innovation and its credibility to respond to disturbances in inflation can be a plausible explanation. In markets dominated by the large financial institution with longer maturity horizon and which capital preservation as the dominant goal; inflation risk is an important consideration on investment decision. Market participant's lower expectation on inflation may result in lower yield due to lower inflation premium market participants required in holding the longer-dated bond. This result is complemented by the variance decomposition analysis on the response of short and long term yield in a policy shock in which inflation explained the majority of the variation. However, the paper reported that the degree of persistence on shocks is of the same magnitude for both real short and long yield. Eggertsson and Woodford (2003) show on their paper that central bank credibility matters in market participants forming their expectation on policy action and future path of inflation. In particular, they show that in zero lower bounds, where the central bank is constrained in lowering the interest rates, promising a persistently lower level of interest rates can significantly bring down the longer yield. This effect can only be possible if markets believed on a credible central bank and alter their expectation on future states of the economy.

Most macroeconomic models in the literature describe the central bank reaction function and how shall its response to disturbances in the economy. A central bank with inflation or price stability as mandates provides larger emphasis on inflation in monetary stabilization policy. In basic New Keynesian (NK) model where wage rigidities and monopoly power as sources of rigidities in the economy, the central bank shall response in countercyclical markup shocks by raising nominal interest rates. To simplify the policy action by the central bank who responds on both shocks in inflation and output gap. Many pieces of literature on monetary stabilization policy assume that the central bank follows a Taylor rule type of reaction function. Taylor rule has some very desirable property, one of them is its simplicity captured stylize facts on how central bank conducts its monetary operation and its ability to effectively communicate future policy action. Where at an efficient state where inflation and the output gap is zero, the nominal interest rate shall move one for one with the natural rate of interest. Despite this desirable property, some of the critiques of "neo-Wicksellian" Taylor rule is on the inability of central banks to accurately estimate the natural rate of interest which is exogenous on monetary policy. On our simulation using the basic NK model, the real interest rate rise by 6 basis point as a response to a 1 percent standard deviation in policy rate shock. This result of our NK model is similar to the result documented by our BVAR model. The paper will structure as follow: (2) I review some recent literature on the effects of monetary policy on real aggregate and sovereign bond yield. (3) The section discussed on how we specify the VAR and NK model. (4) I detailed the result of the paper. (5) Lastly, I end with a conclusion.

2. Review of Literature

Measuring the effects of monetary policy on the yield curve is long been the focus of many studies. Yet several factors outside the control of central bank may influence the level of the long end of the yield curve such as arbitrage, currency movement, development in the foreign market and global liquidity. Braun and Shioji (2006) in their study on the contribution of monetary policy to the movement of the yield curve on the Japanese government bond (JGB) shows that monetary policy account for the majority of variance in long term yield. Evans and Marshal (2001) recorded that long run variability of long term yield is driven mainly by demand shocks. Chun (2011) in his investigation on the variation on the yield curve shows that growth plays a significant role in the pricing of risk by the market participant and that the sensitivity of long yields linked to persistent expectation on inflation. This paper provides evidence, that compliment on the results cited, on the effects of monetary policy in the yield curve, in particular, I show that the majority of the variability of both the short and long term yield is accounted by inflation shocks and

the response of yields an increase in policy rates is only a secondary effect. In addition, we see a larger variation in longer yield than of shorter yield as a response on policy rate shocks and inflation shocks.

The extent to which monetary policy can effectively influence the yield depends in part on the agent's anticipation of the future path of the policy and its communication. In the paper written by Hejazi, Lai, and Yang (2000) about the yield curve of Canadian government bond, they arrived on a different conclusion in which Canadian macro-economic variables have no significant effects on the variation of yield curve however they documented that US macroeconomic variables do affect the Canadian yield curve. The paper is limited to the effects of domestic monetary policy on Philippines sovereign bond yield was not able to account for foreign policy spillover.

The central bank targets the level of policy rates to directly influence the shortest maturing yield by performing an open market operation. However, this allows the central bank to indirectly influence the long end of the yield curve. Woodford (1999) shows in his paper of agents with rational expectations that small but persistent change in short term interest rates, in response to shocks, allows larger effects of monetary policy on long term yield and is optimal at least in the theoretical ground. Credible central bank promised of a permanent low level of interest rate can affect the long term yield even central bank is constraint by the zero lower bound. Eggertsson and Woodford (2003) argue that unconventional policy such as large scale asset purchase works in lowering the long term yield only if the market participants believed the central bank commitment in lowering down the interest rates. Krishnamurthy and Vising-Jorgensen (2011) on similar works shows that it is inappropriate to focus on Treasury rate as a policy target as quantitative easing works through several channels that affect assets differently. In addition, they find a signaling channel, which central bank communicates its policy action, in particular, the quantitative easing program, on demand for long term bond. Wright (2012) on the other look at the effects of FOMC meeting on the variation on the longer yield curve and shows that during the meeting there is larger variation than of other days. The degree and mechanism of how financial market participants form their expectation are crucial for the central bank in easing financial condition and asses its impact on a broader set of asset prices. Central bank credibility is crucial in its assessment on the effects of monetary policy on sovereign bond yield. Communicating its policy and action will be very challenging, in particular, if the market participant cannot anchor expectation on certain policy such as the promised of a permanent low level of interest rate due to lack of central bank credibility.

3. Methodology

3.1 VAR Model

The small scale model I propose is similar to Christiano, Eichenbaum, and Evans (1999) and Rudebusch (1998) however differ on the choice variable to provide domestic relevance. A VAR is a system of a linear equation that can be represented as,

$$B_{Yield} = \sum_{j=1}^{L} AX_{t-j} + u_t^{VAR} \qquad (1)$$

Where B_{Yield} is the government bond yield; X_t is an n vector of variables including the yield of a short and long term government bond; A is an n by n matrix of estimated coefficient. The linear function $\sum_{j=1}^{L} AX_{t-j}$, can be interpreted as a reduced form reaction function of bond yield up to X_{t-j} and its own lag L, in this paper I used VAR(2). Generally, we can also specify (1) into a much familiar form such that X_t and u_t^{VAR} can be further specified as,

$$X_t = \begin{bmatrix} lb \\ tr \\ i \\ gdp \\ \pi \end{bmatrix} \qquad u_t^{VAR} = \begin{bmatrix} \varepsilon_t^{lb} \\ \varepsilon_t^{tr} \\ \varepsilon_t^{i} \\ \varepsilon_t^{gdp} \\ \varepsilon_t^{\pi} \end{bmatrix}$$

Where $lb, tr, i\ gdp\ \pi$ is real long yield, real short yield, repo, GDP and inflation; and $\varepsilon_t^{lb}\ \varepsilon_t^{tr}\ \varepsilon_t^{i}\ \varepsilon_t^{gdp}\ \varepsilon_t^{\pi}$ is the shocks on long yield, short yield, repo, GDP, and inflation consecutively. Some general restriction required that u_t^{VAR} to be uncorrelated to the residual in the equation of the system and it is white noise. This restriction is important for us to account the effects of monetary policy on the government bond yield. Not holding this restriction has also meant that a shock, let say in inflation will result into other shocks in the system to response; which in that case makes, let say, a move in GDP spurious; as we cannot fully account the dynamics. Because the movement in GDP can be of a shock in inflation or its own shock. Aside from that, having all shocks move in the same direction is counter-intuitive, as if the economy encounters very bad luck.

3.2 Basic New Keynesian (NK) Model

There is a continuum of households that maximizes his intertemporal utility subject to his budget constraint. Household rank streams of consumption based on utility preference function on the form,

$$U(C) = \frac{C_t^{1-\varphi}}{1-\varphi} \qquad (2)$$

Household earn endowment and purchase consumption and bond

$$P_t C_t + M_t B_{t-1} = Y_t + B_t \qquad (3)$$

Where $C_t\ Q_t\ B_t\ Y_t$ is consumption, stochastic discount factor, bond holding, and endowment or output. The necessary first order condition to derive the stochastic discount factor in pricing the bond of households can be

$$M_t \equiv \beta\ E_t\left[\left(\frac{U'C_{t+1}}{U'C_t}\right)\frac{P_t}{P_{t+1}}\right] \qquad (4)$$

Equation (4) is called the Lucas asset pricing equation. In which asset price is related to the household intratemporal substitution between future and present consumption times the discount factor. We can log-linear (4) from its steady state

$$i_t = \varphi\Delta c_t - E\{\pi_{t+1}\} - \rho \qquad (5)$$

Where $i_t \equiv log\ Q$ is the nominal interest rate in one period bond; $\Delta c_t \equiv E\{c_{t+1}\} - c_t$ is the consumption innovation; $\pi_t \equiv log\left({}^{P_t}/_{P_{t+1}}\right)$ is the log price level; and $\rho \equiv log\ \beta$, where lower case latter indicates log. With some algebraic manipulation of (5) we can derive the optimal consumption

$$c_t = E\{c_{t+1}\} - \frac{1}{\varphi}(i_t - E\{c_{t+1}\} - \rho) \qquad (6)$$

Since the clearing condition in the goods market is $c_t = y_t$, in which in every period consumption must be equal to output. We can we rewrite (6) in terms of current and potential output,

$$\tilde{y_t} = -\frac{1}{\varphi}\ (i_t - E\{\pi_{t+1}\} - \bar{r_t}) + E\{\tilde{y}_{t+1}\}$$

Where $\tilde{y}_t = log\left({Y_t}/{Y_t^*}\right)$ the output is *gap* and Y_t^* is the potential output which is a function of exogenous real disturbances such as tax distortion or fiscal expansion. Where $\bar{r}_t$ is the *natural rate of interest,* which can be further written as,

$$\bar{r}_t \equiv \rho + \varphi E\{\Delta \bar{y}_{t+1}\}$$

Early works on asset pricing have some difficulty reconciling the empirical evidence and consumption-based asset pricing model finance (Abel, 1990, 1998; Campbell & Cochrane, 1999; Jagannathan & Kocherlakota, 1996).

$$\pi_t = \beta E_t[\pi_{t+1}] + \kappa \tilde{y}_t \qquad (5)$$

In the model, we can describe the CB lost function using Taylor rule as,

$$i_t = \bar{r} + \phi_\pi \tilde{\pi}_t + \phi_y \tilde{y}_t \qquad (6)$$

Where ϕ_π and ϕ_y are none negative coefficient choose by CB that describe the strength of the response of policy rates to deviation in inflation and output from its desired level and $\bar{r}$ the natural rate of interest.

3.3 Data

All data used in the estimation of the model is sourced from Datastream of Refinitiv which one of the financial and economic database. I used quarterly series from Q3 2008 – Q2 2018 of 10 Yr. PHP Government bond, 91 Days Ph. Treasury bill, BSP repo rate, GDP rate, and inflation rate. The yield on Treasury bill and bond; and GDP is on the real term. The choice of these variables is based on a establish theory on monetary policy. However, there is still no consensus among the profession on what policy rate shall be used on VAR. In this paper, I used the overnight repo rate of the Bangko Sentral ng Pilipinas, which is the rate agree by commercial banks and BSP in repurchasing government security (GS). One common feature of the Philippine GS market is that banks have structural demand due to regulatory compliance such as the capital adequacy ratio of banks. Another challenge is that repo transaction can only be available for commercial banks as qualified counterparties and exclude none bank financial institution which is a major player in the bond market. But despite these challenges, I believe that the repo rate can still provide a valuable measurement of financial market expectation on the path of policy as shown in GS yield.

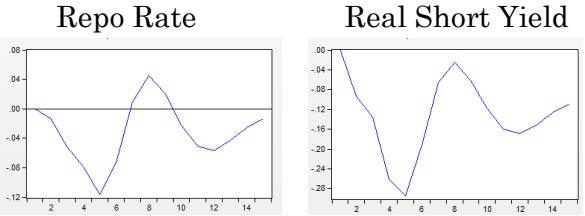
4. Result and Discussion

4.1 VAR Result

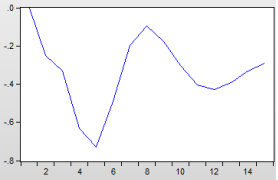
Using the small scale VAR model I propose in this paper, I assess the effects of monetary policy on real government bond yield. I used Cholesky variance decomposition in generating the impulse response function.

VAR is mostly used in empirical analysis and counterfactual experiment in the effects of the monetary policy in real aggregate. As VAR use the latent or lag macroeconomic variables, running OLS equation by equation on the system of the equation produces results that overcome endogeneity and simultaneity problem. However, despite its robust result on estimation, VAR is mostly used on counterfactual experiments on the contemporaneous effects of a shock orthogonal on choose variables in the counterfactual experiment. This paper is limited to the study of the effects of monetary policy on sovereign bond yield. I run two counterfactual experiments in this paper. First, I ask the question of what is the indirect effect of monetary policy on bond yield when the economy is experiencing inflationary pressure. Most of the time this is being preceded by a rise in policy rates, in the Philippine context, this is the BSP repo rates. However, we experience a counterintuitive result in which is the inflation shock is being preceded by lower repo rates which are almost 12 basis point up to 4 quarters before its rise. This reaction of central bank into an inflationary shock is odd of most economic theory available even with experience. In the last 2 quarters of 2018, the Philippines experience cost-push shock from an abrupt increase in prices of oil and rice in which inflation is running above the BSP's 3 percent target. This experience resulted in BSP increasing the policy rate up to 175 basis points to tame inflationary pressure. This precedent is at odds with the result of our model. Figure 1 shows the response of Equation (1) into a 1 percent inflation shocks. In the estimation, I used the Vector Error Correction model due to the presence of cointegration in the model.

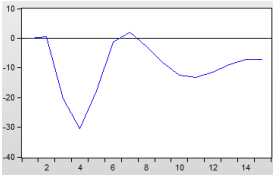
Fig. 1. Impulse Response Function in 1 Std. Dev. on Inflation Innovation Using VECM *



Real Long Yield



Real GDP



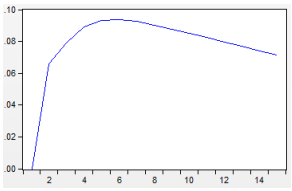
This estimation challenge is called the *price puzzle* in the VAR literature. The existence of price puzzle first documented by Sims (1992) and Eichenbaum (1992) Castelnuovo and Surico (2010) shows an empirical experiment in which price puzzle can only exist if monetary authority conduct policy passively. Another explanation is the omission of variables that capture the inflation expectation of agents in the economy. Christiano, Eichenbaum, and Evans (1996) with the used of commodity prices were able to overcome this estimation challenge. Similar works of Bernanke and Mihov (1998) and McMillin (2001) offer a similar methodology in using commodity price in the VAR model on the effects of monetary policy. I offer two reasons why I don't follow on procedure offer by literature cited. First, the Philippine don't have active commodity market on key agricultural commodities perhaps. This maybe is overcome by using commodity prices available on the foreign market however this will be subject to specification issue since we design the model as a closed economy. And the model is limited on the contemporaneous effects of domestic shocks on domestic factors and don't account foreign factors that may have an effect on domestic development. Secondly, another escape route is by constructing a commodity index, this will be probably good an alternative, however, this will encounter practical implementation. Constructing an index will require lots of resources to produce an accurate and quality commodity index. Perhaps it is a misspecification problem in which the model doesn't include a robust variable that captures agents expectation on the future path of inflation. For practical reason, I look for an alternative estimation procedure to resolve this conundrum. To resolve the price puzzle observe in our original estimation of Equation (1) using unrestricted VAR. I estimated the model using Bayesian VAR (BVAR), with Litterman (1986) prior. BVAR have some important and good properties. One of them is, BVAR were able to overcome the issue of dimensionality problem. In the unrestricted VAR, the fitted residual quality depends on the dimension of the VAR model, a model with larger numbers of variables will provide a less parsimonious result, due to multicollinearity. Another reason for using BVAR in relation on our prior concern is that most researcher wanting to see effects of policy into a real variable for counterfactual experiment require several or maybe many variables that it could to capture many robust dynamics of the model. Christine, Domenico, and Lucrezia (2008) in their study on the asymptotic properties of Bayesian estimation shows that

shrinkage of larger dimension model may control overfitting while preserving the relevant information needed by for estimation.

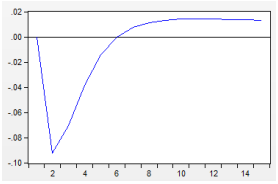
Figure 2 shows the simulation result of my estimation using BVAR. In this time the dynamic response of CB in inflation shocks is corrected by raising the policy rates by almost 9 basis points and this is accompanied by a reduction in GDP. Figure 1 and 2 report consistent response real government bond yield to an inflation shock. Rising policy rates correspond to a decrease in bond price that drives real yield down. One thing we can see is the direct effect of inflation on investor's valuation on government bond by which inflation pressure creates risk on investor's real return as it will decrease their real consumption in the future. Figure 1 & 2 both reported that monetary policy has large effects on real long term government yield than the real short yield. This effects may be due to the dominance of large and complex financial institution in the bond market. Pension funds, insurance companies, and other none banks financial institution have a longer horizon to fulfill its fiduciary obligation and less sensitive to any short term rise in inflation.

Fig. 2. Impulse Response Function in1 Std. Dev. on Inflation Innovation Using BVAR*

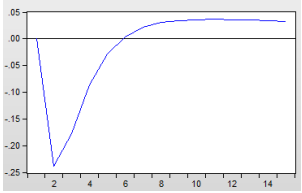
Repo Rate



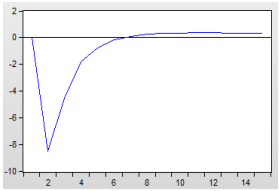
Real Short Yield



Real Long Yield

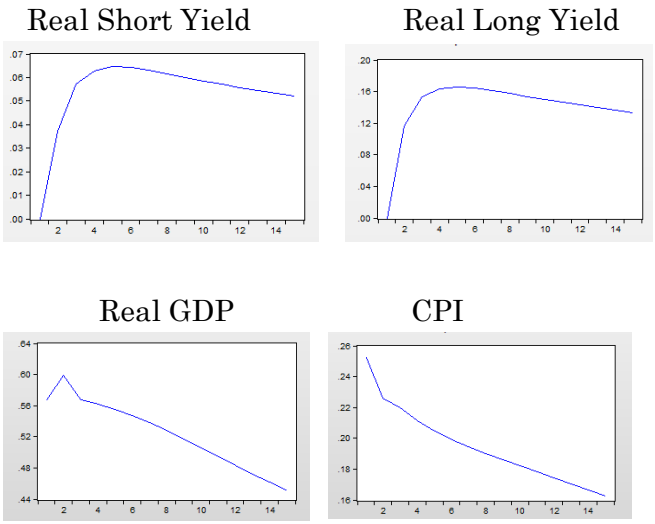


Real GDP



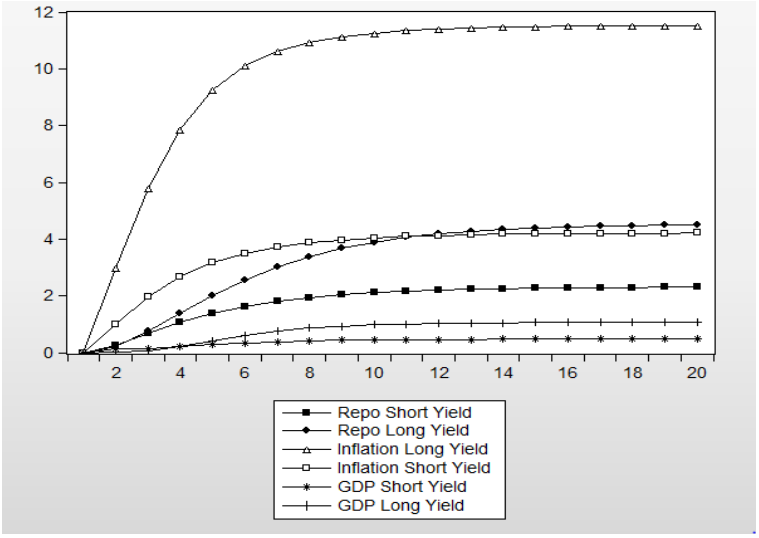
The second question we want to ask on this paper I what will be the direct effects of a monetary policy shocks that as an increase in the policy rate. In Figure 3, the bond yield move in the opposite direction. One thing we need to pay attention with is that we are measuring the size and direction of the real yield on monetary policy. Real yield is the return bondholders will receive adjusted by inflation. A decrease in inflation holds other things equal raises the real yield.

Fig 3. Impulse Response Function in1 Std. Dev. on Policy Shock Using BVAR*



Most of the response of government securities in particular of the long duration is being dominated by inflation. Growth has marginal contribution both on short and long yield variation. This is very clear in Figure 4.

Fig 4. Variance Decomposition of Short and Long Yield



Simulation 3: Figure 4 and 5 shows the simulation result of the NK model. In the simulation, we see that both the nominal and real interest rate have negative response both on a percent standard deviation of monetary and natural interest rate shock.

Fig 4 Impulse Response Function in1 Std. Dev. on Monetary Policy Shock

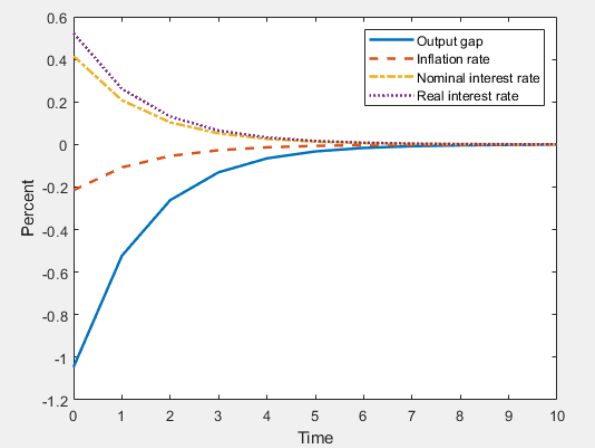
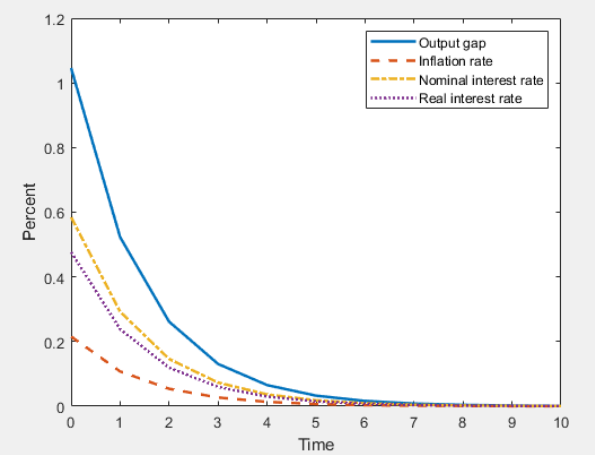


Fig 5 Impulse Response Function in1 Std. Dev. on Natural Rate of Interest



5. Conclusions

Using the proposed small scale empirical BVAR and NK model. This paper able to provide simulation evidence on the effects of the monetary policy on government bond yield. The paper shows that monetary policy has larger effects on long term yield rather on short term yield. I provide a plausible explanation of this result. In which demand of large financial institution for safe assets (sovereign bond) may play a larger role in this dynamics. The transmission mechanism of monetary policy on asset prices shall be seen in the context of institutional arrangement between the CB and the financial markets. In this paper we used the repo rates in which the agree rates between CB and commercial banks who need reserve; however, majority of the trading volume of bonds happens between CB and none banks financial institution such as pension funds and insurance company which have a longer horizon and a high degree of tolerance on short term inflation variation.

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