

Fiscal Policy with Bond in Utility and Inflation

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Abstract

I build up an economy with sticky price in which government can only issue non-state contingent short-term bond to hedge against government spending shock, while households have predilection for and can derive utility from holding short-term bond. The numerical analysis suggests that due to households' preference for the bond, the government issuing short term debt against a positive spending shock, gives rise to declining consumption and lowering asset price and thus higher yield rate, which in return, encourages households to save more and casts a doubt on debt sustainability of the government. However, with inflation shock, demand for short-term bond in real term decreases as the asset price goes up, which lowers the yield rate and hence slacks the debt sustainability problem.

Key words: bond in utility, inflation, short-term bond, consumption, debt sustainability

1 Introduction

During the past decades, it is witnessed that the debt level is soaring to the record high level. Since 2008, to cope with the financial crisis, most economies including advanced and emerging ones, made use of fiscal policy to save the cataclysmal economic situation, which led to the exponential increasing debt level estimated as percentage of GDP. Take the US as an example, by the end of 2008, the gross debt level (as % of GDP) rushed to 73, compared with 63 at the end of 2007. Before that, it took more than a decade for the debt level to reach 63 from 53, during which there was a small up-and-down fluctuation (Figure 1). Besides, the Pandemic hit the world in the end of 2019, giving rise to substantial government spending for every country to hedge against the unexpected shock, i.e. the total public debt (as percentage of GDP) of the US soared up to 135 in one quarter from 103 at the beginning of 2020.

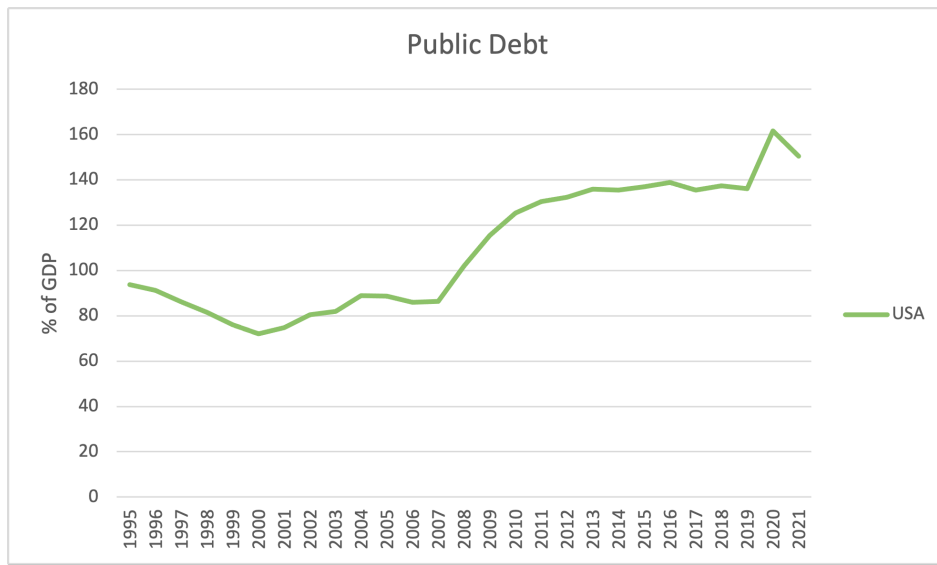


Figure 1: Public Debt, source: OECD

However, despite of the unprecedentedly high debt level, the debt burden has fluctuated between 1% and 2 % of GDP in the past two decades, even though during the pandemic with sudden increment of debt, the cost to service it fell to around 1.5% of 2021 from 1.9% of 2019.

Beyond the increasing debt level, there are several economic theories that play roles in it. In an overlapping generation model, dynamic inefficiency can be mitigated by issuing government debt, which means that welfare for the whole society will be improved as long as the government debt is issued to absorb those over-accumulated capital. Based on the tax-smoothing theory, when unanticipated shocks hit an economy, the government can issue government debt to smooth cost across time

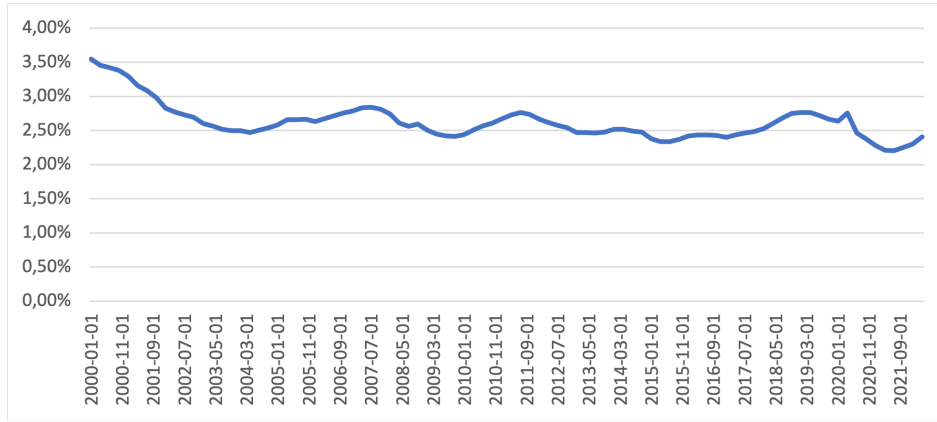


Figure 2: Debt Burden, source:FRED

caused by raising revenue through taxing in the short term (Yared 2019[23]).

Yared (2019)[23] argues the accumulation of public debt by refuting assumptions pertaining to the Ricardian equivalence, while there is an alternative perspective on the climbing public debt, which is debt revenue or fiscal space (Reis 2021[19] 2022[20], Blanchard 2022[6]). According to traditional analysis of debt, in the intertemporal budget constraint, the ratio of debt to GDP comprises ratio of primary surplus discounted by the difference between a discount rate and growth rate plus ratio of debt flow to GDP discounted by the difference between a discount rate and growth rate, in which the discount rate is equal to the debt’s rate for return (Reis 2022[20]). As a result, in order to avoid the public debt going to infinity, the interest rate has to be over the growth rate, which contradicts with the reality (to be discussed below). Therefore, Reis (2021)[19] replaces with marginal product of capital the aforementioned discount rate, which leads to the debt revenue term and hence such an argument that the debt can be sustainably rolled over only if interest rate r is below growth rate g , that is, $r < g$ (Reis 2021[19], Blanchard 2022[6]).

To break down the debt revenue term further, there are multiple streams of literature upholding why economic individuals need government debt. One stream of literature emphasis the role of public debt as a store of value, since in an incomplete financial market, creditors or investors cannot distinguish good opportunities from bad ones and prepare for potential entrepreneurial projects of their own, they have to use government debt to “store” their resources even though the return of the government bond is much lower, and therefore the debt revenue can be regarded as “risk premium” (Reis 2021[19], 2022[20]).

Another stream of literature regards government debt as safe asset. Investors face with idiosyncratic risks when investing projects, which cannot be diversified away in an incomplete market. Therefore, the

investors would like government debt as safe haven. (Reis 2021[19], Brunnermeier et al 2021[7]). Besides, from the perspective of open economy, Bernanke(2005[5]) argues that because of ample demand for US Treasury securities as a result of an excess of savings emanating from China and other emerging market economies and oil producers like Saudi Arabia, namely, the Global Saving Glut (GSG), the public debt raised up and thus the interest rate trended down.

In addition, public debt can play a role as collateral due to financial regulations, while others argues that public debt can provide liquidity, in that transaction of government bond requires very little cost (Angeletos 2022[10]).

With all the facts and associated theories above, it can be suggested that the rising public debt doesn't come out of nowhere and that individuals, regardless of households, firms have demand for public debt for multiple reasons. Further, by textbook theory, when the demand for government bond rises up, the interest rates will accordingly go down, suggesting that the government can finance with a lower cost. Inspired by the literature the fact and the literature mentioned above, this paper tries to capture the roles played by the public debt, or government bond, by including the short-term bond into utility function in an reduced-form way. The results challenge the conventional view about expansionary fiscal policy which is supposed to enlarge consumption by issuing debt to finance spending. On the contrary, in this paper, it's shown that a positive government spending shock lowers consumption followed by decreasing asset price and thus increasing financing cost, which brings about debt sustainability problem to the government.

It is also worth noting that in the past 20 years, inflation rates among some advanced economies were stable and low. However, during the pandemic, the inflation in most economies took a U-turn change and began to soar up, even Japan unexpectedly successfully escaped the long-lasting deflation period. This paper also captures this trait to see whether the inflation can lower government bond and reduce financing cost. The outcome is positive and consistent with literature. With inflation, the government can lower the outstanding debt and asset price and thus financing cost so that the debt sustainability problem can be lifted.

1.1 Literature

Facing with fiscal shocks, the government can either raise taxes or issue bonds to cope with them. Barro(1979)[4] shows that the behaviour of government debt is characterized by random walk. Lucas and Stokey (1983)[17] starts a stream of literature on optimal fiscal policy under a complete market in which the government can use state contingent bonds when facing spending shocks. However, even though the government can only issue non-state contingent bonds, it can also handle the shocks by

constructing complete market Ramsey allocation with non-state contingent bonds so long as that the government is aware of the fluctuation of the equilibrium interest rate with macroeconomic shocks (Angeletos 2002[3]) and that the government can issue as many bonds with different maturities as the size of the support of the state (Buera and Nicolini 2004[8]), or the setting includes flexible price and thus inflation (Chari and Kehoe 1999[9]), which is tantamount to a complete market.

Under incomplete market, Aiyagari and McGratten (1998)[2], in which households face with borrowing constraint, argues that the optimum quantity of debt depends on whether the debt can smooth consumption or crowds out capital and thus lower consumption, while Aiyagari et al (2002)[1] builds up an incomplete market model with and without limiting the debt level of the government, suggesting that higher persistency of government spending process can decrease ability of “self-insurance” for the government.

By twisting the assumption of price flexibility, Sui (2004)[22] establishes a sticky prices model with distortionary taxation and nominal non-state-contingent debt, suggesting that when the variability in government spending goes up, tax smoothing plays an increasingly important role as the inflation used to absorb fiscal shock. Following Sui(2004)[22], Lustig et al. (2008)[18] divides the consumption of household into cash goods and credit goods and trading into liquidity trading round and hedging trading round and the results show that when the government whose ability to lend is limited, is restricted to non-contingent nominal debt of various maturities, optimal policy will be exclusively on use of long-term debt.

Faraglia et al. (2013)[12] analyses how the debt level and the debt maturity influence inflation by means of a model with similar setting of sticky prices and shows that with monetary and fiscal policies under control of a single authority, the level and maturity of debt have little impact on inflation and the authority inclines to use tax policy to hedge against fiscal shock to the government budget, while in the case of un-coordination between monetary and fiscal policies, the authority have predilection for large and long-lasting increase in inflation to inflate away the shock.

Another stream literature discusses about the commitment problem of government with respect to time-consistency of its fiscal policy. Debortoli et al. (2017)[11] argues under the lack of commitment from the government, maturity structure with main composition of long-term debt will be costly for the government to finance itself ex ante and thus flat maturity structure will lower fluctuation of the value of outstanding liabilities at the expense of exposure to fiscal shocks due to the trade-off between market completeness and commitment. Meanwhile, another literature assume away the assumption of buying back or repurchase and reissue (r/r) implicitly at place above (Faraglia et al. 2019[13]) ,

showing that short bond plays an important role in tax smoothing and reducing tax volatility and thus in debt management instead of long bond mentioned above.

The rest of the paper is followed by the model in section 2. Ramsey problem will be discussed in section 3. In section 4, there will be a numerical analysis and section 5 is conclusion.

2 The Economy

The economy is closed and set up in an economy with sticky price where there is only infinitely-lived household who have preference for short-term non-contingent bond. It's assumed that the government will commit to its fiscal policy.

2.1 Household

The model is characterized by representative and infinitely-live household, who maximizes the following utility function:

$$E_t \sum_{t=0}^{\infty} \beta^t U(c_t, h_t, b_t^s) = E_t \sum_{t=0}^{\infty} \beta^t \left(\log c_t - \log h_t + \frac{b_t^{s^{1-\sigma}}}{1-\sigma} \right) \quad (1)$$

, subject to the following budget constraint:

$$P_t c_t + q_t^s B_t^s \leq (1 - \tau_t) P_t w_t h_t + B_{t-1}^s \quad (2)$$

, in which c_t refers to the unit of good consumed by the household in real term. B_t^s is the nominal short-term bond chosen by the household at time t , and accordingly q_t^s is price of the short-term bond at time t . Therefore, B_{t-1}^s is the bond held by the household during period $t-1$, but due at t and thus returns nominal unit. τ_t is the tax rate decided by the government. w_t and h_t are wage and labour supply at time t respectively. Moreover, due to the economy is with sticky price, w_t is endogenous in this case. In the end P_t is the price.

Dividing both sides of (2) with P_t , we will get the following budget constraint in real term:

$$c_t + q_t^s b_t^s \leq (1 - \tau_t) w_t h_t + \frac{b_{t-1}^s}{\pi_t} \quad (3)$$

, in which π_t refers to aggregate inflation $\frac{P_t}{P_{t-1}}$.

Breaking down the utility function, it can be shown that both $\log c_t$ and $\log h_t$ comply with Inada condition. Different from and inspired from literature is the term $\frac{b_t^{s^{1-\sigma}}}{1-\sigma}$, which, in an reduced-form

way, catches the values for household brought up by holding short-term bond for several reasons, such as that households can regard short bond as safe and liquid asset (Brunnermeiers et al. 2022[7], Krishnamurthy and Vissing-Jorgensen 2012[16], Reis 2022[20], Hagedorn 2018[14]), that households value the precautionary values derived from the short bond (Aiyagari and McGrattan 1998[2], Kaplan and Violante 2018[15]). The parameter σ measures the curvature. It should also be noteworthy that the households draw utility from holding the real short bond holding at the beginning of each period.

In the partial equilibrium, it can be derived that the price q_t^s for the short-term bond and the τ_t are following:

$$q_t^s = \frac{\beta c_t}{c_{t+1} \pi_t} + \frac{c_t}{b_t^{s\sigma}} \quad (4)$$

$$\tau_t = 1 + \frac{c_t}{h_t w_t} \quad (5)$$

From (4), it can be foreseen that at steady state, the price of short bond, or put in an alternative way, the demand for short-term bond is no more determined only by the household's discount factor, but also by the consumption and more importantly the number of outstanding short bond.

Due to this change with respect to the asset price, conventional theory is challenged (Hagedorn 2018[14]) It'll be shown later that in our case, when a government spending shock hit, households behave in a way contrary to textbook theory.

2.2 Firms

Following Faraglia et al(2013)[12], in this model, I set up the same monopolistic competition environment. In this environment, the households are monopolistic producer of intermediate products with technology $y_t = h_t$. The demand function for the intermediate good is given by $Y_t = d(P_t)$, where P_t , in this case, represents the relative price of intermediate good in terms of the final good and it is assumed that $d(1) = 1$ and $d'(1) \leq -1$.

To allow for sticky price is employed adjustment costs, which is $\frac{\theta}{2} \left(\frac{P_{i,t}}{P_{i,t-1}} - 1 \right)^2$, where θ refers to the degree of price stickiness.

The firms maximize the following:

$$E_t \sum_{j=0}^{\infty} \beta^j \frac{c_t}{c_{t+j}} \left[\frac{P_{i,t+j}}{P_{t+j}} Y_{t+j} d \left(\frac{P_{i,t+j}}{P_{t+j}} \right) - w_{t+j} h_{i,t+j} - \frac{\theta}{2} \left(\frac{P_{i,t}}{P_{i,t-1}} - 1 \right)^2 \right] \quad (6)$$

, subject to the following constraint:

$$h_{i,t+j} = Y_{t+j} d \left(\frac{P_{i,t+j}}{P_{t+j}} \right) \quad (7)$$

Therefore, the first order condition for firms with respect to P_t is following:

$$\begin{aligned} \frac{1}{P_t} Y_t d \left(\frac{P_{i,t}}{P_t} \right) + \frac{P_{i,t}}{P_t^2} Y_t d' \left(\frac{P_{i,t}}{P_t} \right) - w_t Y_t d' \left(\frac{P_{i,t}}{P_t} \right) \frac{1}{P_t} - \theta \left(\frac{P_{i,t}}{P_{i,t-1}} - 1 \right) \frac{1}{P_{i,t-1}} + \\ \beta E_t \frac{c_t}{c_{t+1}} \theta \left(\frac{P_{i,t+1}}{P_{i,t}} - 1 \right) \frac{P_{i,t+1}}{P_{i,t}^2} = 0 \end{aligned} \quad (8)$$

By letting $d'(1) = \eta$ and assuming that the firms set the same price, the FOC can be turned into the Phillips Curve:

$$\frac{Y_t}{\theta} \left(\frac{1+\eta}{\eta} - w_t \right) - (\pi_t - 1)\pi_t + \beta E_t \frac{c_t}{c_{t+1}} (\pi_{t+1} - 1)\pi_{t+1} = 0 \quad (9)$$

However, in the competitive equilibrium, $Y_t = h_t$, and dividing both sides of (9) with c_t , the PC turns to be:

$$\frac{\frac{h_t}{\theta} \left(\frac{1+\eta}{\eta} - w_t \right)}{c_t} - \frac{(\pi_t - 1)\pi_t}{c_t} + \beta E_t \frac{(\pi_{t+1} - 1)\pi_{t+1}}{c_{t+1}} = 0 \quad (10)$$

2.3 Government

The government budget constraint is as followed:

$$P_t G_t + B_{t-1}^s \leq \tau_t P_t w_t h_t + q_t^s B_t^s \quad (11)$$

, where $\{G_t\}_{t=0}^{\infty}$ is the spending shock. From the budget constraint, it can be shown that government expenditure is financed by issuing short and tax.

Divided by P_t on both sides, (11) then can be:

$$G_t + \frac{b_{t-1}^s}{\pi_t} \leq \tau_t w_t h_t + q_t^s b_t^s \quad (12)$$

, which suggests the value of bonds which come to due can be devalued by inflation so that chances are that government debt can be shrunken via inflation.

3 Ramsey Problem

In the Ramsey problem, at first the government budget constraint can be replaced by the price of short bond and tax rate obtained in the household sector. By replacing the price of bond as well as tax with (4), and (5) respectively, one gets

$$\frac{G_t}{c_t} + \frac{b_{t-1}^s}{c_t \pi_t} \leq \frac{w_t h_t}{c_t} - 1 + \left(\frac{\beta}{c_{t+1} \pi_{t+1}} + \frac{1}{b_t^{s\sigma}} \right) b_t^s \quad (13)$$

, while at the competitive equilibrium the resource constraint is satisfied:

$$h_t = c_t + G_t + \frac{\theta}{2} (\pi_t - 1)^2 \quad (14)$$

As a result, the Ramsey problem will be to maximize household's utility function (1) complying with the constraints (10), (13), and (14). The Lagrangian to the Ramsey problem is given by, with multipliers $\lambda_{g,t}$, $\lambda_{p,t}$ and $\lambda_{r,t}$ attached to the government budget constraint, the Phillips Curve, and the resource constraint, respectively:

$$\begin{aligned} L = E_0 \sum_t \beta^t \left\{ \log c_t - \log h_t + \frac{b_t^{s^{1-\sigma}}}{1-\sigma} + \lambda_{r,t} \left[h_t - c_t - G_t - \frac{\theta}{2} (\pi_t - 1)^2 \right] \right. \\ \left. + \lambda_{p,t} \frac{h_t \eta}{\theta} \left(\frac{1+\eta}{\eta} - w_t \right) \frac{1}{c_t} + (\lambda_{p,t-1} - \lambda_{p,t}) (\pi_t - 1) \pi_t \frac{1}{c_t} \right. \\ \left. + \lambda_{g,t} \left[\left(\frac{w_t h_t}{c_t} - 1 + \left(\frac{\beta}{c_{t+1} \pi_{t+1}} + \frac{1}{b_t^{s\sigma}} \right) b_t^s - \frac{G_t}{c_t} - \frac{b_{t-1}^s}{c_t \pi_t} \right) \right] \right\} \quad (15) \end{aligned}$$

The first order conditions with respect to $c_t, h_t, b_t^s, w_t, \pi_t$ are following:

$$\frac{1}{c_t} - \lambda_{r,t} - \lambda_{g,t} \left(\frac{1+\eta}{\eta} \right) h_t \frac{1}{c_t^2} - (\lambda_{p,t-1} - \lambda_{p,t}) (\pi_t - 1) \pi_t \frac{1}{c_t^2} + \lambda_{g,t} G_t \frac{1}{c_t^2} - (\lambda_{g,t-1} - \lambda_{g,t}) \frac{b_{t-1}^s}{c_t^2 \pi_t} = 0 \quad (16)$$

$$-\frac{1}{h_t} + \lambda_{r,t} + \lambda_{g,t} \left(\frac{1+\eta}{\eta} \right) \frac{1}{c_t} = 0 \quad (17)$$

$$\frac{1}{b_t^{s\sigma}} + (\lambda_{g,t} - \lambda_{g,t+1}) \frac{\beta}{c_{t+1} \pi_{t+1}} + \lambda_{g,t} \left[(1-\sigma) \frac{1}{b_t^{s\sigma}} \right] = 0 \quad (18)$$

$$\lambda_{p,t} \frac{\eta}{\theta} = \lambda_{g,t} \quad (19)$$

$$-\lambda_{r,t}\theta(\pi_t - 1) + (\lambda_{p,t-1} - \lambda_{p,t})(2\pi_t - 1)\frac{1}{c_t} + (\lambda_{g,t} - \lambda_{g,t-1})\frac{b_{t-1}^s}{c_t\pi_t^2} = 0 \quad (20)$$

Equation (16) and (17) refer to the first order condition with respect to c_t and h_t respectively. Combining together and eliminating the multiplier for the resource constraint, one can get a modified labour demand:

$$\begin{aligned} \frac{1}{c_t} + \lambda_{g,t} \left(\frac{1+\eta}{\eta} \right) \frac{1}{c_t} - \left(\lambda_{g,t} \frac{1+\eta}{\eta} \right) \frac{1}{c_t^2} - (\lambda_{p,t-1} - \lambda_{p,t})(\pi_t - 1)\pi_t \frac{1}{c_t^2} - \lambda_{g,t} G_t \frac{1}{c_t^2} - (\lambda_{g,t-1} - \lambda_{g,t}) \frac{b_{t-1}^s}{c_t^2 \pi_t} \\ = \frac{1}{h_t} \end{aligned} \quad (21)$$

Equation (18) indicates the optimal value of $\lambda_{g,t}$, which is non-zero at steady state and hence implies that the government budget constraint is binding at steady state. In order to determine the optimal level of short bond b_t^s , one needs to use the resource constraint at steady state at the same time, which is to be discussed in next section. (19) refers to the FOC with respect to w_t . Same as Faraglia et al.(2013)[12], (19) suggests that the optimal level of wage or marginal cost is chosen by the social planner to balance the benefit out of it as well as the resulting cost of corresponding change of inflation. For the last equation (20) with respect to π_t , similar to that in Faraglia et al.(2013)[12], the first term represents the marginal effect of inflation on the resource cost; the second term indicates the intertemporal effect of inflation change, while the last time shows the impact of inflation on the government debt.

4 Numerical Analysis

4.1 Calibration

In order to do numerical analysis, I apply the log-linearization method in this paper. Before that, one should calculate the steady states from the equations above. The process is following: considering the economy is at steady state, (20) implies that at steady state, the aggregate inflation π^{ss} equals to 1, thus suggesting that the wage equals to $\frac{1+\eta}{\eta}$ according to the Phillips Curve (10). Then combining (21) and the resource constraint (14) yields the values of consumption c^{ss} and labour h^{ss} . Afterwards, the value of short bond holding by households can be solved by means of the government budget constraint (13). Besides, (18) indicates the value of λ_g^{ss} , which also sheds light on λ_p^{ss} based on (19). In the end, I fix the exogenous government spending at steady state equal to 0.35 based on the data of US during the past decade. All the results are summed up on the table 1.

With the steady states, the log-linearization can now be performed with outcomes shown in the Appendix A.

It's assumed that the household discounts the utility with discount factor equal to 0.96. As for the price adjustment cost θ and the elasticity η , I follow SGU (2004)[21] and Faraglia et al. (2013)[12], picking up $\theta = 4.375$ and $\eta = -6$. In the end σ is set to be 0.5.

All the parameters and steady state values of variables are listed in Table 1.

Parameters and Variables	Values
β	0.96
η	-6
θ	4.375
σ	0.5
c^{ss}	0.5
h^{ss}	0.85
b^{sss}	0.1131
w^{ss}	0.83
π^{ss}	1
G^{ss}	0.35

Table 1: Values of Parameters and Variables at steady state

4.2 Outcomes

In this paper, I first assume the government spending shock. Figure 3 in the Appendix B shows the effects of a positive government spending shock on the economy. When the spending shock hits, the impulse response function suggests that the government finances the increasing spending through issuing short-term bond, while lowering tax rate. On the side of households, households tend to decrease consumption and increase labour, which is at odds with the common sense that expansionary government spending is supposed to increase consumption. Moreover, it's also shown that the price of the short bond drops at the same time, implying increasing yield rate correspondingly

The explanation could mainly lie on the utility function incorporating the short bond. Because the households can derive utility from holding short bond, when there is a positive spending shock, the government faces a dilemma: if it issues short-term debt to finance the spending, due to that the asset price goes down, according to Euler equation (4) with respect to short-term bond, households turn to purchase those cheaper short-term bond and thus lower consumption, corresponding to the lower marginal effect of holding short-term bond and larger marginal effect of consumption respectively, since the utility function follows the Inada condition with respect to each variable. With consumption declining and its marginal effect climbing up, the tax rate goes down in the figure, implying that the

government would like to boost up the economy with lower tax rate, but it seems unsuccessful in this way. It should also be noteworthy that with the bond increasing and its asset prices going down, the implications should be twofold: i) The declining asset price mirrors the increasing yield rate, which induces the household to save more and consume more in the future; ii) while higher yield rate also has the government exposed to the risk of default thanks to the higher cost of financing, not least that the government in this case can only issue short-term debt.

It looks like that when a government spending shock hits, considering households have preference for short-term bond, it's easy for the government to finance the spending, but at the expense of shrinking aggregate demand in future and being exposed to high risk of default and volatility, which casts a doubt on the sustainability of the public debt for the government.

However, if we consider the inflation shock, it shows in the Figure 4 in the Appendix B that the shock leads to the decrease of short bond in real term. As mentioned in last section, the equation (20) indicates that inflation can be used to lower the outstanding debt for government, followed by increasing asset price and thus lower yield rate. Therefore, with inflation, the debt sustainability problem can be relieved to some extent, but it should also be noticed that the wage correspondingly drops, and the tax rate raises up.

5 Conclusion

This paper models a stick-price economy in which the government can issue non-state contingent short-term bond to hedge against government spending shock, while the households have preference for and can derive utility from short-term bond at the same time. The outcome suggests that the government is able to issue short-term debt to deal with positive spending shock, while it also faces the dropping consumption and increasing demand of short bond from households, accompanied by the declining asset price and therefore incremental yield rate. As a result, it should be cast doubt upon that the government can use short-term debt against shocks all the time. Instead, chance has it that it will face debt sustainability problem in the future. However, with inflation, the short-term debt in real term will decline and asset price goes up generating the declining the yield rate so that the government can keep debt sustainable.

However, there are some directions towards which the future work in the master thesis could move: i) Including bond with longer maturity; in this paper, it's assumed that the government can only issue short-term bond, which is not consistent with the reality. Besides, the inflation should be theoretically more outstanding had the economy incorporated long-term debt, since as Chari et

al.(1999)[9], cooperating with long-term debt, inflation can engineer a complete market even under an incomplete economy; ii) Developing the micro-foundation of the reduced-form utility including short-term bond. Even though, based on the literature, agents value short-term bond, it should be more enunciated how short-term bond provide different sorts of values for bond holders; iii)Following ii), with bond in utility, it can be discussed how the conventional monetary theory would be challenged.

References

- [1] S. R. Aiyagari, A. Marcet, T. J. Sargent, and J. Seppälä. Optimal taxation without state-contingent debt. *Journal of Political Economy*, 110(6):1220–1254, 2002.
- [2] S. R. Aiyagari and E. R. McGrattan. The optimum quantity of debt. *Journal of Monetary Economics*, 42(3):447–469, 1998.
- [3] G.-M. Angeletos. Fiscal policy with noncontingent debt and the optimal maturity structure. *The Quarterly Journal of Economics*, 117(3):1105–1131, 2002.
- [4] R. Barro. On the determination of debt. 1979.
- [5] B. Bernanke. The global saving glut and the u.s. current account deficit. Technical report, 2005.
- [6] O. Blanchard. *Fiscal policy under low interest rates*. MIT Press, 2023.
- [7] M. K. Brunnermeier, S. A. Merkel, and Y. Sannikov. Debt as safe asset. Technical report, National Bureau of Economic Research, 2022.
- [8] F. Buera and J. P. Nicolini. Optimal maturity of government debt without state contingent bonds. *Journal of Monetary Economics*, 51(3):531–554, 2004.
- [9] V. V. Chari and P. J. Kehoe. Optimal fiscal and monetary policy. *Handbook of macroeconomics*, 1:1671–1745, 1999.
- [10] F. Collard, H. Dellas, and G.-M. Angeletos. Public debt as private liquidity: Optimal policy. 2022.
- [11] D. Debortoli, R. Nunes, and P. Yared. Optimal time-consistent government debt maturity. *The Quarterly Journal of Economics*, 132(1):55–102, 2017.
- [12] E. Faraglia, A. Marcet, R. Oikonomou, and A. Scott. The impact of debt levels and debt maturity on inflation. *The Economic Journal*, 123(566):F164–F192, 2013.
- [13] E. Faraglia, A. Marcet, R. Oikonomou, and A. Scott. Government debt management: The long and the short of it. *The Review of Economic Studies*, 86(6):2554–2604, 2019.
- [14] M. Hagedorn. Dp12769 prices and inflation when government bonds are net wealth. 2018.
- [15] G. Kaplan and G. L. Violante. Microeconomic heterogeneity and macroeconomic shocks. *Journal of Economic Perspectives*, 32(3):167–94, 2018.
- [16] A. Krishnamurthy and A. Vissing-Jorgensen. The aggregate demand for treasury debt. *Journal of Political Economy*, 120(2):233–267, 2012.
- [17] R. E. Lucas Jr and N. L. Stokey. Optimal fiscal and monetary policy in an economy without capital. *Journal of monetary Economics*, 12(1):55–93, 1983.
- [18] H. Lustig, C. Sleet, and Ş. Yeltekin. Fiscal hedging with nominal assets. *Journal of Monetary Economics*, 55(4):710–727, 2008.

- [19] R. Reis. The constraint on public debt when $r < g$ but $g < m$. 2021.
- [20] R. Reis. Debt revenue and the sustainability of public debt. *Journal of Economic Perspectives*, 36(4):103–24, 2022.
- [21] S. Schmitt-Grohé and M. Uribe. Optimal fiscal and monetary policy under sticky prices. *Journal of economic Theory*, 114(2):198–230, 2004.
- [22] H. E. Siu. Optimal fiscal and monetary policy with sticky prices. *Journal of Monetary Economics*, 51(3):575–607, 2004.
- [23] P. Yared. Rising government debt: Causes and solutions for a decades-old trend. *Journal of Economic Perspectives*, 33(2):115–40, 2019.

Appendix A

For (10):

$$\hat{w}_t = \frac{\beta(\pi_{t+1} - \hat{\pi}_t)\theta}{h^{ss}(1+\eta)} \quad (22)$$

, which is modified from the log-linearized Phillips Curve.

For (13):

$$\begin{aligned} w^{ss}h^{ss}c^{ss}\left(\hat{w}_t + \hat{h}_t - \hat{c}_t\right) + \beta\frac{b^{ss}}{c^{ss}}\left(\hat{b}_t^s - c_{t+1} - \pi_{t+1}\right) + (1-\sigma)b^{ss^{1-\sigma}}\hat{b}_t^s \\ = \frac{G^{ss}}{c^{ss}}\left(\hat{G}_t - \hat{c}_t\right) + b^{ss}\frac{b^{ss}}{c^{ss}\pi^{ss}}\left(\hat{b}_{t-1}^s - \hat{c}_t - \hat{\pi}_t\right) \end{aligned} \quad (23)$$

For (14):

$$\hat{c}_t = \frac{h^{ss}\hat{h}_t - G^{ss}\hat{G}_t}{c^{ss}} \quad (24)$$

For (18):

$$\hat{\lambda}_{g,t} = \left(\hat{\lambda}_{g,t} - \hat{\lambda}_{g,t+1}\right)\frac{\beta\lambda_g^{ss}}{c^{ss}\pi^{ss}b^{s\sigma}} \quad (25)$$

For (19):

$$\hat{\lambda}_{p,t} = \hat{\lambda}_{g,t} \quad (26)$$

For (20):

$$\hat{\pi}_t = \left(\hat{\lambda}_{g,t} - \hat{\lambda}_{g,t-1}\right)\frac{b^{ss}}{c^{ss}\theta\lambda_r^{ss}} \quad (27)$$

For (21):

$$\hat{h}_t = \frac{\left(c^{ss} + 2\left(\frac{1+\eta}{\eta}\right)\lambda_g^{ss}c^{ss^2} - 2\frac{c^{ss^2}}{h^{ss}}\right)\hat{c}_t + \left(\left(\frac{1+\eta}{\eta}\right)\lambda_g^{ss}c^{ss^2} - \lambda_g^{ss}h^{ss}\left(\frac{1+\eta}{\eta}\right) + \lambda_g^{ss}G^{ss} + \lambda_g^{ss}\right)\hat{\lambda}_g + \lambda_g^{ss}G^{ss}\hat{G}_t}{\lambda_g^{ss}h^{ss}\frac{1+\eta}{\eta} - \frac{c^{ss^2}}{h^{ss}}} \quad (28)$$

Appendix B

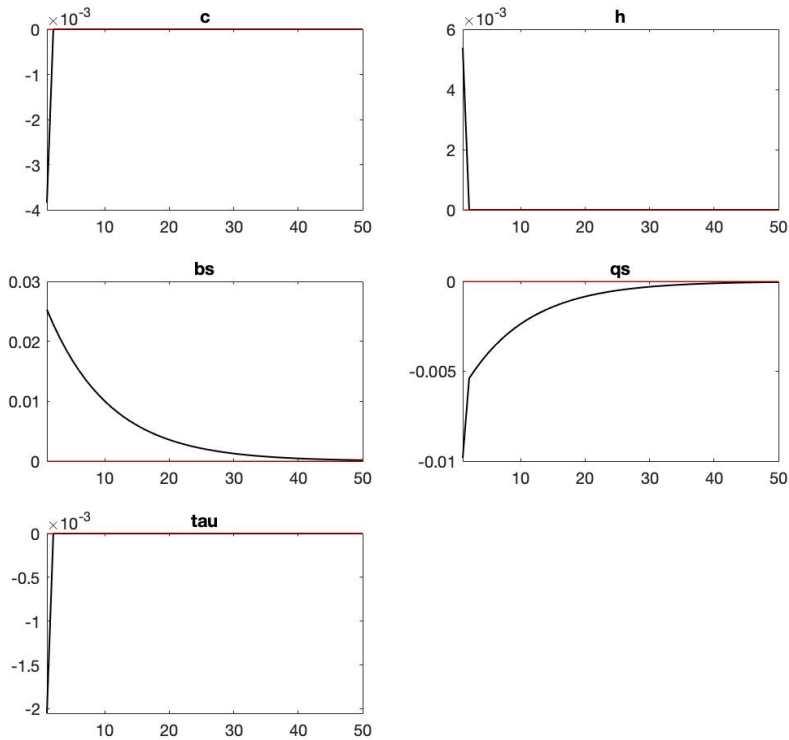


Figure 3: Spending shock

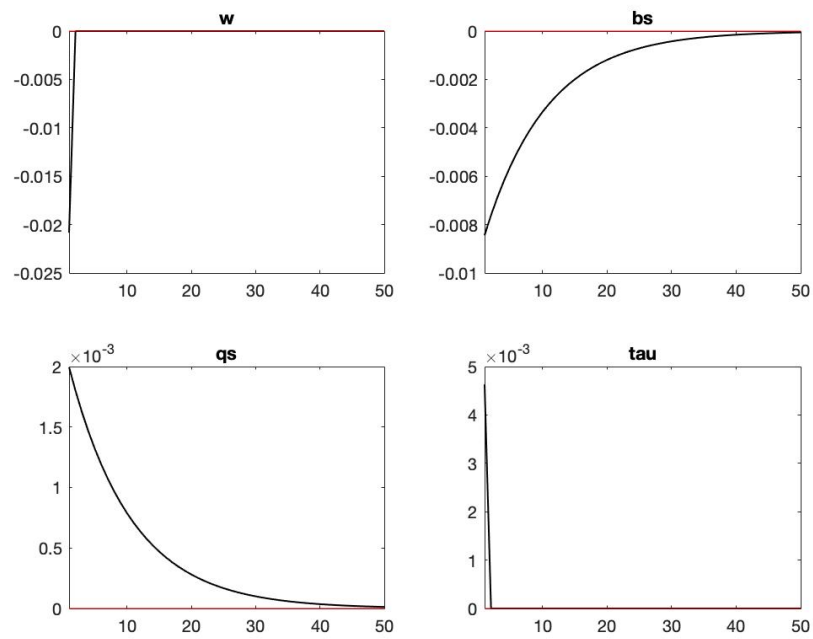


Figure 4: Inflation shock