

## **Public Debt and Inflation Dynamics in a Sticky Price Model**

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### **ABSTRACT**

This paper reports on the theoretical investigation of the relationship between the stance of fiscal policy and inflation dynamics. The research focused on the role of public debt in the canonical sticky-price model with simple financial friction. We show that inflation considerably increases in response to economic shocks if the fiscal authority puts a smaller weight on control of the primary debt. A higher interest-rate smoothing policy is effective in an economy in which the stance of fiscal policy plays a significant role in the determination of inflation dynamics. Simulation results imply that the economy would never fail to experience greater inflation in the near future if the government attempts to accumulate its public debt in the case in which the central bank cannot have the effective instrument to pin down the expected inflation rate.

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## I. INTRODUCTION

The Japanese economy has experienced a severe stagnation, which was mainly caused by financial fragility associated with a bad loan problem, since the 1990s. To revive the economy, the Japanese government has implemented a fiscal stimulus by aggressively accumulating public debt. Indeed, it is well known that the total amount of public debt in Japan is high among developed countries. Once the public sector expects that the accumulation of debt is not sustainable, the Japanese economy would inevitably experience the higher inflation rate in the near future. Therefore, it is unquestionable that the stance of the fiscal policy crucially plays an important role in Japan's inflation dynamics.

Also, several studies have discussed the role of financial frictions in monetary policy analysis. Bernanke, Gertler, and Gilchrist (1999) introduce financial market friction into the standard new Keynesian model, and stress a financial accelerator effect that a change in an external financial premium has the persistent effect on the real economy. Ravenna and Walsh (2006) show that a cost channel, which implies that a rise in working capital induced by a monetary contraction results in an increase in inflation, generates a wedge between stabilizing inflation and stabilizing the output gap in the case of optimal monetary policy. Chowdhury, Hoffman, and Schabert (2006) find that a cost channel plays a significant role in the new Keynesian Phillips curve (NKPC) in developed countries. These studies imply that the role of financial friction is not negligible when the central bank conducts monetary policy. Our question is how the stance of the fiscal policy affects inflation dynamics in an economy with financial frictions.

To answer this question, we theoretically explore the relationship between the stance of fiscal policy and inflation dynamics in a sticky price model with a simple financial friction. Our model shows that the response of inflation to a contractionary monetary policy shock crucially depends on the stance of fiscal policy. Interestingly, the price puzzle that monetary tightening generates an increase in inflation occurs if the government puts a smaller weight on the control of the primary debt. In addition, the inflation rate considerably increases in response to a public debt shock if the government imposes a small weight on the control of the public debt in a fiscal policy rule. Thus, our result addresses that the stance of fiscal policy matters in a sticky price model with financial frictions.

This paper also demonstrates how the central bank solves the problem of the price puzzle generated by an accumulation of public debt. Our model suggests that the central bank should put a higher weight on interest rate smoothing to eliminate the price puzzle induced by a smaller weight on the control of the primary debt. Indeed, a monetary policy rule with a high weight on the lagged interest rate leads to a decline in inflation after a monetary tightening shock.

Our simulation results might indicate that inflation never drastically increases if both the government and the central bank can enhance their credibility of economic policies. The economy would inevitably experience greater inflation in the near future, however, if the government attempts to accumulate public debt in the case of the central bank having no effective instrument to pin down the expected inflation rate.

The remainder of this paper proceeds as follows. Section II describes the model. Section III reports our simulation results. Section IV briefly concludes.

## II. MODEL

Apart from the presence of a cost channel, our model is based on the framework of Woodford (1996) and Black and Kirsanova (2004). Lower case variables denote a log-deviation from the steady state. A log-linearized variable around the steady state is expressed by  $z_t = \log(Z_t / \bar{Z})$ .  $\bar{Z}$  denotes the value of the steady state.

First, the dynamic IS curve, which is derived from the representative household's Euler equation for optimal consumption, is given by

$$x_t = E_t x_{t+1} - \sigma^{-1}(r_t - E_t \pi_{t+1}) + v b_t \quad (1)$$

where the output gap is defined by  $x_t = y_t - y_t^n$ .  $y_t$  represents the log-deviation of actual output and  $y_t^n$  is the log-deviation of the natural rate of output. Also,  $r_t$  is the nominal interest rate,  $\pi_t$  is the inflation rate, and  $b_t$  is the real public debt. Finally,  $\sigma$  and  $v$  are positive parameters.

Second, inflation adjustment is depicted by the NKPC. Firms are subject to monopolistic competition and Calvo (1983) type staggered nominal price rigidities. Thus, under Calvo pricing, fraction  $1 - \omega$  of all firms optimally adjusts their prices, whereas the remaining fraction of firms  $\omega$  does not. Moreover, following Gali and Gertler (1999) and Steinsson (2003), we employ the rule of thumb hypothesis. More precisely, among firms that can adjust prices, a fraction  $\lambda$  sets price optimally, while a fraction  $1 - \lambda$  sets price based on a rule of thumb, which is given as follows:

$$P_t^f = P_{t-1}^* \left( \frac{P_{t-1}}{P_{t-2}} \right)$$

where  $P_t^f$  is the price for firms that use rule-of-thumb pricing and  $P_t^*$  is optimal price index in period  $t$ , and  $P_t$  is price index in period  $t$ .

Under these conditions, we obtain the following hybrid NKPC:<sup>1</sup>

$$\pi_t = \chi_f E_t \pi_{t+1} + \chi_b \pi_{t-1} + \delta \varphi_t \quad (2)$$

where  $\chi_f \equiv \omega \beta / [\omega + (1 - \lambda)(1 - \omega(1 - \beta))]$ ,  $\chi_b \equiv (1 - \lambda) / [\omega + (1 - \lambda)(1 - \omega(1 - \beta))]$ , and  $\delta \equiv (1 - \omega)(1 - \omega \beta) \lambda / [\omega + (1 - \lambda)(1 - \omega(1 - \beta))]$ .  $\beta$  is the positive parameter. Also,  $\varphi_t$  denotes the real marginal cost.

When a cost channel is present, as shown in Ravenna and Walsh (2006) and Chowdhury, Hoffman, and Schabert (2006), real marginal cost is given by

$$\varphi_t = (1 + \psi_R) r_t + (\sigma + \eta) x_t \quad (3)$$

where  $\psi_R$  is the degree of incomplete lending rate pass-through and  $\eta$  is the positive parameter. Real marginal cost now depends on the lending rate because a cost

channel is present. Imperfect lending rate pass-through acts as a kind of a financial accelerator effect emphasized by Bernanke, Gertler, and Gilchrist (1999).

Third, as in Woodford (1996) and Black and Kirsanova (2004), we introduce a debt accumulation equation into the model. The public debt evolves as follows:

$$b_{t+1} = r_t - E_t \pi_{t+1} + \beta^{-1}(b_t + d_t) + \varepsilon_t^f \quad (4)$$

where  $d_t$  is real primary debt and  $\varepsilon_t^f$  represents a fiscal shock. As presumed in Black and Kirsanova (2004), the government conducts fiscal policy based on the following feedback rule:

$$d_t = -\tau b_t \quad (5)$$

To close the model, we now specify a monetary policy rule. This paper assumes that the central bank implements monetary policy based on the following simple instrument rule:

$$r_t = \rho_r r_{t-1} + (1 - \rho_r) \left( \phi_\pi \pi_t + \frac{\phi_x}{4} x_t \right) + e_t \quad (6)$$

where  $\phi_\pi$  is the coefficient of inflation and  $\phi_x$  is the coefficient of the output gap.  $e_t$  represents the monetary policy shock. Also,  $\rho_r$  represents the degree of interest rate smoothing.

Finally, we describe the parameters used in the paper. We calibrate the parameter based on the existing literature on the new Keynesian model. First, we set the degree of price rigidity  $\omega$  to 0.75. Next, in regard to the parameter  $\lambda$ , we set this value to 0.4 based on the parameter range suggested empirical studies for the NKPC. We choose 0.99, 2.0 and 1.0 for  $\beta$ ,  $\sigma$ , and  $\eta$ , respectively. The parameter  $\nu$  is set to 0.05. In regard to incompleteness of the loan rate, we set  $\psi_R$  to 0.<sup>2</sup> With regard to the parameters for the monetary policy rule, following the existing literature in the new Keynesian analysis, we choose 1.5 and 0.5 for  $\phi_\pi$  and  $\phi_x$ , respectively. We set the term for interest rate smoothing to 0 as a benchmark case.

### III. THE EFFECT OF PUBLIC DEBT ON INFLATION DYNAMICS

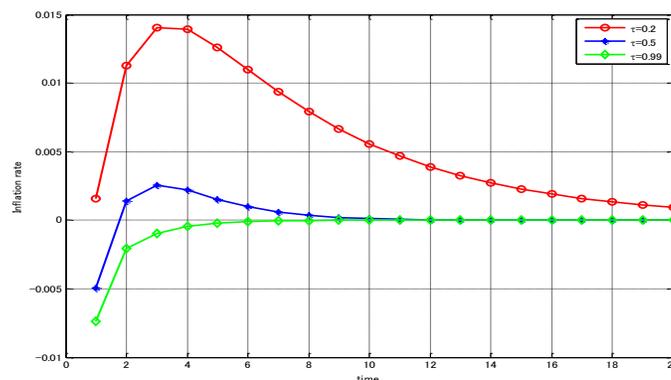
Figure 1 shows the impulse response of inflation to a monetary tightening shock. It is surprising to note that monetary tightening generates an increase in the inflation rate when the fiscal authority puts a smaller weight on controlling the primary debt. Thus, the price puzzle occurs if the fiscal authority has less incentive to control the primary debt. According to Chowdhury, Hoffman, and Schabert (2006) and Castelnuovo (2007), a monetary tightening shock generates the price puzzle when the parameter  $\psi_R$  takes a higher value. Importantly, in contrast to their results, this paper illustrates the presence of the price puzzle even if  $\psi_R = 0$ .

Intuitively, a small weight on controlling public debt weakens the demand

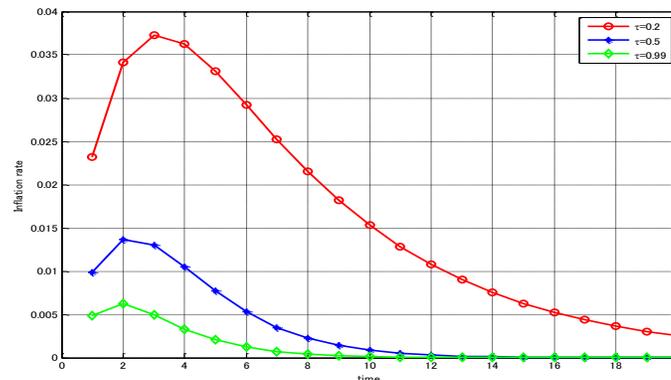
channel that monetary policy affects an inter-temporal allocation of the demand through a change in the real interest rate. In this case the central bank might not fully stabilize inflation by raising the real interest rate. In other words, it is possible that the cost channel dominates the demand channel even if loan rate pass-through is complete. Hence, a monetary contraction results in the price puzzle. On the other hand, the inflation rate responds negatively to a contractionary monetary policy shock when the fiscal authority puts a higher weight on controlling the primary debt.

Figure 2 illustrates the impulse response of inflation to a fiscal shock—that is, an increase in public debt. It turns out that a fiscal shock generates an increase in the inflation rate. In particular, the smaller the value of the parameter  $\tau$  is, the larger the response of the inflation rate to a fiscal shock is. This result is intuitive. A fiscal shock increases the expected inflation rate because the private sector anticipates that a small weight on controlling public debt aggressively induces the accumulation of government debt.

**Figure 1**  
Impulse response to a monetary policy shock



**Figure 2**  
Impulse response to a public debt shock



We now discuss how the central bank prevents the price puzzle associated with an accumulation of the public debt. Castelnuovo (2007) points out that to eliminate the price puzzle, the central bank should introduce policy inertia through interest rate smoothing, which acts as an anchor in stabilizing the expected inflation rate. The price puzzle disappears because the demand channel dominates the cost channel when the central bank gradually manipulates its policy rate.

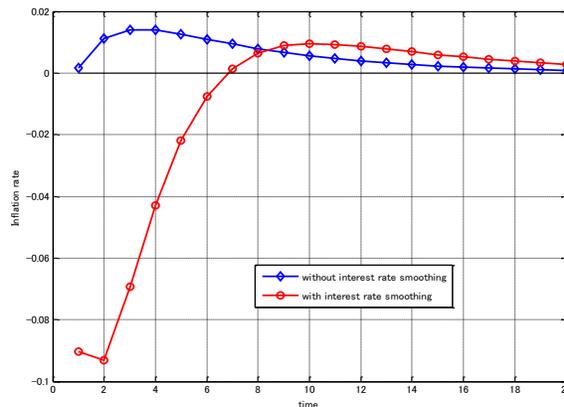
Our question is whether interest rate smoothing can resolve the problem of the price puzzle when the stance of fiscal policy significantly affects the real economy. To answer this question, we introduce the term for interest rate smoothing into the monetary policy rule. According to previous studies, the coefficient for interest rate smoothing takes a 0.6-0.9 range (for example, Clarida, Gali, and Gertler, 2000). We set the term for interest rate smoothing to 0.75.

Figure 3 shows the impulse response of inflation to a monetary tightening shock when the central bank employs an interest rate rule with a high weight on the lagged interest rate in the case in which the value of the parameter  $\tau$  is small. The price puzzle disappears when the central bank puts a high weight on interest rate smoothing in the monetary policy rule. This indicates that a monetary policy rule that includes interest rate smoothing can stabilize the real economy even if the fiscal authority puts a small weight on control of the public debt. In other words, as argued in Castelnuovo (2007), interest rate smoothing can reinforce the demand channel because the presence of the lagged interest rate in a monetary policy rule leads to the stabilization of the expected inflation rate.

Figure 4 illustrates the impulse response of the inflation rate to a fiscal shock when the term for the lagged interest rate is included in an interest rate rule in the case of a small value of the parameter  $\tau$ . We observe that the response of inflation is smaller under the monetary policy rule with interest rate smoothing than that without interest rate smoothing.

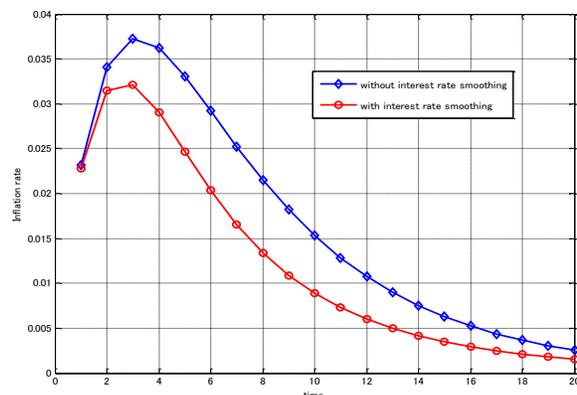
**Figure 3**

Impulse response to a monetary policy shock under the case of interest rate smoothing when  $\tau = 0.2$



**Figure 4**

Impulse response to a public debt shock under the case of interest rate smoothing when  $\tau = 0.2$



What implications do our findings have for current Japanese economy? According to our results, a small weight on public debt in a fiscal policy rule (i.e., a small value of the parameter  $\tau$ ) induces an increase in the inflation rate after monetary tightening. In addition, the response of inflation is quite large and persistent when the fiscal authority puts a smaller weight on the control of the public debt. The Japanese government now combats a severe stagnation and argues that the Japanese economy should be revived by implementing an aggressive fiscal stimulus. In fact, the level of the Japanese public debt is high among developed countries. In the near future, therefore, the inflation rate would drastically increase once the private sector expects that the size of the Japanese public debt is not sustainable.

Our simulation results may suggest two implications for the current Japanese economy.<sup>3</sup> First, the Japanese government should shrink the level of public debt to maintain credibility for fiscal policy. This is because a smaller weight on controlling public debt generates severe inflation. Second, the Bank of Japan (BOJ) should retain the credibility of its monetary policy by managing the expectations of the private sector if the government accumulates its public debt to insulate the Japanese economy.

Accordingly, our model might indicate that inflation never drastically increases if both the Japanese government and the BOJ can enhance their credibility of economic policies. In addition, as our simulation results show, even if an accumulation of public debt creates inflation pressure in the future, the BOJ can stabilize the inflation expectations of the public sector as long as it gradually manipulates its policy rate. The Japanese economy would inevitably experience greater inflation in the near future, however, if the government attempts to accumulate its public debt when the BOJ has no effective instrument to anchor the expected inflation rate.

#### IV. CONCLUSION

This study has theoretically investigated the relation between inflation dynamics and the conduct of fiscal policy, focusing on the role of public debt in the canonical

sticky-price model with simple financial friction. Results have shown that inflation considerably increases in response to economic shocks if the fiscal authority puts a small weight on the control of the primary debt. A higher interest-rate smoothing policy is effective when fiscal policy significantly influences inflation dynamics. Simulation results imply that an economy inevitably experiences greater inflation in the near future if government tries to accumulate public debt when the central bank has no effective instrument to pin down the expected inflation rate.

#### ENDNOTES

1. For example, see Gali and Gertler (1999) and Steinsson (2003) for a detailed derivation of the NKPC.
2. We confirmed that the results are robust to higher values of the parameter  $\psi_R$ .
3. Note that this paper does not focus on the non-negativity constraint on nominal interest rates. Therefore, strictly speaking, our prescription can be applied to the Japanese economy in which the nominal interest rate is above zero.

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