Can the Fiscal Authority Constrain the Central Bank?

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Abstract

The fiscal theory of the price level (FTPL) suggests, in its extreme form, that the fiscal authority always constrains central bank behavior. A Fisherian model is used to show that fiscal policy can be irrelevant for the central bank, and that a central bank can act independently, even when constrained to monetize the government debt. In a model with secured credit and scarce collateral, which can explain low real interest rates, the valuation of consolidated government debt needs to account for inefficiency and liquidity premia. The fiscal authority may wish to tolerate inefficiency so as to finance public goods provision.

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1 Introduction

The purpose of this paper is to explore ways in which the fiscal authority can impose constraints on the central bank. How can fiscal policy matter for the central bank's ability to achieve a particular path for the price level and inflation? How does the impact of fiscal policy on real allocations matter for the central bank? A focus in the paper is the implications of low real interest rates – resulting from a low supply of government debt – for unconventional monetary policy, and for the financing of government spending. A key result is that the fiscal authority may want to tolerate low real interest rates – a symptom of inefficiency in credit markets – so as to efficiently finance public goods provision.

Early work on the relationship between monetary policy and fiscal policy explored how constraints on central banks could lead to results seemingly at odds with standard monetarist doctrine. For example, in Sargent and Wallace (1981), tight monetary policy could lead to higher future inflation, and possibly higher current inflation. As well, Sargent (1982) studied hyperinflationary regimes in the 1920s in Europe, and argued that these hyperinflations were driven by out-of-control fiscal policy. In the Sargent-Wallace (1981) and Sargent (1982) work, the key idea is that high inflation can be generated by a fiscal authority with large deficits that is unwilling or unable to finance these deficits by issuing government debt. As a result, the central bank is forced to use the inflation tax.

In the 1990s, the fiscal theory of the price level (FTPL) was developed, principally by Leeper (1991), Sims (1994), and Woodford (1995). The FTPL starts with the observation that, in standard macroeconomic models, the real value of the government debt is equal to the expected discounted value of future primary government surpluses. This is sometimes described as a valuation equation for government debt, and under some assumptions implies that the current nominal government debt determines the current price level. If we take this idea to the extreme, the price level and inflation cannot be controlled by the central bank.

So, while research by Sargent and Wallace (1981) and Sargent (1982) focused on how large government deficits could lead to the capture of the central bank by the fiscal authority, and excessive use of the inflation tax, FTPL ideas might potentially be used to explain low inflation. Perhaps inflation could fall below the central bank's inflation target, but the central bank would be powerless to raise inflation, as it could be constrained by the nominal government debt and the fiscal authority's commitment to future real primary government surpluses.

But, in reality, central banks need not typically be constrained by fiscal policy. First, while Sargent (1982) makes a good case that hyperinflations can result from excessive demands by the fiscal authority on the central bank, it seems difficult to make that case more generally. Disinflationary experience, and the track record of inflation-targeting central banks suggests that fiscal constraints on monetary policy are sometimes not an issue. By the late 1970s, there was a consensus among policymakers in the United States that inflation was too high. Though there was disagreement about the remedy, disinflation was implemented through central bank policy, and is typically acknowledged to have been a success, in retrospect.

The Volcker disinflation helped in achieving a consensus that inflation control should be a job assignment for the central bank, and some central banks, beginning with the Reserve Bank of New Zealand in 1989, established explicit inflation targets. For the most part, these inflation targeting regimes have been successful. For example, the Bank of Canada established an explicit inflation target in 1991. Since then, the Bank has targeted the headline consumer price index at 2%, with a range of 1-3%. Figure 1 shows the natural log of the CPI for Canada for the period 1992-2017, along with a 2% inflation trend. Even over this 25-year period, the CPI level has tracked the 2% inflation path remarkably closely, though with some persistent undershooting of the target after the 2008-2009 recession. Still, in September 2017, the actual CPI was only 5.5% below the 2% inflation path, representing a very small cumulative deviation from target over the 25-year period. Unless there were some implicit and unannounced commitment of the fiscal authority working in the background, the history of disinflation and inflation control in inflation-targeting countries seems inconsistent with the existence of significant fiscal constraints pushing these countries into high-inflation territory.

[Figure 1 here.]

But what about the ability of the FTPL to explain the recent persistent undershooting of inflation targets by central banks in the United States, the euro area, Sweden, Japan, and Switzerland, for example? In the FTPL, the central bank appears to be tied to the fiscal authority in ways that some key central banks were not in the past, or even in the present. For example, the Bank of England was, until 1946, a private entity. The Bank was founded in 1694, and by the nineteenth century had been granted a monopoly in supplying circulating currency in the U.K., and stood as a ready lender to the Crown. But the Bank also engaged in private lending, and it paid dividends to its stockholders, rather than making transfers to the fiscal authority, as most modern central banks do. As well, the Federal Reserve System was initially set up as a quasi-private central bank that did not hold government debt in its asset portfolio. It was not until the 1920s that open market operations began to play an important role in the U.S., and the Federal Open Market Committee was not set up until the 1930s. Initially, the regional Federal Reserve Banks were somewhat independent institutions that issued currency and made discount window loans to district member banks, with these member banks receiving dividends from their regional Feds. Finally, the European Central Bank, due to its special role as the central bank in a monetary union, does not intervene through open market operations in government debt (though it holds some government debt in its asset portfolio), but through lending to private banks in its jurisdiction.

Why do such arrangements matter for how the FTPL might work? Within the FTPL framework, if future real primary government surpluses are held constant, then the fiscal authority could create low inflation by limiting growth in the nominal outstanding government debt. However, if the central bank can create money growth through central bank lending (or, similarly, through purchases of private assets) – as most central banks have the power to do – then these central banks are not constrained as they are in FTPL constructs.

Finally, an important issue for contemporary central banks is the persistently-low real rate of interest on government debt. Macroeconomists have explored several reasons for the low real rate of interest, including low productivity growth and demographic factors. But perhaps more compelling is the idea that there exists a shortage of safe assets. That is, the demand for safe assets is high because of uncertainty about financial stability and new financial regulations. And the supply is low in the aftermath of the financial crisis, which reduced the private supply of safe assets, and because of higher risk associated with sovereign debt. As a result, safe government debt can bear a liquidity premium, which will imply that the value of government debt can exceed the present value of future government primary surpluses. That is, the liquidity premium on government debt implies that government debt has "monetary" properties, as its value exceeds the appropriately discounted sum of the future payoffs on the asset, much as the value of money exceeds the valuation of its intrinsic payoffs. This then implies that the fiscal constraints implicit in the FTPL do not hold (see also Bassetto and Cui 2017). For example, if the real interest rate is negative, then the fiscal authority can issue debt and finance an indefinite flow of strictly positive future transfers. Primary surpluses are not required to support the real value of the government debt.

In this paper, we first construct a Fisherian model of inflation, in which the paths of output and the real interest rate are exogenous. This setup gives us some insight into how institutional arrangements can matter for the determination of the price level and inflation. We first suppose a central banking arrangement in which the central bank conducts no open market operations, but issues currency and reserves to finance loans to the private sector. Then, central banking lending, financed by currency issue, generates central bank profits that are distributed as dividends to the central bank's shareholders – private households. In this context, the central bank can set a policy so as to determine the price level and inflation, in a manner completely divorced from fiscal policy. Inflation is generated through an increasing nominal quantity of currency, backed by central bank loans. And even if there were no fiscal activity at all, this would not be a problem for the central bank in controlling inflation. Thus, in the model, the fiscal authority is not necessary to make monetary policy work.

Extending the Fisherian model in a way that integrates monetary policy with fiscal policy, it is possible to derive FTPL conclusions. But there are circumstances in which a seeming recipe for runaway inflation is in fact not. For example, the central bank can be constrained to "monetize" the federal government debt, but this does not mean that the central bank cannot control inflation as it chooses. Indeed, recent experience with quantitative easing in some countries is consistent with these results. For example, in Japan, the attempt beginning in 2013 to raise inflation through large-scale asset purchases has to date been unsuccessful. Our model suggests that this is due to the failure of the Bank of Japan to raise the nominal interest rate on reserves. If there is quantitative easing and the nominal interest rate stays low, monetizing the debt simply involves replacing government debt with interest-bearing reserves, and that need not be inflationary.

The second step in the paper is to extend the model to include production and secured credit. The model is related to Andolfatto and Williamson (2015) and Williamson (2017), though government debt is posted as collateral in the model here and in Williamson (2017), and traded directly in Andolfatto and Williamson (2015). In this model, if collateral constraints bind, there exists a liquidity premium on government debt. Then, the market value of the consolidated government debt exceeds the present value of future primary government surpluses, because of inefficiencies in exchange caused by a scarcity of safe assets. Then, if the fiscal authority makes government debt sufficiently scarce, it is possible for the issue of government debt to generate an indefinite flow of strictly positive transfers.

This has implications for the financing of government spending. If the fiscal authority is dependent on the revenue that can be generated through a scarcity of government debt, it then faces a tradeoff. More public goods can be provided if government debt is more scarce, but this tightens collateral constraints, and reduces spending on private goods. Implicitly, the model implies a government spending multiplier that can be greater than one, if government debt is sufficiently scarce, or less than zero, if government debt is sufficiently plentiful. Even if monetary policy keeps the nominal interest rate at zero forever, it can be optimal for the fiscal authority to keep government debt scarce so as to provide more public goods, at the expense of efficiency in the private sector. This is analogous to the inefficiency that occurs as the result of the inflation tax. But in this context, the nominal interest rate is zero, which in many mainstream models will imply deflation.

There are two important takeaways from this paper. First, specifying an intertemporal government budget constraint is not enough to tell us the determinants of the price level and inflation. If we followed the logic of the extreme FTPL view, then any economic entity – a firm, for example – that possesses an intertemporal budget constraint and has nominally-denominated debt outstanding could determine the price level. Second, the insight from the FTPL, that the valuation of public liabilities is analogous to asset pricing, is a useful one. But then it is important to think about rational-bubble phenomena, with respect to public liabilities. That is, public liabilities can be valued for more than their fundamental payoffs. This is well-understood for assets we traditionally consider "money," bet possibly not well-understood for interest-bearing government debt.

Recent related work includes Bassetto and Cui (2017), Berentsen and Waller (2017), and Dominguez and Gomis-Porqueras (2017). Each of these papers examines issues related to low real interest rates and the implications for FTPL ideas.

The remainder of the paper proceeds as follows. In the second section, a Fisherian model of inflation is constructed and used to explore some basic issues in price level and inflation determination. Then, in Section Three, the model is extended to include production and secured credit. This model is then used to study issues in fiscal and monetary policy arising from scarce safe assets and low real interest rates. Finally, the last section is a conclusion.

2 Fisherian Model

To focus on some basic ideas, it is useful to start with a simple model in which monetary factors matter only for inflation. In this section we will analyze an economy with exogenous endowments, implying exogenous real interest rates.

There is a unit-mass continuum of households, each of which maximizes

$$\sum_{t=0}^{\infty} \beta^t u(c_t),$$

where $0 < \beta < 1$ and $u(\cdot)$ is strictly increasing, strictly concave, and twice differentiable, with $u'(0) = \infty$. Here, c_t denotes consumption in period t.

The fiscal authority issues one-period nominal debt, with B_t denoting the quantity of bonds issued in period t, each of which is a claim to R_t units of money in period $t+1$. Also, the fiscal authority can distribute lump sum transfers to each household in equal amounts, or can tax each household lump sum, with τ_t denoting the lump sum transfer for each household in period t. The central bank has a monopoly on the issue of currency, and can also issue reserves, which are one-period claims to money in the next period. Reserves and government debt are identical claims to money in the next period, so one unit of reserves is also a claim to R_t units of money in the next period. Let E_t and M_t, respectively, denote the quantity of currency and the quantity of reserves at the beginning of the period, in nominal terms. At the beginning of the period, currency and reserves are assumed to be convertible one-for-one at the central bank.

Let P_t denote the price of consumption in terms of currency, with $\pi_t = \frac{P_t}{P_{t-1}}$ denoting the gross inflation rate. Letting lower case denote quantities in real terms, a household enters period t with e_{t-1} units of currency, m_{t-1} units of reserves, and b_{t-1} units of bonds, each acquired in the previous period, and defined in units of the period $t-1$ consumption good. Then, assets pay off, and the household trades on the asset market, where it acquires bonds and reserves which will be held until period $t+1$. Following this, each household receives an exogenous endowment of perishable consumption goods y_t. Households cannot consume their own endowments, and exchange currency for consumption goods on a competitive market. There is assumed to be no memory in exchange involving purchases of goods, so household-issued IOUs are not accepted in payment. As well, neither government bonds nor reserves are accepted in payment, as these assets are electronic data entries that cannot be verified by households selling goods. We will extend our model to include transactions using credit, but for our arguments in this section it does little or no harm to restrict attention to exchange involving currency only.

After goods exchange occurs, the households carries currency e_t, reserves m_t, and government bonds b_t into the next period, with each quantity defined in units of the period t consumption good.

2.1 A Private Central Bank

To understand fiscal/monetary interaction, it helps to start with a thought experiment – an institutional environment in which there is no explicit fiscal/monetary interaction. So, suppose first that the central bank is a private entity, as some central banks have been – the Bank of England before 1946, for example. The central bank has a monopoly on the issue of currency, and it can make loans to private households. Suppose also that households possess shares in the central bank, and that these shares pay dividends each period. We will assume that the shares are not traded, but this assumption is innocuous. Shares in the central bank are uniformly distributed across households.

In real terms, the central bank's budget constraints are given by

$$e_0 + m_0 - l_0 = d_0, \tag{1}$$

$$e_t + m_t - l_t = \frac{e_{t-1}}{\pi_t} + (m_{t-1} - l_{t-1})\frac{R_{t-1}}{\pi_t} + d_t, \text{ for } t = 1, 2, 3, ... \tag{2}$$

Here, d_t denotes the dividend per household in period t. Thus, in equation (1), the central bank issues currency and reserves, makes loans, and pays out the residual as a dividend to households. In each succeeding period, the central bank receives the payments on its loans from the previous period, adjusts outstanding currency and reserves, makes new loans, and pays out the remaining funds as dividends to households.

The fiscal authority is completely independent of the central bank and has budget constraints

$$b_0 = \tau_0, \tag{3}$$

$$b_t = b_{t-1}\frac{R_t}{\pi_t} + \tau_t, \text{ for } t = 1, 2, 3, ... \tag{4}$$

That is, in period 0, the fiscal authority issues government debt and makes a corresponding transfer to households. Then, in each succeeding period, the debt is paid off, new debt is issued, and the net proceeds are issued as a household transfer.

The household's asset market constraint is

$$b_t + m_t - l_t + c_t \leq (b_{t-1} + m_{t-1} - l_{t-1})\frac{R_{t-1}}{\pi_t} + \frac{e_{t-1}}{\pi_t} + d_t + \tau_t, \tag{5}$$

On the right-hand side of inequality (5), at the beginning of the period the household has net wealth given by the payoffs on government bonds and reserves, minus what it takes to pay off loans to the central bank, plus currency held over from the previous period, plus the central bank dividend, plus the transfer from the fiscal authority. On the left-hand side of inequality (5), the household purchases government bonds and reserves, receives central bank loans, and purchases consumption goods with currency.

The household's budget constraint is

$$b_t + m_t - l_t + c_t + e_t \leq y_t + (b_{t-1} + m_{t-1} - l_{t-1})\frac{R_{t-1}}{\pi_t} + \frac{e_{t-1}}{\pi_t} + d_t + \tau_t \tag{6}$$

where we have accounted for current income y_t on the right-hand side of the inequality (6), and end-of-period money holdings m_t on the left-hand side of the inequality.

In equilibrium,

$$c_t = y_t \tag{7}$$

Therefore, from the household's problem and (7), we get

$$-u'(y_t) + \beta \frac{u'(y_{t+1})R_t}{\pi_{t+1}} = 0 \tag{8}$$

As well, from (1), (2), (5), (3), (4), and (7), assuming the asset market constraint holds with equality,

$$e_t = y_t. \tag{9}$$

Then, we can write the present value of central bank dividends as

$$\sum_{t=0}^{\infty} \frac{\beta^t u'(y_t)d_t}{u'(y_0)} = \sum_{t=0}^{\infty} \frac{\beta^t u'(y_t)y_t}{u'(y_0)} \left(1 - \frac{1}{R_t}\right), \tag{10}$$

which assumes the no-Ponzi-scheme condition,

$$\lim_{t\to\infty} \frac{\beta^t u'(y_t)\left(e_t + m_t - l_t\right)}{u'(y_0)} = 0.$$

Equation (10) states that the present value of central bank dividends is equal to the present value of central bank profits, or seigniorage.

2.1.1 Independent Central Bank

In some previous research, for example Sargent and Wallace (1981) and Aiyagari and Gertler (1985), the fiscal authority is assumed to have some power over the central bank, and can force transfers from the central bank to the fiscal authority. These central bank transfers are then used to finance primary government deficits. For example, in Sargent and Wallace (1981), there is an upper limit on the government debt which, if it binds, implies that seigniorage needs to be generated to finance the deficit. Note that, in our institutional setup, the fiscal authority cannot require the central bank to transfer resources for the fiscal authority's use.

How does monetary policy work here? One way to structure the central bank's choices is to have it choose a sequence of nominal interest rates on central bank loans $\{R_t\}_{t=0}^{\infty}$, along with sequences of loans, currency, reserves, and dividends $\{l_t, e_t, m_t, d_t\}_{t=0}^{\infty}$ to support the nominal interest rate sequence. Given $\{R_t\}_{t=0}^{\infty}$ and exogenous endowments $\{y_t\}_{t=0}^{\infty}$, from (8) the sequence of inflation rates $\{\pi_t\}_{t=1}^{\infty}$ is determined by

$$\pi_t = \beta \frac{u'(y_t)R_{t-1}}{u'(y_{t-1})}, \tag{11}$$

which is just a Fisherian relationship. The sequence of real interest rates is exogenous, and so the current nominal interest rate determines the inflation rate in the next period. So, given $\{R_t\}_{t=0}^{\infty}$ and (11), $\{l_t, e_t, m_t, d_t\}_{t=0}^{\infty}$ must satisfy the sequence of budget constraints (1) and (2), and the present value of dividends must satisfy (10).

But what about determination of the price level in period 0, which we require to determine the sequence of price levels $\{P_t\}_{t=0}^{\infty}$? From (10), we can write

$$d_0 = -\sum_{t=1}^{\infty} \frac{\beta^t u'(y_t) d_t}{u'(y_0)} + \sum_{t=0}^{\infty} \frac{\beta^t u'(y_t) y_t}{u'(y_0)} \left(1 - \frac{1}{R_t}\right). \tag{12}$$

So, from (12), if the central bank specifies $\{R_t\}_{t=0}^{\infty}$ and the sequence of future real dividends $\{d_t\}_{t=1}^{\infty}$, and also specifies the nominal dividend in the first period, D_0, then the price level is determined as

$$P_0 = \frac{D_0}{-\sum_{t=1}^{\infty} \frac{\beta^t u'(y_t) d_t}{u'(y_0)} + \sum_{t=0}^{\infty} \frac{\beta^t u'(y_t) e_t}{u'(y_0)} \left(1 - \frac{1}{R_t}\right)} \tag{13}$$

So, the sequence of price levels is given by

$$P_t = P_0 \Pi_{s=1}^{t} \pi_s, \text{ for } t = 0, 1, 2, ... \tag{14}$$

Further, we require that $d_t \geq 0$ for all t, i.e. the central bank cannot impose a tax. As well, the central bank can control only the sum $e_t + m_t$ each period, and not its composition, as households can exchange currency for reserves one-for-one at the central bank at the beginning of the period. But, $e_t \geq y_t$, with $e_t = y_t$ if $R_t > 1$, as determined by the demand for currency, so the central bank's choice of total outside money, in real terms, must be at least as large as the endowment that must be purchased each period, i.e.

$$e_t + m_t \geq y_t, \tag{15}$$

for all t. But, as long as (15) is satisfied, then given the dividend and nominal interest rate policy of the central bank, increasing m_t in any period t by increasing l_t one-for-one is irrelevant, from (1) and (2). That is, there is a always a liquidity trap, in that expanding the central bank's balance sheet by increasing reserves is irrelevant, given the path for the nominal interest rate. The central bank loan rate and the interest rate on reserves are identical in equilibrium so, from the household's point of view, a one-for-one increase in central bank loans and reserves nets out.

A perpetual zero lower bound monetary policy, i.e. $R_t = 1$ for all t, is a special case that will be discussed later in this subsection.

What about fiscal policy? This setup for determination of prices and inflation by the central bank works so long as the fiscal authority does not somehow interfere with it. Assume the no-Ponzi-scheme condition

$$\lim_{t \to \infty} \beta^t \frac{u'(y_t)}{u'(y_0)} b_t = 0.$$

Then, (3), (4), and (8) imply

$$\sum_{t=0}^{\infty} \beta^t \frac{u'(y_t)}{u'(y_0)} \tau_t = 0 \tag{16}$$

Non-interference of the fiscal authority in central banking policy would be fiscal policy that sets the sequence of real transfers $\{\tau_t\}_{t=0}^{\infty}$ to satisfy (16), and then sets nominal transfers in response to central bank policy.

2.1.2 Dominant Fiscal Policy?

It might seem odd that the fiscal authority could somehow interfere with monetary policy, given this institutional setup. By assumption, the only connection between the government and the central bank is the monopoly power over currency issue that the government grants to the central bank as an initial endowment. The usual view of loss of independence for the central bank concerns situations where the government coerces transfers from the central bank, as in hyperinflations.

But, proponents of the FTPL might take another view. For example, from (3) and (4), we can write

$$b_t = -\sum_{s=t+1}^{\infty} \beta^{s-t} \frac{u'(y_s)}{u'(y_t)} \tau_s, \text{ for } t = 0, 1, 2, ..., \tag{17}$$

i.e. the current real value of the government debt is equal to the present value of future primary government surpluses – a standard FTPL relationship. Then, following FTPL logic, we could argue that, if $b_t = \frac{B_t}{P_t}$, where B_t is the value of the government debt in nominal terms, then if the fiscal authority commits to $\{\tau_t\}_{t=0}^{\infty}$ and to $\{B_t\}_{t=0}^{\infty}$, then from (17), this determines the price level path $\{P_t\}_{t=0}^{\infty}$, as long as

$$P_{t+1} \geq \frac{\beta u'(y_{t+1}) P_t}{u'(y_t)}, \text{ for } t = 0, 1, 2, 3, ...,$$

so that the implied nominal interest rate is nonnegative.

While this certainly does not break any of the rules of formal economic modeling, and provides part of an internally consistent description of what is exogenous, what is endogenous, and how equilibrium quantities and prices are determined, there is nothing in the economics of the problem that leads us to this conclusion. And it is perhaps damning that the FTPL approach works just as well in this context, in which the central bank is as independent as we might imagine, as it does in any other.

To clarify the problems with the FTPL here, suppose any private entity large or small, which issues debt in nominal terms, backed by future payoffs to which this entity commits, in real terms. If the private entity commits to the real stream of future payoffs, and to the current nominal value of the debt, it must determine the price level. If we do not take that argument seriously, we should not take seriously the FTPL in this context.

In this institutional context, the central bank has a monopoly on the issue of currency, and is disconnected from fiscal policy. Thus, it seems hard to argue that the fiscal authority's commitment to paths for transfers and nominal government debt could drive the behavior of the central bank.

This example shows how fiscal support is not necessary for central banking to "work," i.e. for the central bank to have control over prices and inflation. Indeed, the Federal Reserve System was founded as a quasi-private set of regional banks with the power to set their own lending rates, and to inject outside money into the economy through discount window lending. The current monetary system in the United States, whereby monetary control occurs through open market operations, evolved beginning in the 1920s, and was not envisioned by the initial framers of the Federal Reserve Act. It would have made no sense to write down a consolidated government budget constraint for the U.S. Treasury and the Federal Reserve System circa 1914.

2.2 Central Banking Integrated with the Fiscal Authority

In this subsection, we will consider an institutional structure that captures the essence of central banking as it exists currently in most rich countries. We will allow the central bank to conduct open market operations in government debt, and assume that, instead of paying dividends to private sector agents, the central bank makes transfers to the fiscal authority. It is important to note that one key central bank in the world, the European Central Bank, does not operate this way. The ECB does not intervene day-to-day using open market operations, but through central bank lending ("financing operations"), though the ECB does hold some government debt of its member countries.

Rewrite the central bank's budget constraints as

$$e_0 + m_0 = l_0 + \bar{b}_0 - b_0 + d_0, \tag{18}$$

$$e_t + m_t - l_t - \bar{b}_t + b_t = \frac{e_{t-1}}{\pi_t} + (m_{t-1} - \bar{b}_{t-1} + b_{t-1} - l_{t-1})\frac{R_{t-1}}{\pi_t} + d_t, \text{ for } t = 1, 2, 3, ... \tag{19}$$

where $\bar{b}_t$ denotes the quantity of government debt issued by the fiscal authority in period t, and b_t denotes government debt held by households, so $\bar{b}_t - b_t$ is the quantity of government debt held by the central bank in period t. In this case, d_t is no longer a dividend paid to households, but the real transfer from the central bank to the fiscal authority. As well, rewrite the fiscal authority's budget constraints as

$$\bar{b}_0 = \tau_0 - d_0, \tag{20}$$

$$\bar{b}_t = \bar{b}_{t-1}\frac{R_t}{\pi_t} + \tau_t - d_t, \text{ for } t = 1, 2, 3, ... \tag{21}$$

Then, given (20), (21), (1), and (2), we can write consolidated government budget constraints as

$$e_0 + m_0 + b_0 - l_0 = \tau_0, \tag{22}$$

$$e_t + m_t + b_t - l_t = \frac{e_{t-1}}{\pi_t} + (m_{t-1} + b_{t-1} - l_{t-1})\frac{R_{t-1}}{\pi_t} + \tau_t, \text{ for } t = 1, 2, 3, ... \quad (23)$$

Next, from (22) and (23) we can write the present value of transfers from the fiscal authority to households as

$$\sum_{t=0}^{\infty} \beta^t \frac{u'(y_t)}{u'(y_0)} \tau_t = \sum_{t=0}^{\infty} \frac{\beta^t u'(y_t) e_t}{u'(y_0)} \left(1 - \frac{1}{R_t}\right),$$

or, from (22), and (9),

$$e_0 + m_0 + b_0 - l_0 = -\sum_{t=1}^{\infty} \beta^t \frac{u'(y_t)}{u'(y_0)} \tau_t + \sum_{t=0}^{\infty} \frac{\beta^t u'(y_t) y_t}{u'(y_0)} \left(1 - \frac{1}{R_t}\right) \quad (24)$$

Equation (24) states that the initial real value of consolidated government liabilities, on the left-hand side, is equal to minus the present value of future transfers, plus the present value of central bank profits.

2.2.1 Independent Central Bank

An institutional setup that will support central bank independence is to have the fiscal authority set the path for taxes so as to finance the interest payments on the debt it issues, so that

$$\bar{b}_0 = -\sum_{t=1}^{\infty} \beta^t \frac{u'(y_t)}{u'(y_0)} \tau_t. \quad (25)$$

Then, from (24), we get

$$e_0 + m_0 + - \left(\bar{b}_0 - b_0\right) - l_0 = \sum_{t=0}^{\infty} \frac{\beta^t u'(y_t) y_t}{u'(y_0)} \left(1 - \frac{1}{R_t}\right). \quad (26)$$

Then, the net liabilities of the central bank at the first date, on the left-hand side of (26), equals the present value of central bank profits, on the right-hand side of (26). An interpretation of this institutional setup is that this separates the valuation of the liabilities of the central bank from the valuation of the liabilities of the fiscal authority. As well, from (26), and (18),

$$d_0 = \sum_{t=0}^{\infty} \frac{\beta^t u'(y_t) y_t}{u'(y_0)} \left(1 - \frac{1}{R_t}\right), \quad (27)$$

so the entire present value of central bank profits is transferred to the fiscal authority on the first date (as otherwise central bank profits would affect the valuation of government debt).

This institution works analogously to the private benevolent central bank, with the only difference being that the central bank can lend to the fiscal authority by holding government debt. From (27), $\{R_t\}_{t=0}^{\infty}$ determines d_0, and then the sequence of price levels $\{P_t\}_{t=0}^{\infty}$ can be determined by the nominal transfer from the central bank to the fiscal authority in the first period, i.e. $P_0 = \frac{D_0}{d_0}$. Then $\{P_t\}_{t=0}^{\infty}$ is determined by (11) and (14). So a central bank that is independent, in this sense, functions in a similar way to the private benevolent central bank. The fiscal authority preserves central bank independence by not making use of central bank transfers to service its debt, or to finance spending.

2.2.2 Non-Independent Central Bank

How might we have a departure from central bank independence in this context? Typically, a central bank that has lost its independence is described as "monetizing the debt." This may be necessary for the loss of central bank independence, but is it sufficient? Suppose, at the extreme, that the fiscal authority can force the central bank to purchase all of the government debt in each period, so $b_t = 0$ for all t. Then, in equation (24), the initial real value of net central bank liabilities is determined by the present value of future taxes plus the present value of the stream of central bank profits,

$$e_0 + m_0 - l_0 = -\sum_{t=1}^{\infty} \beta^t \frac{u'(y_t)}{u'(y_0)} \tau_t + \sum_{t=0}^{\infty} \frac{\beta^t u'(y_t) y_t}{u'(y_0)} \left(1 - \frac{1}{R_t}\right) \tag{28}$$

This need not cause a loss of central bank independence, however. For any given exogenous path for the future sequence of transfers $\{\tau_t\}_{t=1}^{\infty}$, set by the fiscal authority, from (28) the central bank can set any arbitrary path for nominal interest rate $\{R_t\}_{t=0}^{\infty}$, thus generating a positive present value for central bank profits on the right-hand side of (28). This then determines the right-hand side of (28), and implies a particular value for net central bank liabilities on the left-hand side of (28). But, since the real demand for currency at the first date is y_0, which is exogenous, all of the adjustment must happen in net interest-earning liabilities $m_0 - l_0$. Since (27) still holds, even with debt monetization, the sequence of price levels can be determined in exactly the same way as with an independent central bank.

That is, the "monetization" of the debt could amount only to a transfer of interest-bearing liabilities from the fiscal authority to the central bank, and therefore be inconsequential. For example, hyperinflationary periods are sometimes interpreted (e.g. Sargent 1982) as ones in which central banks lose independence and are forced to monetize government debt. But large "monetizations" have occurred recently in which central banks in Japan, the United States, Switzerland, the Euro area, and Sweden, for example, accomplished large expansions in their balance sheets, in part by converting government debt to bank reserves. These central bank balance sheet expansions certainly did not cause hyperinflations. If anything, the central bankers who carried out the government debt monetization seemed puzzled that this did not cause more inflation than it did. But that is entirely consistent with (28) and with what determines inflation in this model.

What could cause a loss of central bank independence that has some consequences for prices and inflation? Suppose for example that the fiscal authority prohibits the payment of interest on central bank reserves, which implies that $m_t = 0$ for all t, so long as $R_t > 1$ for all t. Also, suppose that central bank lending is prohibited, so $l_t = 0$ for all t. Then, from (22), $\tau_0 = y_0$. Given these restrictions on what the central bank can do, if the fiscal authority sets a sequence of future transfers $\{\tau_t\}_{t=1}^{\infty}$ such that

$$-\sum_{t=1}^{\infty}\beta^t\frac{u'(y_t)}{u'(y_0)}\tau_t < y_0,$$

then the central bank is forced to generate a sufficient flow of central bank profits so that (28) holds. In this context, an out-of-control fiscal authority is one that wants a high present value of transfers, which have to be financed with high central bank profits, i.e. high nominal interest rates, which are associated with high inflation. Here, the key issue is not how the initial price level P_0 is determined, but whether or not the central bank can be constrained to finance spending by the fiscal authority, through inflation.

Helicopter Drops A helicopter drop, as first envisioned by Friedman (1969), is an issue of government debt by the fiscal authority, which is then purchased by the central bank. In recent times, helicopter drops have been suggested as a solution to chronic undershooting of central bank inflation targets (see for example Bernanke 2016 and Turner 2015).

Those who promote helicopter drops as a solution to a low-inflation problem must be thinking in terms of a tightly constrained central bank. As we have shown, a central bank with sufficient flexibility need not increase nominal interest rates and inflation, even though it is forced to convert government debt into central bank liabilities. If the central bank chooses to keep nominal interest rates low, then it can simply transform the government debt into interest-bearing central bank liabilities, with no implications for inflation. However, if the fiscal authority forces the central bank to make a stream of positive transfers to the fiscal authority, the central bank has no choice but to increase interest rates an inflation so as to generate the required central bank profits. Thus, high inflation driven by a lack of central bank independence is not about debt monetization but about forced transfers from the central bank to the fiscal authority.

3 Secured Credit and Scarce Collateral

What we can say about fiscal/monetary policy interaction with a pure Fisherian model is limited, particularly given that the real interest rate is exogenous in the above example. An important contemporary policy issue relates to persistently low real interest rates, the causes of this phenomenon, and the implications for monetary and fiscal policy (see for example Bassetto and Cui 2017). In this section, we will extend the model, by allowing for production, along with a role for government debt in securing credit transactions. This allows us to explore some interesting issues as, if the real interest rate is low for reasons that relate to a special role for government debt, then the economy can be non-Ricardian, and some "standard" elements of fiscal-monetary interaction change.

The model is related to those in Andolfatto and Williamson (2015) and Williamson (2017c). There is a continuum of households with unit mass, and each household has a unit mass of consumers. There are two markets on which these consumers purchase goods: the *cash market* and the *credit market.* Each period, a fraction θ of consumers in a household each learns that he or she will purchase goods in the cash market, and $1-\theta$ learn they will purchase goods in the credit market. Here $0 < \theta < 1$. Each consumer receives assets from the household, goes to the assigned market, purchases goods, and consumes on the spot. In the cash market, only currency is accepted in exchange, and in the credit market sellers will accept currency or within-period credit secured by government debt. That is, in both markets the sellers of goods have no access to buyers' histories, so unsecured credit is not a possibility. As well, in the cash market sellers do not have access to the technology which would allow them to evaluate collateral posted by buyers, whereas this technology is available in the credit market.

We use the large-household setup as a convenient stand-in for financial intermediary relationships. In other work, for example Williamson (2016, 2017a, 2017b), banks are modeled explicitly, and government debt plays a similar role, within a Lagos-Wright (2005) structure. In Williamson (2016, 2017a, 2017b), risk associated with transactions is shared through banking contracts and banks have relationships with the central bank, with households holding government debt and reserves indirectly, by holding financial intermediary deposits. In the current model, risk sharing happens within the household, and households hold reserves and take out central bank loans directly. There are some advantages in the current context to using a large-household construct; in particular this allows us to tie the results more closely to what we get in standard representative agent frameworks.

One member of the household is a worker/seller who supplies n_t units of labor to produce n_t consumption goods, which can be sold on the cash market or the credit market. The household cannot consume its own output, and a consumer cannot share consumption within the household.

The representative household maximizes

$$\sum_{t=0}^{\infty} \beta^t \left[\theta u(c_t^m) + (1-\theta) u(c_t^b) - n_t \right], \tag{29}$$

where c_t^m denotes the consumption of consumers who purchase goods in the cash market, and c_t^b is consumption of consumers who purchase goods in the credit market.

We will assume that the institutional setup is the same as the last one considered in the Fisherian model. That is, the central bank turns over its profits to the fiscal authority each period, and the central bank can conduct open market operations.

The asset market constraint for the household is

$$b_t + m_t - l_t + \theta c_t^m + e_t' \leq (b_{t-1} + m_{t-1} - l_{t-1}) \frac{R_{t-1}}{\pi_t} + \frac{e_{t-1}}{\pi_t} + \tau_t, \qquad (30)$$

Here, e_t' denotes currency provided by the household to consumers to purchase goods in the credit market. So, (30) states that, on the right-hand side of the inequality, available wealth at the beginning of the period consists of the payoffs on government bonds and reserves, minus what it takes for the household to pay off loans from the previous period, plus currency carried over from the previous period, plus the transfer from the government, respectively. On the left-hand side of (30), the household purchases government bonds and reserves to hold over until the following period, and holds sufficient currency for purchases by the household's consumers on the cash market, and possibly for purchases by the household's consumers on the credit market, respectively.

Consumers purchase credit market goods with currency and IOUs that come due at the end of the period. These IOUs must be secured with government debt. The household must then meet a collateral constraint

$$(1-\theta)c_t^b \leq e_t' + R_t \left(b_t + m_t - l_t\right), \qquad (31)$$

so the household must post enough collateral so that it does not have the incentive to run away from its IOUs at the end of the period. On the right-hand side of the constraint (31), currency brought to the credit market is exchanged for goods, but government bonds and reserve balances, minus central bank loans, are posted as collateral (net obligations of the public sector to the household are accepted as collateral), and can be seized by the lender should the household abscond at the end of the period. The net value of collateral to the household at the end of the period is $R_t \left(b_t + m_t - l_t\right)$, in units of period t goods.

The household's budget constraint is given by

$$b_t + m_t - l_t + \theta c_t^m + (1-\theta) c_t^b + e_t \leq n_t + (b_{t-1} + m_{t-1} - l_{t-1}) \frac{R_{t-1}}{\pi_t} + \frac{e_{t-1}}{\pi_t} + \tau_t. \qquad (32)$$

On the right-hand side of the inequality (32), available wealth for the household is, respectively, the current output of the household, which is sold to other households, plus the net payoff on government and central bank obligations at the beginning of the period, plus currency held over from the previous period, plus the transfer from the government. On the left-hand side, respectively, the household purchases government debt and reserves, receives loans from the central bank, purchases goods on the cash and credit markets, and acquires currency that is held over until the next period.

The household chooses $\left\{c_t^m, c_t^b, n_t, b_t, m_t, l_t, e_t'\right\}_{t=0}^{\infty}$ to maximize (29) subject to (30)-(32), given $b_{-1} = m_{-1} = l_{-1} = 0$.

From the household's problem, the first-order conditions can be written as

$$u'(c_t^m) = R_t u'(c_t^b), \qquad (33)$$

$$1 = \beta \frac{u'(c_{t+1}^m)}{\pi_{t+1}}, \tag{34}$$

$$u'(c_t^m) = R_t[u'(c_t^b) - 1] + \beta \frac{u'(c_{t+1}^m) R_t}{\pi_{t+1}}. \tag{35}$$

In equilibrium, total consumption is equal to total output,

$$\theta c_t^m + (1-\theta) c_t^b = n_t, \tag{36}$$

and total net outside assets held by the representative household represent an upper bound on total expenditure (with expenditure in the credit market appropriately discounted),

$$\theta c_t^m + \frac{(1-\theta)}{R_t} c_t^b \leq e_t + b_t + m_t - l_t. \tag{37}$$

The consolidated government budget constraints are (22) and (23).

For the household, from (22), (23), (33), and (34), the present value of transfers is given by

$$\sum_{t=0}^{\infty} \frac{\beta^t u'(c_t^m) \tau_t}{u'(c_0^m)} = \sum_{t=0}^{\infty} \frac{\beta^t}{u'(c_0^m)} \left\{ e_t \left[u'(c_t^m) - 1 \right] + (m_t + b_t - l_t) R_t \left[u'(c_t^b) - 1 \right] \right\}, \tag{38}$$

assuming that

$$\lim_{t \to \infty} \frac{\beta^t u'(c_t^m) (e_t + m_t + b_t - l_t)}{u'(c_0^m)} = 0.$$

To understand (38), first note that we can rewrite (34) and (35) as asset pricing relationships for currency and government bonds, respectively. That is,

$$1 = \underbrace{\frac{\beta u'(c_{t+1}^m)}{\pi_{t+1} u'(c_t^m)} \left[u'(c_t^m) - 1 \right]}_{\text{liquidity premium}} + \underbrace{\frac{\beta u'(c_{t+1}^m)}{\pi_{t+1} u'(c_t^m)}}_{\text{fundamental}} \tag{39}$$

$$\frac{1}{R_t} = \underbrace{\frac{1}{u'(c_t^m)} \left[u'(c_t^b) - 1 \right]}_{\text{liquidity premium}} + \underbrace{\frac{\beta u'(c_{t+1}^m)}{\pi_{t+1} u'(c_t^m)}}_{\text{fundamental}} \tag{40}$$

In equation (39) the left-hand side is the price of currency in terms of currency, which is unity. On the right-hand side of the equation, the fundamental is the household's current valuation of the intrinsic payoff to currency in the next period, which is the discounted value of money after accounting for inflation. The liquidity premium captures the extra liquidity services from holding currency – the liquidity premium – which is proportional to the inefficiency wedge in the cash market, $u'(c_t^m) - 1$. That is, the marginal social disutility of producing a unit of output is one, given quasilinear preferences, so inefficiency in the market in which currency is traded for goods is captured by the difference between the marginal utility of consumption and unity. Similarly, in equation (40) the fundamental payoff on nominal government debt is the same as for currency, and is valued by the household in exactly the same way, but the liquidity premium is different, and is proportional to the inefficiency wedge in the credit market, $u'(c_t^b) - 1$.

Then, in equation (38), the departure from the standard FTPL formula is caused by what unhinges the prices of currency and government debt from their fundamentals in equations (39) and (40). That is, the right-hand side of (38) is increasing in the inefficiency wedges $u'(c_t^m) - 1$ and $u'(c_t^b) - 1$, and the right-hand side goes to zero when these inefficiency wedges disappear.

On the right-hand side of (38), the first term,

$$\sum_{t=0}^{\infty} \frac{\beta^t}{u'(c_0^m)} e_t \left[u'(c_t^m) - 1 \right],$$

corresponds to the what we called central bank profits in the Fisherian model, though a positive nominal interest rate did not cause any inefficiency in the Fisherian model, since consumption was fixed in that context. Here, the central bank makes profits when the nominal interest is positive, and this is reflected in a typical inefficiency in the cash market. A higher nominal interest rate implies that households economize more on cash, reducing cash purchases and increasing the inefficiency wedge in the cash market, $u'(c_t^m) - 1$. The second term on the right-hand side of (38),

$$\sum_{t=0}^{\infty} \frac{\beta^t}{u'(c_0^m)} \left(m_t + b_t - l_t \right) R_t \left[u'(c_t^b) - 1 \right]$$

is more unconventional, though its interpretation is closely related to that for central bank profits. If the household's collateral constraint binds, then there is a positive inefficiency wedge in the credit market, i.e. $u'(c_t^b) > 1$. Thus, a shortage of currency, in real terms, creates an inefficiency wedge in the cash market, and a shortage of government debt, in real terms, creates an inefficiency wedge in the credit market.

Then, if we write (38) in the usual FTPL fashion, using (30) and (31), we get

$$\begin{aligned} & e_0 + m_0 + b_0 - l_0 \\ = \quad & -\sum_{t=1}^{\infty} \frac{\beta^t u'(c_t^m)\tau_t}{u'(c_0^m)} + \sum_{t=0}^{\infty} \frac{\beta^t}{u'(c_0^m)} \left\{ \theta c_t^m \left[u'(c_t^m) - 1 \right] + (1-\theta) c_t^b \left[u'(c_t^b) - 1 \right] \right\} \end{aligned} \tag{41}$$

In (41), the left-hand side of the equation is the initial real value of consolidated government debt and, as in (38), the second term on the right-hand side reflects liquidity premia on currency and government debt, and the associated inefficiencies in markets in which these assets support exchange. We have modified the second-term on the right-hand side so that consumption quantities weight the inefficiency wedges. Or, in other words, we can think of equation (41) as a valuation equation for consolidated government liabilities, where we need to take account not only of the fundamental payoffs on government debt (future primary government surpluses), but also the liquidity premia on consolidated government liabilities (government debt, reserves, and currency).

It is also useful to determine the price of government debt which is a claim to consumption, if this real government debt has the same collateral role that we have modeled here for nominal government debt. That is, if r_t is the real interest rate, then from (39) and (40), we obtain

$$\frac{1}{r_t} = \frac{\beta u'(c_{t+1}^m) u'(c_t^b)}{u'(c_t^m)}, \tag{42}$$

so the price of real government debt exceeds its fundamental value if and only if $u'(c_t^b) > 1$, i.e. if and only if there is inefficiency in the credit market. That is, the real interest rate is low due to binding collateral constraints, reflected in inefficiency in the credit market.

3.1 Monetary and Fiscal Policy

How we specify policy in this model matters, but a convenient approach is to follow Andolfatto and Williamson (2015), and Williamson (2016, 2017a, 2017b). That is, the fiscal authority is assumed to determine exogenously the path for the real quantity of consolidated net government debt. So, the fiscal authority sets $\{v_t\}_{t=0}^{\infty}$ exogenously, where

$$v_t = e_t + b_t + m_t - l_t. \tag{43}$$

This implies that the sequence of transfers $\{\tau_t\}_{t=0}^{\infty}$, from (22), (23) and (34), is given by

$$\tau_0 = v_0, \tag{44}$$

$$\tau_t = v_t + \frac{e_{t-1}(R_{t-1} - 1)}{\beta u'(c_t^m)} - v_{t-1} \frac{R_{t-1}}{\beta u'(c_t^m)}, \text{ for } t = 1, 2, 3, ... \tag{45}$$

Thus, in order to achieve a particular exogenous path for the real net consolidated government debt, the path for taxes will have to adjust to monetary policy, which we will specify as a sequence of nominal interest rates $\{R_t\}_{t=0}^{\infty}$. With this policy structure, the fiscal authority determines the total real quantity of consolidated government debt, while the central bank determines the composition of consolidated government debt through open market operations, so as to achieve a particular path for the nominal interest rate.

Then, given fiscal policy $\{v_t\}_{t=0}^{\infty}$ and monetary policy $\{R_t\}_{t=0}^{\infty}$, we can solve for $\{c_t^m, c_t^b\}_{t=0}^{\infty}$ from (33) and (37), period-by-period. That is,

$$u'(c_t^m) = R_t u'(c_t^b) \tag{46}$$

and either

$$u'(c_t^b) = 1 \text{ and } \theta c_t^m + \frac{(1-\theta)}{R_t} c_t^b \leq v_t, \tag{47}$$

or

$$u'(c_t^b) > 1 \text{ and } \theta c_t^m + \frac{(1-\theta)}{R_t} c_t^b = v_t, \tag{48}$$

solves for c_t^m and c_t^b. Equation (46) is a marginal rate of substitution condition for goods purchased on the cash and credit markets, which must hold in each period. Conditions (47) and (48) state that there must either be efficiency in the credit market with a nonbinding household collateral constraint, or there is inefficiency in the credit market and a binding collateral constraint.

3.1.1 Collateral Constraint Does Not Bind

Suppose first that the collateral constraint does not bind for all t. This implies $c_t^b = c^*$, where c^* solves $u'(c^*) = 1$. As well, from (46), c_t^m satisfies

$$u'(c_t^m) = R_t. \tag{49}$$

Then, if we follow a FTPL approach to rewriting the intertemporal consolidated government budget constraint, from (41), (46), and (47),

$$v_0 = -\sum_{t=1}^{\infty} \frac{\beta^t R_t \tau_t}{R_0} + \sum_{t=0}^{\infty} \frac{\beta^t}{R_0} \left\{ \theta c_t^m \left[R_t - 1 \right] \right\}. \tag{50}$$

Given our policy regime, fiscal policy determines the left-hand side of (50) whereas, given (49), monetary policy determines the second term on the right-hand side of (50). This implies that the first term on the right-hand side of (50) – the present value of primary government surpluses – must be adjusted by the fiscal authority in response to monetary policy.

Suppose that

$$v_t \geq c^*, \text{ for all } t. \tag{51}$$

We can then show that, if (51) holds, then monetary policy is unconstrained by fiscal policy or, what amounts to the same thing, collateral constraints do not bind for any t, and for any monetary policy. To see this, note first that (51) implies that, if $R_t = 1$, then in equilibrium $c_t^m = c_t^b = c^*$, and the inequality in (47) holds. But then, given (49), the constraint in (47) is satisfied for any $R_t > 1$. As a result, for any nominal interest rate path $\{R_t\}_{t=0}^{\infty}$, c_t^m solves (49), $c_t^b = c^*$, and the inequality in (47) is satisfied. Thus there are no constraints on monetary policy, and from (34) and (49), inflation is determined in Fisherian fashion by

$$\pi_t = \beta R_t,$$

so the central bank can determine any path for inflation that it wants, provided $\pi_t \geq \beta$. Of course, monetary policy has implications for the real allocation and, in standard fashion, an optimal monetary policy is the Friedman rule, i.e. $R_t = 1$ for all t.

Thus, provided that the fiscal authority provides enough government debt, in real terms, the central bank is unconstrained. In other words, provided the fiscal authority does not create a scarcity of safe assets, collateral constraints will never bind and the central bank can conduct open market operations so as to achieve any inflation path it wants, provided inflation is always greater than minus the rate of time preference.

3.1.2 Binding Collateral Constraints

Collateral constraints will bind when the real value of consolidated government debt is low, that is when there is a shortage of safe assets, due to actions of the fiscal authority. To understand the basic implications of binding collateral constraints, consider stationary policies, i.e. $v_t = v$ for all t, and $R_t = R$ for all t. Assume that (51) does not hold. Then, we can show that collateral constraints bind for $R \in [1, \hat{R})$, where, from (46) and (48), $(\hat{R}, \hat{c})$ solves

$$u'(\hat{c}) = \hat{R},$$

$$\theta\hat{c} + \frac{(1-\theta)c^*}{\hat{R}} = v.$$

That is, consumption in the credit market c^b is strictly increasing in the nominal interest rate, and ultimately there is some finite $R = \hat{R}$ such that the collateral constraint ceases to bind, with $\hat{c}$ the level of consumption in the cash market when the constraint ceases to bind.

Therefore, if $R \in [1, \hat{R})$ then in the resulting stationary equilibrium, with $c_t^m = c^m$, and $c_t^b = c^b$ for all t, from (46) and (48), (c^m, c^b) solves

$$u'(c^m) = Ru'(c^b) \tag{52}$$

$$\theta c^m + \frac{(1-\theta)}{R}c^b = v \tag{53}$$

Then, in this equilibrium, from (42) the gross real interest rate is given by

$$r = \frac{1}{\beta u'(c^b)} \tag{54}$$

So, the binding collateral constraints make the real interest rate low, as $u'(c^b) > 1$ when the constraint binds. From (52) and (53) the real interest rate increases as R increases, in this equilibrium, as an increase in the nominal interest rate causes substitution toward purchases in the credit market. The real interest rate increases from $r = \frac{1}{\beta u'(v)}$ when $R = 1$ to $r = \frac{1}{\beta}$ when $R = \hat{R}$.

Provided that $-c\frac{u''(c)}{u'(c)} < 1$, which implies that substitution effects dominate income effects with respect to the effects of the nominal interest rate on the demand for consumption of goods in the cash market, (34) implies that the inflation rate increases with the nominal interest rate when the collateral constraint binds.[1] But this effect is less than one-for-one, as the real interest rate increases when the nominal interest rate increases.

[1] The assumption that $-c\frac{u''(c)}{u'(c)} < 1$ essentially implies that asset demand is increasing in the rate of return on the asset. This assumption seems innocuous, and it will sharpen our comparative statics results and make the analysis more straightforward. In some cases this will only be a sufficient condition for a particular result, so it is not always a strong assumption.

As well, from (44)-(46), we can back out the stream of transfers that supports the fiscal policy, given monetary policy. That is, $\tau_0 = v$, and $\tau_t = \tau$, a constant, for $t = 1, 2, 3, ...$, where

$$\tau = \frac{\theta c^m}{\beta u'(c^m)} \left[\beta u'(c^m) - 1\right] + \frac{(1-\theta)c^b}{\beta R u'(c^b)} \left[\beta u'(c^b) - 1\right] \tag{55}$$

Then, in (55), τ is the per-period transfer in periods $t = 1, 2, 3, ...$, that supports consolidated government debt v forever, $R_t = R$ for all t, and (c^m, c^b) solving (52) and (53). Thus, note from (55) that with sufficient inefficiencies in the cash and credit markets, i.e. sufficiently large $u'(c^m)$ and $u'(c^b)$, fiscal and monetary policy can support positive transfers forever. And this can occur even if $R = 1$, so that the nominal interest rate is zero. That is, given $R = 1$, from (52) and (53), $c^m = c^b = v$, and (55) give

$$\tau = \frac{v}{\beta u'(v)} \left[\beta u'(v) - 1\right] \tag{56}$$

So, from (56), $\tau > 0$ if and only if $v < \hat{v}$, where $\hat{v}$ solves $u'(\hat{v}) = \frac{1}{\beta}$. In this case, with zero-lower-bound monetary policy forever, fiscal policy can support strictly positive transfers forever provided that the real interest rate is negative, from (54). The real interest rate is negative if the consolidated government debt is sufficiently small, implying that the liquidity premium on government debt is sufficiently large.

It is also useful to determine the present value of transfers in this equilibrium. Since $\tau_0 = v$ and given (55), the present value of transfers at date 0 is

$$\sum_{t=0}^{\infty} \beta^t \tau_t = \frac{1}{1-\beta} \left\{ \frac{\theta c^m}{u'(c^m)} \left[u'(c^m) - 1\right] + \frac{(1-\theta)c^b}{R u'(c^b)} \left[u'(c^b) - 1\right] \right\}. \tag{57}$$

So, if there is an inefficiency in the cash market, or in the cash and credit markets, then the present value of transfers is strictly positive. Again, it is useful to consider the zero lower bound case where $R = 1$, so $c^m = c^b = v$. Then, from (57),

$$\sum_{t=0}^{\infty} \beta^t \tau_t = \frac{v}{(1-\beta)\, u'(v)} \left[u'(v) - 1\right],$$

so provided $v < c^*$ the present value of transfers is strictly positive at the zero lower bound.

Thus, note the non-Ricardian nature of tax policy. Focusing in particular on the zero-lower-bound case, an increase in transfers associated with a one-time permanent increase in the quantity of consolidated government debt at the first date is a free lunch. From (56), if $v < \hat{v}$, transfers increase at every future date as a result, and from (52) and (53) consumption in the cash market and in the credit market increase, as currency and government debt outstanding both increase, in real terms.

In what sense does fiscal policy constrain monetary policy when there is a shortage of government debt, for example in this stationary policy case in which $v < c^*$? Assuming that $-c\frac{u''(c)}{u'(c)} < 1$, so that inflation increases in this equilibrium with the nominal interest rate, the shortage of government debt puts a lower bound on the set of inflation rates that can be supported by monetary policy. That is, the lower bound on inflation is achieved when $R = 1$, so from (34), (52) and (53),

$$\pi \geq \beta u'(v), \tag{58}$$

so the smaller is v, the larger is the lower bound on inflation.

But, if collateral constraints bind, what policy would the central bank choose, given v, which is determined by fiscal policy? In this stationary equilibrium, in which (c^m, c^b) is determined by (52) and (53), welfare is determined by period utility for a household, which is

$$W = \theta[u(c^m) - c^m] + (1-\theta)[u(c^b) - c^b]. \tag{59}$$

Then, from (59), the derivative of welfare with respect to the nominal interest rate is

$$\frac{dW}{dR} = \theta[u'(c^m) - 1]\frac{dc^m}{dR} + (1-\theta)[u'(c^b) - 1]\frac{dc^b}{dR}, \tag{60}$$

where, from (52) and (53),

$$\frac{dc^m}{dR} = \frac{(1-\theta)\left[u'(c^b) + c^b u''(c^b)\right]}{(1-\theta)u''(c^m) + \theta R^2 u''(c^b)}, \tag{61}$$

$$\frac{dc^b}{dR} = \frac{-\theta R u'(c^b) + \frac{(1-\theta)c^b u''(c^m)}{R}}{(1-\theta)u''(c^m) + \theta R^2 u''(c^b)}. \tag{62}$$

Therefore, if we evaluate the derivative in (59) at $R = 1$, from (52), (53), and (60)-(62), we get

$$\frac{dW}{dR} = (1-\theta)v[u'(v) - 1] > 0,$$

so the zero lower bound is not optimal, given fiscal policy. At the zero lower bound the central bank should conduct an open market sale of government debt so as to raise the nominal interest rate. Though this reduces the quantity of exchange in the cash market, exchange in the cash-and-credit market increases, and the second effect more than compensates for the first, so that welfare increases. This result is similar to what holds in Andolfatto and Williamson (2015) and Williamson (2017c).

When $R = \hat{R}$ (recall that this is the nominal interest rate at which collateral constraints cease to bind), note that $\frac{dc^b}{dR} = 0$ and $\frac{dc^m}{dR} < 0$, from (61) and (62). Therefore, $\frac{dW}{dR} < 0$ when $R = \hat{R}$, and we also know that $\frac{dW}{dR} < 0$ when $R > \hat{R}$ for conventional reasons. That is, when $R > \hat{R}$, consumption in the cash market declines when the nominal interest rate increases, and consumption in the cash-and-credit market is constant at c^*. Therefore, the optimal nominal interest R^{**} satisfies $1 < R^{**} < \hat{R}$, so collateral constraints bind at the optimum.

Thus, so long as collateral constraints bind at the zero lower bound, fiscal policy will not constrain the central bank, in that suboptimal fiscal policy does not cause the central bank to go to the zero lower bound. However, were the central bank to have a specific inflation target, then if that inflation target violates (58), the central bank is constrained. However, in that instance the central bank would necessarily be choosing an inflation target that is suboptimal.

3.1.3 Government Spending

Typically, a fiscal authority which puts constraints on the central bank, thus threatening central bank independence, is viewed as dysfunctional – a source of inefficiency. But how might we see fiscal constraints on the central bank as efficient? In this section, and the next, we explore how the fiscal authority might restrict the supply of government debt so as to generate revenue to finance public goods provision. As a result, the central bank's control over inflation can be compromised, but that may be efficient.

A shortage of collateral can potentially have implications for government spending. That is, if there is less collateral, and a larger liquidity premium on government debt, this might generate a larger flow of revenue for the government. Thus, while tighter collateral constraints decrease private consumption, there could be beneficial effects for government revenue, through higher central bank profits and revenues from rolling over the government debt.

To see how this works, suppose for simplicity that the government provides public goods g_t to each household, and that all revenue for the provision of public goods must be raised through the issue of consolidated government liabilities, with lump sum transfers $\tau_t = 0$ for $t = 1, 2, 3, ...$. We will permit a positive lump-sum transfer at $t = 0$, as this is necessary to endow households with the assets they need in period 0 to trade. We could complicate the model by including distorting taxation, for example, but our results are clearer without those details. We will assume that public goods provide utility to households, and write the period utility function of a household as

$$U(c_t^m, c_t^b, g_t) = \theta u(c_t^m) + (1-\theta)u(c_t^b) + w(g_t),$$

where $w(\cdot)$ is strictly increasing, strictly concave, and twice differentiable, with $w'(0) = \infty$ and $w'(\infty) = 0$. In the household's constraints, (30) and (32) we set $\tau_t = 0$, for $t = 1, 2, 3, ...$, and permit $\tau_0 \geq 0$.

We need to include public goods in the consolidated government budget constraints, which are then written as:

$$e_0 + m_0 + b_0 - l_0 = g_0 + \tau_0, \tag{63}$$

$$e_t + m_t + b_t - l_t = \frac{e_{t-1}}{\pi_t} + (m_{t-1} + b_{t-1} - l_{t-1})\frac{R_{t-1}}{\pi_t} + g_t, \text{ for } t = 1, 2, 3, ... \tag{64}$$

We will consider the case in which collateral constraints bind for all t, so the intertemporal consolidated government budget constraint can be written, from

(63), (64), (35), (30), and (31) as

$$
\begin{aligned}
& e_0 + m_0 + b_0 - l_0 \qquad (65) \\
= \quad & -\sum_{t=1}^{\infty} \frac{\beta^t u'(c_t^m) g_t}{u'(c_0^m)} + \sum_{t=0}^{\infty} \frac{\beta^t}{u'(c_0^m)} \left\{ (\theta c_t^m + g_t) \left[u'(c_t^m) - 1 \right] + (1-\theta) c_t^b \left[u'(c_t^b) - 1 \right] \right\}
\end{aligned}
$$

In equation (65), the left-hand side is the real value of the initial consolidated government debt, while the first term on the right-hand side is the present value of primary government surpluses, and the second and third terms on the right-hand side capture the liquidity premia on consolidated government debt arising from inefficiencies in the cash market and credit market, respectively.

Suppose that fiscal policy keeps the real value of the consolidated government debt constant at v, which implies that c_t^m and c_t^b solve

$$u'(c_t^m) = R_t u'(c_t^b), \qquad (66)$$

$$\theta c_t^m + \frac{(1-\theta)}{R_t} c_t^b = v - g_t. \qquad (67)$$

Then consider the simplest case where $R = 1$ (zero-lower-bound monetary policy) for all t. Then, if $g_t = g$, a constant, for all t, from (66) and (67) there exists a stationary equilibrium with $c_t^m = c_t^b = v - g$. Thus, the zero-lower-bound policy implies that expenditure in the cash and credit markets is the same, and (67) states that total expenditure on private goods plus public goods provision is equal to the value of consolidated government debt each period. From (63) the transfer in the initial period is

$$\tau_0 = v - g,$$

which states that the period 0 government deficit, $g + \tau_0$, is financed with the issue of consolidated government debt v. Note, as stated above, that the transfer starts households in the first period with the assets they need to purchase $(c_0^m, c_0^b) = (v - g, v - g)$ in period 0. Then, from (64),

$$g = v \left[1 - \frac{1}{\beta u'(v-g)} \right], \qquad (68)$$

which defines a relationship between the value of the consolidated government debt v and the level of public goods provision g in each period. It proves more useful to rewrite (68) in terms of public goods and private consumption c (equal to consumption in the cash and credit markets, in this zero-lower-bound equilibrium), given that $c = v - g$, obtaining

$$g = c \left[\beta u'(c) - 1 \right]. \qquad (69)$$

Then (69) describes an equilibrium locus for (c, g) consistent with constant consolidated government debt $v = c + g$.

We will assume that $0 < -c\frac{u''(c)}{u'(c)} < 1$, which implies, from (66) and (67) that, with $g_t = g$ and $R_t = R$, an increase in R results in an increase in consumption in the credit market, and a decrease in consumption in the cash market. In other words, substitution effects are assumed to dominate income effects, and the demand for currency is assumed to fall when the nominal interest rate rises.

From (69), we can derive a government spending "multiplier," expressed as a function of c, i.e.

$$\frac{d(c+g)}{dg} = \frac{\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right]}{\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right] - 1} \tag{70}$$

So, for low values of c, i.e. if

$$\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right] - 1 > 0,$$

an increase in g is associated with a more-than-one-for-one increase in total output, i.e. the multiplier is greater than one. But, for large values of c, i.e. if

$$\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right] - 1 < 0,$$

the multiplier is negative. Thus, when collateral is very scarce, an increase in government debt can finance more government spending, and at the same time support more exchange and more private consumption. However, if collateral is not so scarce (though it still bears a liquidity premium), then an increase in government spending crowds out consumption because there is less collateral available to finance private spending. For example, if we assume that the coefficient of relative risk aversion is constant (and less than one, as assumed above), then the relationship (69) can be depicted as in Figure 2. Public goods provision increases and then decreases as private consumption increases. The curve in Figure 2 is essentially the mirror image of a Laffer-type relation. That is, when private consumption and public goods provision are very low, inefficiency wedges in the cash and credit markets are high − analogous to high tax wedges. When private consumption is high, then public goods provision is low, and inefficiency wedges in the cash and credit markets are low.

But what about optimal fiscal policy, in this class of zero-lower-bound equilibria? The fiscal policy problem is to maximize period utility

$$W(c,g) = u(c) + w(g) - c - g \tag{71}$$

subject to the constraint (68). Substituting for the constraint (69) in the objective function (71), we can write the fiscal authority's objective function in terms of private consumption c, that is the objective function is

$$\phi(c) = u(c) - c + w(c\left[\beta u'(c) - 1\right]) - c\left[\beta u'(c) - 1\right] \tag{72}$$

Further, note that $v = cu'(c)$ in this equilibrium, so given $0 < -c\frac{u''(c)}{u'(c)} < 1$, c is strictly increasing in v for $c < c^*$. Therefore, though the fiscal authority chooses v, solving the problem as if the fiscal authority is choosing c is equivalent.

Differentiating (72), we obtain

$$\phi'(c) = u'(c) - 1 + \left\{\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right] - 1\right\} w'\left\{c\left[\beta u'(c) - 1\right]\right\} \tag{73}$$

From (69), government spending is nonnegative for $c \in [0, \hat{c}]$, where $u'(\hat{c}) = \frac{1}{\beta}$. So, given $0 < -c\frac{u''(c)}{u'(c)} < 1$, therefore $\phi'(0) = \infty$, and $\phi'(\hat{c}) = -\infty$ so at the optimum $0 < c < \hat{c}$, and therefore, from (69), $g > 0$ at the optimum. But, since $\hat{c} < c^*$, therefore $u'(c) - 1 > 0$ at the optimum, so the fiscal authority permits inefficiency in goods market exchange at the optimum so as to generate revenue to finance government spending.

Proposition 1 *Assume that* $\frac{cu''(c)}{u'(c)}$ *is constant. If (75) holds, then there is a unique solution to the fiscal authority's problem, satisfying the first order condition*

$$u'(c) - 1 + \left\{w'(c\left[\beta u'(c) - 1\right]) - 1\right\}\left\{\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right] - 1\right\} = 0. \tag{74}$$

Alternatively, if (75) does not hold, then (74) holds at the optimum but, in addition,

$$w'\left\{c\left[\beta u'(c) - 1\right]\right\} > 1$$

at the optimum.

Proof. Since $\frac{cu''(c)}{u'(c)}$ is constant, the function

$$\psi(c) = \beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right] - 1$$

is strictly decreasing in c for $c \geq 0$. Define $\tilde{c}$ as the unique solution to $\psi(\tilde{c}) = 0$. From (69), $\tilde{c}$ is the quantity of consumption that maximizes the provision of public goods. As well, define g^* as the solution to $w'(g^*) = 1$. That is, g^* maximizes the household's surplus from consumption of public goods. First, suppose that

$$w'\left\{\tilde{c}\left[\beta u'(\tilde{c}) - 1\right]\right\} \geq 1 \tag{75}$$

which implies that the surplus from public goods provision attains a constrained maximum when $c = \tilde{c}$. Then, $c > \tilde{c}$ and $g < g^*$ at the optimum. However, if (75) does not hold, then $g > g^*$ is feasible, but cannot be optimal. That is, suppose that $g > g^*$ is feasible and optimal. Then there exists an alternative allocation with smaller g but identical surplus from public goods provision and larger c, which implies a greater surplus from the provision of private goods. This alternative allocation therefore dominates the proposed optimum in welfare terms – a contradiction. ■

The example demonstrates that, even given a zero-lower-bound monetary policy, which implies that central bank profits are zero, the fiscal authority can generate the analogue of seigniorage revenues, if it restricts the supply of government debt. In order to generate revenue to support the provision of public goods, the fiscal authority may want to indefinitely tolerate low real interest rates and inefficiency.

In Figure 2, which depicts the equilibrium relationship between c and g when the coefficient of relative risk aversion is constant, the curve represents a menu for the fiscal authority, given a monetary policy with $R = 1$. The fiscal authority can choose any point on the curve through the appropriate choice of v. Any points on the increasing portion of the curve are suboptimal, as moving to the right along the increasing portion of the curve implies that welfare for the household is strictly increasing.

What does this analysis say about how fiscal policy choices constrain monetary policy? First, note from (65) that in a stationary equilibrium inefficiency is required in order to support positive provision of public goods forever. That is, the present value of primary government surpluses is negative, and this needs to be offset through liquidity premia on consolidated-government liabilities. In particular, in a zero-lower-bound stationary equilibrium, from (34) the gross inflation rate is given by

$$\pi = \beta u'(c),$$

but from (69) $g > 0$ implies $\beta u'(c) > 1$, so inflation must be positive to support a positive level of public goods provision forever. Thus, at the optimum, the fiscal authority's setting for the quantity of government debt necessarily constrains inflation to be strictly positive. The lower bound on inflation, determined by the fiscal authority, will in general depend on the household's preferences for private vs. public goods, from Proposition 1.

3.1.4 Monetary Policy and Government Spending at the Zero Lower Bound

In this subsection, we want to further explore what happens when the fiscal authority behaves purposefully in setting the quantity of consolidated government debt outstanding, in an environment in which the fiscal authority needs to finance public goods provision. In general, how does the level of government debt affect public goods provision and private consumption? As well, how do fiscal constraints on monetary policy affect the optimal choice of the gross nominal interest rate R?

With $R_t = R$ and $v_t = v$ for all t, in a stationary equilibrium, from (64), (30), (31), and (34), (66) and (67), we get

$$v = \frac{\theta c^m + g}{\beta u'(c^m)} + \frac{(1-\theta)c^b}{\beta u'(c^m)} + g, \tag{76}$$

$$u'(c^m) - Ru'(c^b), \tag{77}$$

$$\theta c^m + \frac{(1-\theta)}{R} c^b = v - g, \tag{78}$$

and (76)-(78) solve for c^m, c^b, and g, given the policy variables R and v.

First we will examine the effects of fiscal policy. For simplicity, focus on the effects of policy at the zero lower bound. For fiscal policy, totally differentiate (76)-(78), and evaluate derivatives at the zero lower bound on monetary policy, $R = 1$. Then, the effects of a change in consolidated government debt v on consumption are given by

$$\frac{dc^m}{dv} = \frac{dc^b}{dv} = \frac{1}{\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right]}$$

Therefore,

$$\frac{dg}{dv} = 1 - \theta \frac{dc^m}{dv} - (1-\theta)\frac{dc^b}{dv} = \frac{\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right] - 1}{\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right]}$$

If we assume, as above, that $0 < -\frac{cu''(c)}{u'(c)} < 1$, then $\frac{dc^i}{dv} > 1$ for $i = m, b$. If $\frac{cu''(c)}{u'(c)}$ is constant, then $\frac{dg}{dv} > 0$ for small v, and $\frac{dg}{dv} < 0$ for large v. Thus, increasing the consolidated government debt at the zero lower bound always increases private consumption and increases reduces the provision of public goods, for low v. But when v is sufficiently large, the provision of public goods decreases when v increases. This seems counterintuitive, as we might think that an increase in government debt would be financing more public goods. But, increasing v relaxes the collateral constraint, reduces the liquidity premium on government debt, and can then reduce government revenue.

For monetary policy, we want to examine the effect of a departure of the nominal interest rate from the zero lower bound. The effect on consumption is given by the derivatives

$$\frac{dc^m}{dR} = \frac{-u''(c)(1-\theta)c - u'(c)(1-\theta)\beta\left[u'(c) + cu''(c)\right]}{-u''(c)\beta\left[u'(c) + cu''(c)\right]}$$

$$\frac{dc^b}{dR} = \frac{\theta\beta u'(c)\left[u'(c) + cu''(c)\right] - u''(c)(1-\theta)c}{-u''(c)\beta\left[u'(c) + cu''(c)\right]}$$

Then, the effect on government spending is given by

$$\begin{aligned} \frac{dg}{dR} &= -\theta\frac{dc^m}{dR} - (1-\theta)\frac{dc^b}{dR} + (1-\theta)c \\ &= (1-\theta)c\left[1 - \frac{1}{\beta u'(c)\left[1 + \frac{cu''(c)}{u'(c)}\right]}\right] \end{aligned}$$

For nonnegative g, we require $\beta u'(c) \geq 1$, which implies that, for low values of c, $\frac{dg}{dR} > 0$, and for high values of c, $\frac{dg}{dR} < 0$. Here, "tighter" monetary policy can increase government spending at the ZLB, which is perhaps counterintuitive. If fiscal policy is optimal, that is if (74) holds, then government spending must decline if R increases.

We can also calculate the effect on welfare of an increase in R at the zero lower bound:

$$\begin{aligned}\frac{dW}{dR} &= [u'(c)-1]\left[\theta\frac{dc^m}{dR}+(1-\theta)\frac{dc^b}{dR}\right]+[w'(g)-1]\frac{dg}{dR} \\ &= \frac{(1-\theta)c}{\beta u'(c)\left[1+\frac{cu''(c)}{u'(c)}\right]}\left\{[u'(c)-1]+[w'(g)-1]\left[\beta u'(c)\left[1+\frac{cu''(c)}{u'(c)}\right]-1\right]\right\}\end{aligned}$$

But, from the results in the previous subsection, if we evaluate this derivative given optimal fiscal policy, so that (74) holds, then $R=1$ is optimal. Thus, if fiscal policy is being conducted optimally, in which case the collateral constraint binds and the real interest rate is low, then the zero lower bound is optimal. Thus, if the central bank is behaving optimally, then optimal fiscal policy constrains monetary policy, in that $R \geq 1$ is a binding constraint. The nominal interest rate should be zero, but this is not because the central bank is choosing a Friedman rule, as fiscal policy has created an inefficiency that makes inflation high and private consumption low, even when $R=1$.

4 Conclusion

How does fiscal policy constrain the central bank? In a Fisherian model, we showed how the central bank could be set up as an institution with no fiscal constraints. The central bank could be endowed with a monopoly on the issue of currency, distributing central bank profits to its shareholders, in an environment in which fiscal policy is irrelevant for the path for the price level. Thus, the fiscal authority is by no means necessary for determining the price level and inflation. As well, the central bank may be constrained to purchase the entire stock of government debt issued at each point in time, but that does not mean that the central bank loses control of inflation, so long as the fiscal authority does not constrain the central bank to generating a stream of transfers to the government. That is, helicopter drops, without a requirement that the central bank increase the nominal interest rate and central bank profits, can be irrelevant.

In a model with production and secured credit, the value of the government debt can exceed the present value of future primary government surpluses, in contrast to what happens in the basic FTPL. The intertemporal consolidated government budget constraint can still be written as a valuation equation for consolidated government liabilities, but it includes terms reflecting liquidity premia on those liabilities. A shortage of safe assets, implies that collateral constraints bind, the real interest rate is low, and there is inefficiency in markets using cash and in markets using secured credit. In such circumstances, the government expenditure multiplier can exceed unity, even in the long run, in the absence of sticky wages and prices, and in a context where all agents are rational and forward-looking. The fiscal authority may want to bear inefficiencies in exchange, arising from a scarcity of safe assets, in order to generate revenue to support public goods provision.

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Figure 1: Log of CPI for Canada and 2% Trend

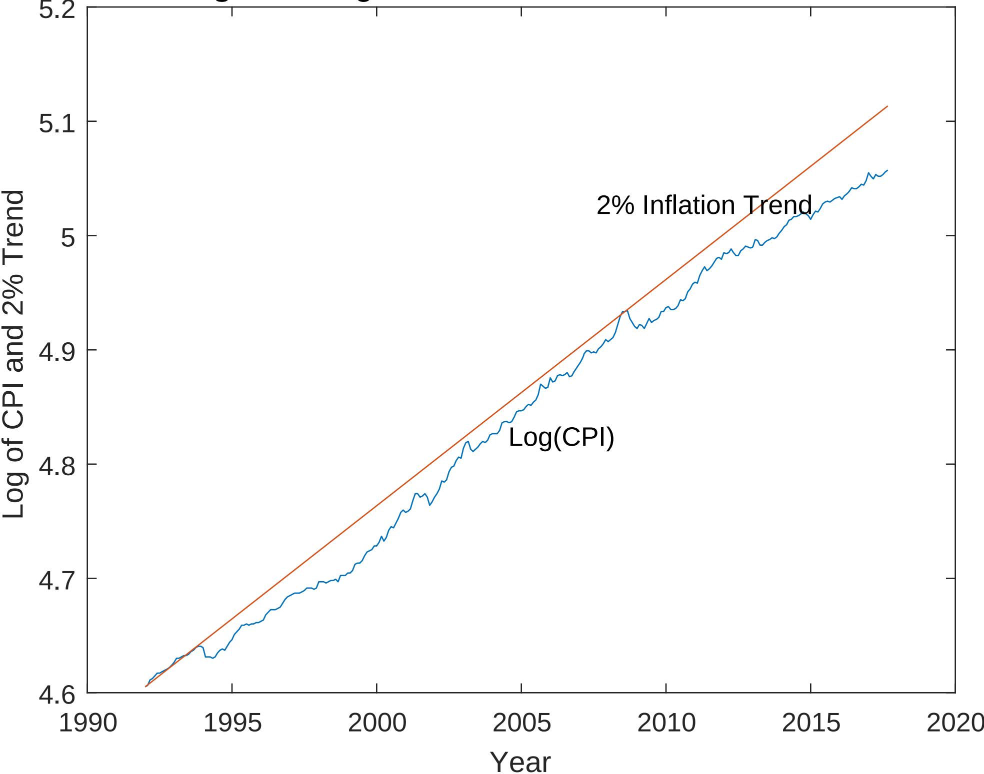

Figure 2: Relationship Between Public Goods Provision and Private Consumption, with Binding Collateral Constraints