Commitment versus Discretion in a Political Economy Model of Fiscal and Monetary Policy Interaction☆

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Abstract

Does price commitment result in lower welfare? I pair an independent monetary authority controlling nominal bonds with a fiscal authority microfounded by the political economy model of Battaglini and Coate (2008). Without price commitment, time inconsistency is alleviated by interaction between the benevolent monetary authority and the politically distorted fiscal authority. With price commitment, nominal bonds will be used for wasteful spending by the politically distorted fiscal authority. Price commitment results in lower welfare because it eliminates monetary control over fiscal decisions.

JEL classification: E52, E61, E63

Keywords: Price Commitment, Monetary Policy, Monetary Fiscal Policy Interaction, Time Inconsistency

☆The views expressed in this paper are those of the author and not necessarily those of the Federal Reserve Board or of the Federal Reserve System. The author thanks Urban Jermann, an exceptional referee, Matthias Doepke, Martin Eichenbaum, Mirko Wiederholt, Nicolas Ziebarth, Chris Vickers, Luca Dedola, Marco Bassetto, Andre Kurmann, Saroj Bhattarai, Cornell, NBER SI, and the Texas Monetary Conference.

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1. Introduction

Kydland and Prescott (1977) and Barro and Gordon (1983) find that price commitment results in higher welfare in models with benevolent fiscal and monetary authorities and nominal bonds. The political economy literature offers microfoundations for fiscal spending decisions that provide a better basis for modeling the fiscal authority. I incorporate a fiscal authority based on the political economy model of Battaglini and Coate (2008) into a structure of fiscal and monetary interaction and nominal bonds and find that price commitment leads to lower welfare. The fiscal authority's objective is to maximize the utility of a subset of the citizens instead of maximizing the welfare of the society as a whole. Fiscal decisions are endogenous to the environment and the amount of nominal bonds. By making fiscal decisions endogenous I show that price commitment by the monetary authority will allow the politically distorted fiscal authority to spend with impunity leading to a welfare loss.

This paper presents a model of fiscal and monetary authority interaction where each authority responds to the endogenous decision making of the other through the government budget constraint. The model ties together several literatures, most notably political economy models of fiscal decision making such as Battaglini and Coate (2008) that analyze the consequences of political frictions, monetary theory models such as Rogoff (1985b) that analyze optimal central bank structure and debt models such as Chari et al. (1991) that analyze the use of nominal debt as a margin for budget balancing. The model shares some characteristics with the unpleasant monetary arithmetic of Sargent and Wallace (1981) with the important differences that fiscal choices are endogenous and the fiscal authority issues nominal instead of indexed bonds

As Fischer (1995) describes, there are two main theoretical literatures describing central bank independence: the conservative central banker of Rogoff (1985b) and the principal-agent design of Persson and Tabellini (1993). This paper unites the two literatures by plausibly microfounding the fiscal authority inside a structure that resembles a principal-agent model with the monetary authority as principal and fiscal authority as agent. Cooperation between the two authorities does not lead to the first best welfare outcome due to the time inconsistency problem of nominal debt: a benevolent monetary authority with discretionary policy will inflate away the real value of nominal debt at the start of every period, allowing a benevolent fiscal authority to set taxes to the minimum. Consumers anticipate this inflation and will not hold nominal bonds whose real value will disappear. As in Rogoff (1985a) a second best outcome is achievable through competition between the two authorities. The political distortion modifies the aims of the fiscal authority. Then, the divergence in aims between the benevolent monetary authority and politically distorted fiscal authority anchors inflation expectations, as long as monetary policy is discretionary rather than committed.

In the course of proving that price commitment leads to lower welfare, I provide a new answer to a different question in monetary economics: why governments issue nominal bonds. The analysis shows that nominal bonds provide a method for an independent central bank to discipline a politically distorted fiscal authority. As a consequence of the politically distorted fiscal authority's desire to reward its coalition, the presence of the fiscal authority overcomes the time inconsistency problem of nominal debt by anchoring consumers' inflation expectations.

In models with benevolent fiscal and monetary authorities where both are trying to maximize overall welfare, the benevolent fiscal authority is unable to raise revenue from nominal bonds due to the time inconsistency problem of nominal debt. Price commitment eliminates the benevolent monetary authority's ability to inflate; equivalently it turns nominal bonds into indexed bonds. The benevolent fiscal authority can then use these pseudo-indexed bonds to increase welfare by smoothing taxes as in Barro (1979). The benefit of price commitment is stark: discretionary monetary policy means there will be no bond revenue while price commitment allows the benevolent optimal amount of bond revenue.

In contrast, with a politically distorted fiscal authority and a benevolent monetary authority, discretionary policy will allow the fiscal authority to raise some bond revenue for tax smoothing while price commitment allows bond revenue to be used for both tax smoothing and wasteful spending. Additionally, the cost of price commitment will be positive: price commitment removes the threat of inflation the monetary authority uses to constrain spending by the fiscal authority. With price commitment, a politically distorted fiscal authority is able to issue bonds to fund wasteful spending that will require higher taxes in the future to pay off.

A benevolent monetary authority knows that inflating away the entire real value of nominal bonds will give the politically distorted fiscal authority budgetary freedom to spend revenue on wasteful transfers rather than on public goods. Maintaining a positive level of nominal debt will constrain wasteful spending, but if debt is too high it will require high distortionary taxes to pay off. Thus the split between the aims of the authorities anchors inflation expectations: the independent monetary authority will inflate away some of the debt, so that taxes will be lower, but not all of the debt, so the fiscal authority is still constrained in its spending decisions. The remaining debt will be enough to prevent the distorted fiscal authority from spending revenue wastefully.

The threat of inflation allows the benevolent monetary authority some control over the spending decisions of the politically distorted fiscal authority. This control has two beneficial effects: it alleviates time inconsistency and it limits the degree of the political distortion. Pairing a politically distorted fiscal authority with a benevolent monetary authority allows the fiscal authority to raise revenue with nominal bonds. The bonds increase overall welfare because they enable tax smoothing. Price commitment increases the amount of nominal bonds that can be issued and thus increases possible bond revenue. However, the extra revenue raised from these new bonds will be spent at the discretion of the politically distorted fiscal authority. The benefits of the extra revenue will not outweigh the future increases in distortionary taxes that will be necessary to pay off the bonds thus welfare will be lower.

The key contribution of this paper is integrating an explicit microfoundation for the policies of the fiscal authority with a monetary authority and nominal bonds. Similar literature to this paper comes from modern macroeconomic models that examine fiscal and monetary policy interaction in non-cooperative game-theoretic settings. Dixit and Lambertini (2003) is a precursor to the more thorough macroeconomic models of Adam and Billi (2008), Adam (2011), and Martin (2011). These papers include separate and independent fiscal and monetary authorities to examine the benefits of monetary conservatism. While they feature richer macroeconomic modeling, they do not utilize political economy to model the fiscal decision maker, nor include the effect of distortionary taxes on fiscal debt decisions.

Adam and Billi (2014) adds distortionary taxes but removes debt from the consideration set of the government. It finds that having fiscal policy determined before monetary policy leads to higher welfare because then the monetary authority knows the fiscal choices. In this paper the fiscal authority is already constrained by the debt left by the previous fiscal authority. The reverse timing, with the monetary authority moving first, leads to higher welfare because the fiscal authority is already tightly bound. However, as in both Adam and Billi (2014) and Adam and Billi (2007), the order of moves is important for the outcome.

Niemann (2011) adds a government more impatient than the monetary authority, and the citizenry, to the type of model Díaz-Giménez et al. (2008) examines. He finds that monetary conservatism can lead to lower inflation, but higher debt as the government responds to the cost of financing debt. A crucial distinction between all of the macroeconomic papers above and this one is that this paper does not consider monetary conservatism in the same fashion. In the other papers, conservatism is defined as a monetary policymaker who is more inflation averse than the citizens. Here, the central bank is not exogenously conservative, it maximizes the welfare of citizens. The distortion between monetary and fiscal authorities comes from the fiscal side due to the endogenous self-interest of the fiscal authority. The monetary authority is not more conservative than the fiscal policymaker nor the populace, it is more benevolent. Having distinct utility functions for monetary and fiscal policies provides a similar benefit to conservatism in limiting consumers' inflation expectations.

Niemann et al. (2013) looks at optimal policies for the monetary authority depending on which monetary instrument the authority uses. The ability of the monetary authority to control a myopic fiscal authority depends on the choice of instrument. Optimal plans involve a tradeoff between alleviating time inconsistency of monetary policy, and enabling fiscal waste. In this paper, the monetary authority has a single instrument, equivalent to the interest rate. Alleviating time inconsistency comes not from instrument choice but from the interaction of distinct utility functions. The political economy model considered does not rely on myopia but rather self-interested utility maximizing agents.

A considerable amount of study of monetary and fiscal interactions has centered on the Fiscal Theory of the Price Level as seen in Leeper (1991). The theory proposes that the fiscal authority can set the price level by changing the present value of expected future tax revenue and thus how much consumers expect to be repaid for their bonds. For an overview see Bassetto (2008). The paper's model shares some similarities with Leeper's active monetary, passive fiscal regime as well as the unpleasant monetary arithmetic of Sargent and Wallace (1981) but differs in giving the monetary authority explicit power over the price level without money, and by making government choices endogenous.

The rest of the paper provides the model and comparisons of the different forms of fiscal policy and price commitment. Section 2 lays out the model. In Section 3, following the analysis above, I show a benevolent fiscal authority is unable to raise revenue with nominal bonds while a politically distorted fiscal authority is able to do so. Welfare is higher in the latter situation since the bond revenue may be used for tax smoothing. Price level commitment leads to overuse of bonds by the politically distorted fiscal authority and thus lower welfare. Finally, Section 4 concludes.

2. The Model

Nominal government debt, when sustainable, links periods. Fiscal policy consists of setting taxes, expenditure on a public good, direct transfers to citizens, and nominal bond issuance. The timing in a period is as follows: a real shock determines wages (and the distortion due to taxes) at the beginning of every period. After the shock, the monetary authority sets the price level then the fiscal authority chooses its policy. Figure 1 illustrates the sequence of decisions in a period. The model's order of decisions is important and will be discussed at more length below.

Insert "Timing of Monetary and Fiscal Decisions" figure here.

2.1. Consumers

There are n identical consumers, indexed by i when necessary. A consumer's per period utility function is

$$u(c, g, l) = c + A\log(g) - \frac{l^{1+1/\epsilon}}{\epsilon + 1} \tag{1}$$

and an individual seeks to maximize $U = \sum_t \beta^t u(c_t, g_t, l_t)$ where c is a consumption good, g is government spending on a public good, l is labor, and β the discount rate. The parameter $\epsilon > 0$ is the Frisch elasticity of labor supply. A is a parameter allowing adjustment of the utility of government spending on the public good. Utility linear in consumption is used to eliminate wealth effects to preserve consumers homogeneity for the political process and simplify the interest rate.[2]

A representative consumer i in period t faces the budget constraint

$$c + qB_i' \leq w_\theta l(1-\tau) + \frac{B_i}{P(B)} + T_i \tag{2}$$

[2] More complicated utility functions, and corresponding interest rates, lead to the possibility of strategic manipulation where the level of debt the fiscal authority chooses, and consumers' expectation of future fiscal decisions, affects the interest rate directly as discussed in Battaglini (2011). For some expectations, issuing more debt can drive down the interest rate on current debt. The interaction between strategic manipulation by the fiscal authority and the monetary authority's changes to the interest rate is beyond the scope of this paper.

Variables without a prime refer to variables in period t while variables with a prime refer to variables in period $t+1$. The consumer can consume c or purchase nominal bonds B_i' at a price q where each bond pays a nominal unit of income in the next period. $B = \sum_i B_i$ is the total number of bonds in the economy[3].

The consumer's income consists of labor income at wage w_θ that is taxed by the government at the distortionary tax rate $0 \leq \tau \leq 1$ together with direct transfers $T_i \geq 0$ from the government. $P(B)$ is the price level determined by the monetary authority at the start of the period as a function of the number of bonds.

The price level in the current period will generally be abbreviated as $P = P(B)$ and the price level in the next period as $P' = P(B')$. The price level is not an intertemporal variable. The ratio of current to next period price level $\frac{P}{P'}$ determines the real return on bonds. For simplicity I normalize this ratio by making bonds pay 1 nominal unit of income in the next period. Thus the real value of bonds will only depend on P' which is set independently every period.

The consumer's budget constraint and linear utility imply the equilibrium bond price

$$q(B') = \beta E_{\theta'} \left[\frac{1}{P'(B')} \right] \tag{3}$$

where the expectation is over possible realizations of the wage shock in the next period.

A consumer's utility is defined entirely by the government's choices of taxation τ and public good spending g. Deriving the optimal amount of labor as a function of the tax rate τ shows

$$l_\theta^*(\tau) = (\epsilon w_\theta (1 - \tau))^\epsilon \tag{4}$$

Plugging this into the consumer's utility function shows the indirect utility

[3]With identical consumers, the symmetric equilibrium examined in the paper induces all consumers to hold identical bonds $B_i = \frac{B}{n}$. The choices of fiscal and monetary authorities will only depend on aggregate bonds.

function before transfers is

$$W_\theta(\tau, g) = \frac{\epsilon^\epsilon (w_\theta(1-\tau))^{\epsilon+1}}{\epsilon+1} + A\log(g) \tag{5}$$

2.2. Firms

The representative firm has a linear production technology

$$z = w_\theta l \tag{6}$$

used to produce an intermediate good z at wage w_θ with labor l. At the beginning of each period an i.i.d. technology shock hits the economy such that wages $w_\theta \in \{w_l, w_h\}$ where $w_l < w_h$. The probability that $w_\theta = w_h$ is π, the probability that $w_\theta = w_l$ is $1 - \pi$.

The intermediate good z is split costlessly between the consumption good c and the public good g such that

$$c + g = z. \tag{7}$$

This defines the per period resource constraint

$$c + g = w_\theta l. \tag{8}$$

2.3. Government

The government controls fiscal policy. Raising revenue is possible via a distortionary labor tax τ and by selling nominal bonds B'. A positive bond level means the government is in debt hence owes revenue to consumers. The government can spend revenue on a public good g that benefits all n citizens or on non-negative transfer payments T_i that benefit individuals. It must also repay nominal bonds $\frac{B}{P}$.

The government's budget constraint is

$$g + \sum_i T_i + \frac{B}{P} \leq \mathrm{Rev}_\theta(\tau) + qB' \tag{9}$$

where

$$\mathrm{Rev}_\theta(\tau) = n\tau w_\theta(\epsilon w_\theta(1-\tau))^\epsilon \tag{10}$$

is the total tax revenue raised by the distortionary labor tax on all n consumers.

Define the budget surplus before transfers as

$$S_\theta(\tau, g, B'; \frac{B}{P}) = \mathrm{Rev}_\theta(\tau) + qB' - g - \frac{B}{P}. \tag{11}$$

The surplus must be large enough to pay for any transfers hence $S_\theta(\tau, g, B'; \frac{B}{P}) \geq \sum_i T_i$. Transfers themselves must be non-negative: $\forall i \ T_i \geq 0$.

There are endogenous limits to the amount of bonds the government can issue. The upper bound on debt is defined as the maximum amount of bonds the government is able to repay in the case of the bad realization of the wage shock w_l if it spends nothing on the public good and transfers. Define the upper bound $\overline{B}$ as $\overline{B} = \frac{\max_\tau \mathrm{Rev}_l(\tau)}{q(\overline{B})}$.

The lower bound on debt is the amount of bonds such that revenue from the bonds would be sufficient to fund optimal public good spending without utilizing the distortionary labor tax. The optimal amount of public good spending is g^s such that $\frac{nA}{g^s} = 1$. This equation equates the declining marginal benefit of providing the public good with the opportunity cost to consumers of consuming the revenue directly with linear utility. Define $\underline{B}$ as $\underline{B} = -\frac{nA}{q(\underline{B})}$ the level of bonds where one more unit of government spending has the same marginal utility as individual consumption. This is the Samuelson level of bonds such that the government can finance g^s directly from the bonds.

The Samuelson level of bonds $\underline{B}$ is the bond level where the government is entirely funded by interest from bonds, all future distortionary labor taxes are zero, and government spending is constant at the optimum.

2.3.1. Self-Interested Fiscal Policy

Fiscal policy decisions will be made either by a benevolent fiscal authority or a self-interested fiscal authority. A benevolent fiscal authority attempts to maximize the welfare of all citizens. A self-interested fiscal authority attempts to maximize the utility of a subgroup of the citizenry. In this section, I provide an overview of the political equilibrium I will be examining the model. A more precise description is included in the analysis of the behavior of the self-interested fiscal authority in Section 3.2.

Following the political system laid out in Battaglini and Coate (2008) who extend the political economy model of Baron and Ferejohn (1989), citizens vote each period to decide that period's fiscal policy $\{\tau, g, B, \{T_i\}_1^n\}$. In each period there are T rounds of voting to determine fiscal policy. Each round of voting starts with one citizen being randomly assigned the power to propose a choice of fiscal policy. The proposer puts forward his policy choices of $\{\tau, g, B, \{T_i\}_1^n\}$. The proposal is enacted if $m \leq n$ citizens vote for it. If enacted, this ends the voting for that period, a new round will begin next period. If the proposal fails the voting round ends and a new round begins with a new randomly selected proposer. There can be a maximum of T proposal rounds after which a dictator is appointed. The dictator chooses policies unilaterally with the constraint that all transfers T_i must be equal. A fiscal policy proposal defines the fiscal policy for a single period. The next period a new proposer is randomly selected and the process begins anew. Fiscal commitment across periods possible due to the design of the political system.

I focus on a symmetric Markov-perfect equilibrium. These are proposals that depend only on current productivity and real debt $\{w_\theta, \frac{B}{P}\}$ where $\theta \in \{h, l\}$. The proposals are independent of both the history of the economy and proposal round. Thus we only need to examine the proposal in the first round.

In order for a proposal to be accepted, the proposal must make the members of the m coalition as well off as the expectation of waiting a round for the next proposal. In practical terms, proposers will propose fiscal instruments to maximize the utility of the m citizens in the coalition without care for non-coalition citizens. This is in contrast to the choices of a benevolent fiscal authority which will maximize the welfare of all n citizens.

2.4. Monetary Authority

The monetary authority chooses the price level P to maximize welfare. Inflation is costless. Both these modeling choices are made to emphasize the political mechanism at work in the model. Choosing P directly is equivalent to the monetary authority controlling the interest rate on nominal bonds, as the monetary authority would do in the cashless limit via infinitely small open market operations that result in zero seignorage. Additionally, moving P rather than operating through money holdings simplifies the model by allowing us to consider the simple indirect utility function with a correspondingly simple interest rate, and not split money and bond holdings.

The model utilizes timing akin to a Stackelberg game with the monetary authority as leader and the government as follower. The monetary authority chooses the price level P after the shock in each period. Since P determines the payout to bonds, choosing P is equivalent to choosing the interest rate on those bonds. Thus monetary policy controls the real value of government debt which is equivalent to consumer wealth. After the monetary authority moves, the fiscal authority chooses its fiscal instruments. See Figure 1. The choice of timing is discussed at more length in Section 2.5.

The monetary authority lacks commitment. Each period the monetary authority chooses the price level for that period only and cannot credibly promise what it will do in the future. Specifically, I constrain the monetary authority to choose the price level solely as a function of its information set $\{B, w_\theta\}$ at the beginning of a period. This is a consequence of the monetary authority's lack of commitment, and narrows the space of possible equilibria.

The monetary authority can only use current variables because strategies that threaten non-optimal ex-post actions, such as trigger strategies, require commitment to maintain the threat. The monetary authority is restricted to the current bond level and shock because bonds are the only intertemporal good and thus the only variable the monetary authority can observe at the beginning of a period after realization of the shock. Predicating monetary policy on fiscal policy decisions that took place in previous periods or will take place in future periods is ruled out because it is equivalent to commitment in another form.

2.5. Timing

The choice of timing in the model is important. The default timing is that the monetary authority chooses the price level before the fiscal authority chooses fiscal instruments. This timing results in a model that mirrors the real world while the alternative timing, that the fiscal authority chooses fiscal instruments before the monetary authority chooses the price level, does not. Under the alternative timing, no revenue from nominal bonds is available to either a benevolent or self-interested fiscal authority. This paper shows that the default timing is optimal, and would be chosen by both the monetary and fiscal authorities. For more information, see Section 3.3.1.

Timing and commitment are inseparable because a discrete timing structure implicitly requires commitment by both authorities. The follower and leader in a Stackelberg game are committed to maintain the current follower and leader timing in all future periods ignoring any profitable deviations in leadership. Assuming the fiscal authority leads each period requires the monetary authority to follow. One consequence of this paper is to show that if the monetary authority leads, and commits to leading, welfare will be higher due to the ability to raise revenue from nominal bonds. Thus if citizens could choose a timing, they would choose the default timing examined in this paper.

3. Model Analysis

A benevolent fiscal authority attempts to maximize total welfare. Since consumers are identical and utility quasilinear, this is equivalent to maximizing the utility of a single average representative consumer.

3.1. The Benevolent Fiscal Authority's Problem

The benevolent fiscal authority's problem can be written as

$$\max_{\tau, g, B', \{T_i\}_1^n} W_\theta(\tau, g) + \frac{\sum_i T_i}{n} + \beta \left[\pi v_H \left(B'\right) + (1-\pi) v_L \left(B'\right)\right] \tag{12}$$

$$\text{s.t. } \; T_i \geq 0 \; \forall i, S_\theta(\tau, g, B'; \frac{B}{P}) \geq \sum_i^n T_i \tag{13}$$

The first constraint is that transfers must be non-negative and the surplus must be weakly positive. Any surplus will be distributed to citizens as a transfer with each citizen receiving an equal amount. The continuation value function $v_\theta(B')$ takes into account movements in the price level next period P' caused by the fiscal authority's choice of nominal bonds B'.

The first order conditions of this problem are

$$\frac{1-\tau}{1-\tau(1+\epsilon)} = \frac{nA}{g} \tag{14}$$

$$\frac{1-\tau}{1-\tau(1+\epsilon)} = \frac{-n\beta}{q(B')}\left[\pi v_H'(B') + (1-\pi)v_L'(B')\right] \tag{15}$$

The expression $\frac{1-\tau}{1-\tau(1+\epsilon)}$ is the marginal distortionary cost of taxation. The first equation equates the marginal cost of raising an additional unit of revenue via taxation with the marginal benefit of spending that revenue on public goods. The second equation equates the marginal cost of raising an additional unit of revenue via taxation with the expected marginal cost of raising the revenue by issuing bonds at the price q (and thus smoothing taxation by pushing it into the future).

The monetary authority chooses P to maximize welfare

$$\max_P \left[\begin{array}{r} \max\limits_{\tau,g,B',\{T_i\}_1^n} W_\theta(\tau,g) + \frac{\sum_i T_i}{n} + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right] \\ \text{s.t. } \; T_i \geq 0 \;\forall i, S_\theta(\tau,g,B';\frac{B}{P}) \geq \sum_i^n T_i \end{array}\right] \tag{16}$$

Combining the monetary and fiscal authority's problems and simplifying we can write this recursively for a given bond level B as

$$v_\theta(B) = \max_P \left[\begin{array}{l} \max\limits_{\tau,g,B'} W_\theta(\tau,g) + \frac{S_\theta(\tau,g,B';\frac{B}{P})}{n} + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right] \\ \quad \text{s.t. } \; S_\theta(\tau,g,B';\frac{B}{P}) \geq 0 \end{array}\right] \tag{17}$$

Solving the monetary authority's problem for optimal P yields the monetary authority's pricing function $P(B)$

$$P(B) = \begin{cases} \infty, & \text{if } B > 0 \\ 1, & \text{if } B = 0 \\ \min\{1, \frac{B}{\underline{B}}\}, & \text{if } B < 0 \end{cases} \tag{18}$$

At the beginning of a period the monetary authority will face three possibilities for the number of nominal bonds: a positive amount of nominal bonds (the government is in debt), no nominal bonds, or a negative amount of nominal bonds (the government is owed revenue). For a positive amount of nominal bonds, the monetary authority erases the entire real value of the bonds by setting the price level to infinity. This allows the benevolent fiscal authority to lower taxes since it no longer needs to raise revenue to pay off bonds. Because taxes are distortionary lower taxes translates into higher welfare.

If there are no nominal bonds, the price level does not affect welfare. Bonds are the only nominal quantity in the maximization problem. If there are no bonds the price level does not matter. The monetary authority will then set the price level to its default value of 1 as explained in Section 3.2.2. If there are a negative amount of nominal bonds, the monetary authority will deflate (if necessary) until the real value of society's debt to equal the Samuelson level $\underline{B}$.

Claim 1. *The benevolent fiscal authority's solution is to issue 0 bonds to raise 0 revenue in every period or to purchase $\underline{B}$ bonds in the first period and 0 bonds thereafter. See Figure 3 for an illustration.*

Insert "Revenue with a Benevolent Fiscal Authority" figure here.

The behavior of the monetary authority drives the result. The benevolent fiscal authority is unable to raise revenue from nominal bonds because the monetary authority will erase their real value every period. Thus there will be no bond revenue available for tax smoothing.

As shown by Aiyagari et al. (2002) and Battaglini and Coate (2008), the fiscal authority would optimally have a negative level of bonds. This allows the government to fund itself via bond remittances rather than distortionary labor taxation. In those papers the government accumulates a stockpile of real bonds over time.

In this paper the word accumulate is inappropriate: all bonds must be stockpiled by the government in a single period. If citizens hold any negative amount of bonds the monetary authority will deflate until the real value of those bonds equals the Samuelson level $\underline{B}$. Hence consumers will demand full compensation for the entire amount of $\underline{B}$ negative bonds immediately; there will be no time to accumulate a stockpile. In that single period, distortionary taxes would be extremely high to fund the bond purchases. This would have a tremendous negative welfare impact that may not be offset by the lowered cost of revenue in the future.

3.2. The Self-Interested Fiscal Authority's Problem

Following the outline of Barseghyan et al. (2013), I focus on a symmetric Markov-perfect equilibrium. These are proposals that depend on current productivity and real debt $\{w_\theta, \frac{B}{P}\}$ where $\theta \in \{h, l\}$. The proposals are independent of both the history of the economy and proposal round. A citizen will vote for a proposal if it makes him at least as well off as waiting for the next proposal round will. Hence a proposer will propose fiscal instruments that make citizens indifferent between voting for a proposal and waiting for the next round. I choose equilibria where proposals in each round are voted for by the necessary $m-1$ citizens (and the proposer). This means that the equilibrium path consists of a single round with a single proposal that is voted for by the necessary citizens.

The equilibrium is a set of fiscal proposals for each round $r \in \{1, \ldots, T\}$ for the tax rate, public good spending, bond level and transfers $\{\tau^r, g^r, B'^r, T_i^r\}$. The transfers will be used by the proposer to convince a random group of $m-1$ other citizens to support the proposal. Revenue not spent on transfers or public good spending is the effective transfer to the proposer. An equilibirum defines a value function $v_\theta^r(B)$ for each round representing the expected continuation payoff value for a citizen. The last value function $v_\theta^{T+1}(B)$ is the result of the default proposal by the dictator appointed after round T.

Given a set of value functions $\{v_\theta^r(B)\}_{r=1}^{T+1}$ the fiscal proposals must satisfy the proposer's maximization problem. Similarly the fiscal proposals define the optimal value functions. I start with the first relationship. Since the first proposal in the first round is accepted, I drop the r superscripts for simplicity. Formally, given the value functions the optimization problem for the fiscal proposals can be written as

$$\max_P \left[\begin{array}{rl} \max\limits_{\tau,g,B',T_i} & W_\theta(\tau,g) + S_\theta(\tau,g,B';\frac{B}{P}) - (m-1)T_i + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right] \\ \text{s.t.} & W_\theta(\tau,g) + T_i + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right] \geq v_\theta^{r+1}(B) \\ & T_i \geq 0 \ \forall i, S_\theta(\tau,g,B';\frac{B}{P}) \geq (m-1)T_i \end{array} \right] \tag{19}$$

where the maximization over P represents the choice of the monetary authority that turns current nominal debt B into real debt $\frac{B}{P}$ the fiscal authority must repay. The first constraint is the incentive compatibility constraint that states the proposal must make those citizens receiving a transfer at least as well off in expectation as they would be if they waited for the next proposal round. The other constraints force the proposal to be feasible given government's budget constraint.

Given fiscal choices the value functions are determined by[4]

$$v_\theta(B) = \max_P \left[W_\theta(\tau,g) + \frac{S_\theta(\tau,g,B';\frac{B}{P})}{n} + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right] \right] \tag{20}$$

This expression comes from the three possibilities for a citizen in a proposal round. With probability $1/n$ a citizen is the proposer and thus receives the surplus after transfers. With probability $\frac{m-1}{n}$ a citizen is not the proposer but is a member of the randomly selected coalition that votes for the proposal and

[4]It's helpful to remember that $P = P(B)$ is a function of the current amount of bonds as are all other fiscal choices. Specifically, $S_\theta(\tau,g,B';\frac{B}{P})$ can be written as $S_\theta(\tau,g,B';P(B))$ to highlight that B is the only state variable.

thus receives the transfer T_i. With probability $\frac{n-m}{n}$ a citizen is not in the proposer's coalition and receives no transfer. Since utility is quasilinear, the expected utility in a round is the payoff multiplied by the probability.

Because the first proposal is accepted in each round and all proposals will be identical, the value functions will be identical for every proposal round $r \in \{1, \ldots, T\}$. If the round T proposal is rejected, the round $T+1$ dictator's proposal will result in the value function

$$v_\theta^{T+1}(B) = \max_P \left[\max_{\tau, g, B'} W_\theta(\tau, g) + \frac{S_\theta(\tau, g, B'; \frac{B}{P})}{n} + \beta \left[\pi v_H (B') + (1-\pi) v_L (B') \right] \right] \tag{21}$$

subject to uniform transfers and the same feasibility constraints as before.

I characterize this equilibrium in the next section and prove its existence in the appendix.

3.2.1. Characterization of Self-Interested Fiscal Authority's Problem

The self-interested fiscal authority's problem combined with the monetary authority's choice of P is

$$v_\theta(B) = \max_P \left[\begin{array}{r} \max\limits_{\tau, g, B', \{T_i\}_1^n} W_\theta(\tau, g) + \dfrac{\sum_i T_i}{m} + \beta \left[\pi v_H (B') + (1-\pi) v_L (B') \right] \\ \text{s.t. } \; T_i \geq 0 \; \forall i, S_\theta(\tau, g, B'; \dfrac{B}{P}) \geq \displaystyle\sum_i^n T_i \end{array} \right] \tag{22}$$

The self-interested fiscal authority's optimization problem differs from the benevolent fiscal authority's problem only in potential transfers. If there are no transfers, the problem is identical to that of the benevolent fiscal authority hence the optimal choices are identical. If there are transfers the optimal choices are

$$\frac{n}{m} = \frac{1-\tau^*}{1-\tau^*(1+\epsilon)} \tag{23}$$

$$\frac{n}{m} = \frac{nA}{g^*} \tag{24}$$

$$B^{'*} = \arg\max_{B'} \left[\frac{qB'}{m} + \beta \left[\pi v_H (B') + (1-\pi) v_L (B') \right] \right] \tag{25}$$

The left hand side $\frac{n}{m}$ term represents the amount each individual in the governing coalition will receive as a transfer if an additional unit of revenue is raised from every consumer. The first equation shows the marginal benefit to coalition members from additional revenue is equal to the marginal cost of raising that additional unit by distortionary taxation. The second equation displays the choice of the government to spend revenue: the marginal benefit of transfers to the governing coalition is equal to the marginal benefit from using that revenue on public good spending. The third equation balances the optimal amount of bonds to issue to fund increased transfers versus the cost of increased bonds in the next period.

When there are transfers the tax rate, government spending, and level of bonds $\{\tau^*, g^*, B^{'*}\}$ will be constant. The government will raise revenue from taxes τ^* and bonds $B^{'*}$. It will spend g^* on the public good. Whatever revenue is left over after that spending will be used to fund transfers.

We can determine when there will be transfers. If the revenue from taxes τ^* and bonds $B^{'*}$ is sufficient to cover spending g^* on the public good, there will be transfers. Thus there is a cutoff

$$C_\theta = \text{Rev}_\theta(\tau^*) + qB'^* - g^* \tag{26}$$

which is the amount of bonds such that $S_\theta(\tau^*, g^*, B'^*; C_\theta) = 0$. If the current level of bonds in the period is above C_θ there will be no revenue for transfers. Thus the optimization problem will be identical to that of the benevolent fiscal authority. If the current level of bonds is below C_θ there will be transfers while taxes, public good spending and bond issuance are $\{\tau^*, g^*, B^{'*}\}$ respectively.

The problem can be simplified to resemble that with a benevolent fiscal authority

Claim 2. *The equilibrium value functions $v_H(B')$ and $v_L(B')$ solves the equa-*

tion

$$v_\theta(B) = \max_{P} \left[\begin{array}{c} \max\limits_{\tau,g,B'} W_\theta(\tau,g) + \dfrac{S_\theta(\tau,g,B';\frac{B}{P})}{n} + \beta\left[\pi v_H(B') + (1-\pi) v_L(B')\right] \\ s.t.\ \ \tau \geq \tau^*, g \leq g^*, B' > B'^*, S_\theta(\tau,g,B';\dfrac{B}{P}) \geq 0 \end{array} \right] \tag{27}$$

and equilibrium policies $\{\tau_\theta(\frac{B}{P}), g_\theta(\frac{B}{P}), B_\theta(\frac{B}{P})\}, P_\theta(B)$ *are the optimal policies.*

The new constraints are limits on the lowest taxes, highest government spending and least bonds. If there are transfers, these three variables will equal their starred values.

The monetary authority chooses P to maximize welfare[5]

$$P_\theta(B) = \begin{cases} \frac{B}{C_\theta}, & \text{if } B > C_\theta \\ 1, & \text{if } B \leq C_\theta \end{cases} \tag{28}$$

See Figure 4 for an illustration. If the amount of nominal bonds is less than the bond cutoff this means there are transfers. If the monetary authority were to increase the price level, the amount of debt the self-interested fiscal authority must repay will go down. Thus revenue the self-interested fiscal authority had originally directed to bond repayment will instead go to transfers while taxes and government spending will remain constant at τ^* and g^*. The total decrease in the real value of nominal bond holdings is equal to the total increase in transfers. Because utility is quasilinear it does not matter who gains and who loses: increasing the price level will not change welfare hence the monetary authority will keep the price level constant.

Insert "The Monetary Authority's Decision with a Self-Interested Fiscal Authority" figure here

If the amount of nominal bonds is greater than or equal to the bond cutoff there will be no transfers. The self-interested fiscal authority's optimization

[5]This pricing requires $C_\theta \geq 0$. If $C_\theta = 0$ the second condition would be $P = \infty$ The issue arises because the monetary authority can't change a positive level of bonds into a negative one (nor vice-versa) since $P > 0$. $C_\theta < 0$ implies that even if the government accumulated a surplus there would be no transfers, an unlikely situation.

problem is identical to that of the benevolent fiscal authority. Hence the monetary authority's problem is also identical. The monetary authority will erase the real value of bonds by increasing the price level as long as the fiscal authority will use the newly freed revenue to decrease taxes rather than increase transfers. By definition this is the case as long as the amount of nominal bonds is greater than or equal to the bond cutoff.

Claim 3. *The self-interested fiscal authority's solution is to issue C_h bonds that raise $\beta(\pi C_h + (1-\pi)C_l)$ revenue in every period. See Figure 5 for an illustration.*

Insert "Revenue with a Self-Interested Fiscal Authority" figure here

The self-interested fiscal authority issues C_h bonds because that level maximizes the amount of revenue raised while holding taxes and government spending at their constant, starred values. Issuing more bonds raises no additional revenue because the monetary authority will inflate away those bonds no matter the realization of the wage shock. If the self-interested fiscal authority issues less than C_h bonds it will forego revenue that would be available upon a good realization of the shock.

To clarify as much as possible: on the equilibrium path, the fiscal authority will always issue C_h bonds while setting taxes to τ^* and public good spending to g^*. The monetary authority will choose $P = 1$ if the wage shock is w_h and will choose $P = \frac{C_h}{C_l}$ if the wage shock is w_l. Inflation is used as a method to make non-state contingent bonds state-contingent as in Bohn (1988).

The fiscal authority uses the revenue freed by inflating away the real amount the government owes to perfectly smooth taxes across periods. For any realization of the wage shock and any bond level, taxes will be constant at τ^* and government spending constant at g^*. These are the lowest possible taxes and highest possible spending. Thus this equilibrium has the highest possible welfare within the constraints of the model.

3.2.2. Equilibrium Existence

Definition 1. *An equilibrium is a collection of value functions $v_\theta(B)$, fiscal choices $\tau_\theta(\frac{B}{P}), g_\theta(\frac{B}{P}), B'_\theta(\frac{B}{P})$, monetary choice $P_\theta(B)$, expectations about the interest rate $q_\theta(B)$ for $\theta \in \{h, l\}$, such that given $v_\theta(B)$ and $q_\theta(B)$, the fiscal choices solve the fiscal authority's problem and given $v_\theta(B)$ and $q_\theta(B)$, the monetary choice $P_\theta(B)$ solves the monetary authority's problem where given fiscal choices, monetary choice, and $q_\theta(B)$, $v_\theta(B)$ are optimal.*

We only need the value functions and debt state variable to establish the equilibrium. Everything can be derived, as above, from those.

Claim 4. *If the value functions $v_H(B'), v_L(B')$ satisfy Claim 2, and optimal debt satisfies Equation 25, then there is an equilibrium in which $v_H(B'), v_L(B')$ are proposed and accepted in the first round of voting, and fiscal choices $\tau_\theta(\frac{B}{P}), g_\theta(\frac{B}{P}), B'_\theta(\frac{B}{P})$ and monetary choice $P_\theta(B)$ are optimal. Existence is then established by showing the joint optimality of the value functions and fiscal and monetary choices*

Due to linear utility there may be a non-singleton set of price levels P that result in identical welfare. I impose two price selection criteria. First, absent welfare gains, the monetary authority will set the price level to 1. This default price level is a normalization brought on by specifying that bonds return 1 unit of nominal income.

Second, the monetary authority will deviate from $P = 1$ only for positive welfare gains. When the monetary authority determines the price level, it will minimize $|P - 1|$ while maximizing welfare. For a welfare level k the set $\{P \text{ s.t. } v(B) = k\}$ where $v(B)$ is the welfare function may not be a singleton. As an equilibrium choice, I assume the government always chooses the element of this set that minimizes $|P - 1|$. These requirements mimic an aversion to inflation and deflation.

Similarly, there may be a non-singleton set of bond amounts B' that result in the same bond revenue $qB' = E\left[\frac{1}{P(B')}\right] B'$. For a revenue level k the set $\{qB = k\}$ may not be a singleton. Amongst all possible choices in this set, I select the equilibrium where the fiscal authority always chooses the minimum element.

3.3. Main Results

Proposition 1. *A self-interested fiscal authority is able to support a positive level of nominal bonds while a benevolent fiscal authority is unable to do so.*

Claims 1 and 3 establish this proposition. A benevolent fiscal authority paired with a benevolent monetary authority will be unable to raise revenue from nominal bonds. Changing the benevolent fiscal authority to a self-interested fiscal authority allows the fiscal authority to raise revenue by issuing nominal bonds.

As long as there is sufficient need for the tax smoothing that bonds allow, welfare will also be higher with a self-interested fiscal authority. Specifically, the productivity shocks w_h, w_l and corresponding probabilities must be large enough such that

$$\sum_t \beta^t W_\theta(\tau^*, g^*) > \sum_t \beta^t W_\theta(\tau_0, b_0) \tag{29}$$

where τ_0, b_0 are the tax rate and public good spending that prevail without the possibility of bonds. The left side is a constant while the right can be derived from the benevolent monetary authority's first order condition without bonds and the government's budget constraint.

I now compare the possibilities for monetary policy.

Definition 2. *Price level commitment is defined as $P = k$ for some k for all periods*[6]*. Discretionary monetary policy is defined as $P = P(B)$ at the start of every period.*

The definition of price level commitment is equivalent to the fiscal authority issuing indexed rather than nominal bonds: the monetary authority has no

[6]The requirement that commitment holds for all periods is unnecessary but simplifying for what follows; price commitment of any length suffices.

control over the price level and thus no control over the real value of nominal bonds. This is the natural definition of price level commitment due to the restrictions on the monetary authority's price function discussed in Section 2.4. More generally, commitment by the monetary authority to any pricing function $P(B)$ other than the ones derived previously will result in lower welfare by construction. Price level commitment is an extreme example. Other examples of commitment would be to pricing functions that ignore fiscal choices or respond insufficiently strongly to fiscal deviations.

Proposition 2. *Price level commitment by a monetary authority with a self-interested fiscal authority and nominal bonds results in lower welfare than discretionary monetary policy.*

Claim 3 shows that discretionary monetary policy leads to the lowest tax rate τ^* and highest public good spending g^* possible. By definition these values are synonymous with the highest possible welfare. The monetary authority uses revenue freed by inflation rather than the distortionary labor tax to repay bonds. To prove Proposition 2 I need to establish that price level commitment leads to taxes and government spending that are not τ^*, g^* for at least single period. The situation with price level commitment is similar to Barseghyan et al. (2013); the main difference is that shocks in this paper are not persistent.

Intuitively the fiscal authority will have to use tax revenue rather than inflation to smooth taxes between periods. Since taxes are distortionary this will lead to lower welfare. With price level commitment the self-interested fiscal authority will issue what will be ex-post too many bonds because it doesn't know the realization of tomorrow's productivity shock. The benefit of bonds is that they increase transfers today, the cost is the possibility that repaying the bonds will require higher taxes tomorrow. If the shock is w_h the tax rate τ^* will raise sufficient revenue to repay the bonds. If the shock is w_l, the tax rate τ^* won't raise sufficient revenue to repay the bonds thus necessitating higher taxes. But there is only a $1-\pi$ probability of the bad shock w_l so the fiscal authority issues bonds hoping it does not happen. If it does, taxes will be higher than τ^* leading to lower welfare.

In contrast to price level commitment, a monetary authority with a self-interested fiscal authority could choose a Markov strategy of setting $P = \infty$ for any amount of nominal bonds, thus eliminating bonds. This no bonds equilibrium is weakly worse than the equilibrium described in the paper. Whether or not bonds are available, a self-interested fiscal authority will set taxes at τ^* at a minimum and government spending at g^* at a maximum. Those are the same values which the paper's equilibrium supports for all periods. The starred values τ^*, g^* themselves are not dependent on the amount of bonds available (though the cutoff C_θ is). Without bonds, no smoothing will be possible, hence the possibility of worse welfare outcomes.

3.3.1. Connection to the Fiscal Theory of the Price Level

As summarized by Bassetto (2008), the Fiscal Theory of the Price Level (FTPL) holds that the price level is determined by the government budget constraint viewed as a bond valuation equation:

$$\frac{B}{P} = \text{Present value of fiscal surpluses} \tag{30}$$

where P is the price level, B is the amount of nominal bonds, and surpluses are controlled by the spending and tax decisions of the fiscal authority. If the fiscal authority changes the present value of surpluses, for example by lowering taxes permanently with no concomitant reduction in public spending, the price level P will automatically adjust to equalize the two sides of the equation.

This paper shares some elements with the FTPL because of its emphasis on the interaction between authorities with the monetary authority threatening responses to fiscal choices through control of the government's budget constaint. However, there are two important differences. First, the monetary authority directly controls P: the price level does not adjust automatically. While the paper does not provide microfoundations for this control, it is an equilibrium choice by the monetary authority rather than an outcome. Second, the default timing of the paper prevents FTPL-type situations where the fiscal authority determines the price level because the monetary authority moves first. Both of these results are tied to viewing the government's budget constraint to be a constraint rather than an equilibrium outcome as the FTPL does.

The alternative timing, where the fiscal authority chooses before the monetary authority, is more similar to the situation of active fiscal policy as in Leeper (1991). While this timing shares with the FTPL the idea that the fiscal authority's choices force changes in the price level, the outcome is different. The price level does not adjust automatically, instead there is a problem of fiscal commitment that results in no nominal bonds, and thus an indeterminate price level.

With the alternative timing, the fiscal authority won't raise revenue for bond repayment via distortionary taxes because it knows the monetary authority will inflate away the value of any bonds that are due. By not raising tax revenue, the fiscal authority forces the monetary authority to raise the price level P thus lowering the amount of tax revenue necessary to repay bonds to ensure the government's budget constraint holds. Because the the monetary authority will inflate away the real value of any nominal bonds, no revenue is possible from nominal bonds.

This timing has more similarities to the unpleasant monetarist arithmetic of Sargent and Wallace (1981) which holds that seignorage, as a consequence of printing money and thus changing the price level, rather than the price level itself will adjust to equalize the government's budget constraint. Since seignorage is rebated to government, it also changes the composition of fiscal surpluses. This paper does not have money, so the monetary authority cannot change the amount of seignorage. Moreover, the linear nature of the inflation tax is first best so the monetary authority would choose to use it rather than distorting along other dimensions.

4. Conclusion

Price commitment is a dangerous thing. Discretionary monetary policy keeps fiscal policy in line. Monetary price commitment gives the fiscal authority the power to ignore monetary constraints. Counterintuitively, giving the monetary authority commitment lessens its power over the fiscal authority to the detriment of overall welfare.

This paper shows that monetary policy benefits from distorted fiscal policy. Without an explicit commitment mechanism, revenue from nominal bonds is possible only if fiscal policy is self-interested. Although the utility functions of the monetary and fiscal authorities will differ, the overall outcome is better for the monetary authority's goal of maximizing welfare than when they are identical.

The source of the welfare gain is a desire by the monetary authority to avoid what it views as waste. Eliminating the entire debt burden of a self-interested fiscal authority leads to wasteful spending. Controlling the self-interested fiscal authority provides justification for nominal bonds. Indexed bonds, as in the case of price level commitment, allow a self-interested fiscal authority to act without constraint. If the power to choose the type of bonds is vested in either the monetary authority or citizens, they will choose nominal bonds.

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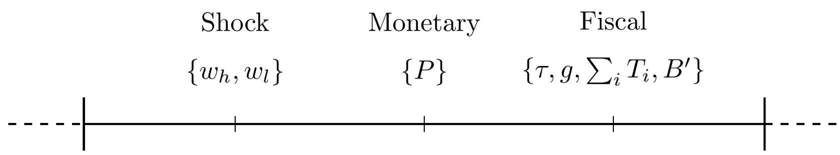

Figure 1: Timing of Monetary and Fiscal Decisions

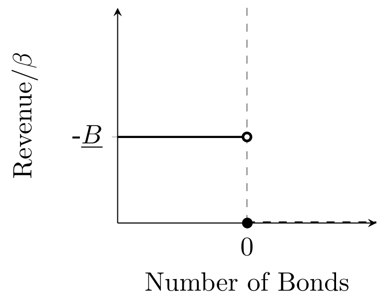

Figure 2: Revenue with a Benevolent Fiscal Authority

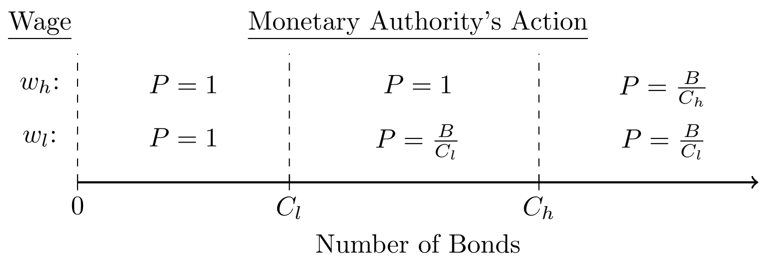

Figure 3: The Monetary Authority's Decision with a Self-Interested Fiscal Authority

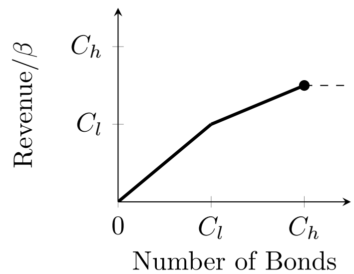

Figure 4: Revenue with a Self-Interested Fiscal Authority

Appendix A. Appendix to Commitment versus Discretion in a Political Economy Model of Fiscal and Monetary Policy Interaction

Appendix A.1. Proof of Propositions 1 and 2

I begin by proving Claim 1 that the benevolent fiscal authority suffers from time inconsistency and cannot raise revenue from nominal bonds.

Appendix A.1.1. Proof of Claim 1

To do this it suffices to show that

$$P(B) = \begin{cases} \infty, & \text{if } B > 0 \\ 1, & \text{if } B = 0 \\ \frac{B}{\underline{B}}, & \text{if } \underline{B} < B < 0 \\ 1, & \text{if } B \leq \underline{B} \end{cases} \tag{A.1}$$

Concentrating on the case of $B > 0$, I show that welfare always increases as the real value of bonds is diminished, thus there is always an incentive for the monetary authority to increase the price level.

To find the appropriate price level, choose $B_0 > 0$. I will build a non-optimal function $\phi_\theta(B)$ that equals $v_\theta(B)$ at B_0 but is less elsewhere (and strictly concave). This will fulfill the conditions of Theorem 4.10 of Stokey et al. (1989) stating that derivatives of $v_\theta(B)$ are equal to the derivatives of $\phi_\theta(B)$ at B_0. For clarity and notational simplicity let $b = \frac{B}{P(B)}$ and $b_0 = \frac{B_0}{P(B_0)}$.

Choose B from a neighborhood of B_0. Define

$$g(b) = \text{Rev}\left(\tau(b_0)\right) + qB'(b_0) - b \tag{A.2}$$

which is a non-optimal amount of government spending while still fulfilling debt repayment obligations. The amount of transfers will be the residual after paying back b bonds

$$S_\theta(\tau_\theta(b_0), g(b), B'(b_0); b) = \text{Rev}\left(\tau(b_0)\right) + qB'(b_0) - g(b) - b \tag{A.3}$$

Define the non-optimal utility function to be

$$\phi_\theta(B) = \max_P W\left(\tau(b_0), g(b)\right) + \frac{S_\theta(\tau_\theta(b_0), g(b), B'(b_0); b)}{n} \tag{A.4}$$

$$+ \beta\left[\pi v_H\left(B'(b_0)\right) + (1-\pi) v_L\left(B'(b_0)\right)\right] \tag{A.5}$$

$$= \max_P \Gamma_\theta(B) \tag{A.6}$$

Expand the indirect utility and transfers terms. The terms dependent on P are the direct utility benefit of government spending, the bond holdings of the household in the current period, and transfers. Differentiate the right hand side, noting that the terms dependent on P in transfers will cancel, and find

$$\frac{\partial \Gamma_\theta(B)}{\partial P} = -\frac{B}{P^2} + \frac{A}{g}\left(\frac{B}{P^2}\right) \tag{A.7}$$

$$= -\frac{B}{P^2} + \left[\frac{1-\tau\left(\frac{B}{P}\right)}{1-\tau\left(\frac{B}{P}\right)(1+\epsilon)}\right]\left(\frac{B}{nP^2}\right) \tag{A.8}$$

$$= \left[\frac{\epsilon\tau\left(\frac{B}{P}\right)}{1-\tau\left(\frac{B}{P}\right)(1+\epsilon)}\right]\left(\frac{B}{nP^2}\right) > 0 \tag{A.9}$$

where I've substituted in the first order condition of the fiscal authority. Taking the second derivative confirms the necessary conditions. A similar construction proves the case for $B < 0$.

Appendix A.1.2. Proof of Claim 2

Showing that the self-interested fiscal authority's problem is equivalent to

$$v_\theta(B) = \max_P \left[\begin{array}{ll} \max_{\tau, g, B'} & W_\theta(\tau, g) + \frac{S_\theta(\tau, g, B'; \frac{B}{P})}{n} + \beta\left[\pi v_H\left(B'\right) + (1-\pi) v_L\left(B'\right)\right] \\ \text{s.t.} & \tau \geq \tau^*, g \leq g^*, B' \in \left[B'^*, \overline{B}\right] \\ & S_\theta(\tau, g, B'; \frac{B}{P}) \geq 0, \forall k \; B' = \min\{B' : qB' = k\} \end{array}\right] \tag{A.10}$$

follows from the bond cutoff C_θ. If bonds are below C_θ the first order conditions set $\{\tau^*, g^*, B^*\}$ and the excess revenue is transferred to the m coalition. With linear utility splitting 1 dollar of transfers between m citizens has the same welfare effect as splitting 1 dollar between n citizens.

If bonds are above or equal to C_θ our problem is identical to benevolent fiscal policy. At C_θ our constraints just bind to $\{\tau^*, g^*, B^*\}$. Derivatives $\frac{\partial \tau}{\partial B} \geq 0$, $\frac{\partial g}{\partial B} \leq 0$ so for bonds above C_θ we have $\tau \geq \tau^*, g \leq g^*$.

Appendix A.1.3. Proof of Claim 3

To prove Claim 3 regarding the optimal choices of a self-interested fiscal authority I need to show the pricing function

$$P(B) = \begin{cases} \frac{B}{C_\theta}, & \text{if } B > C_\theta \\ 1, & \text{if } B \leq C_\theta \end{cases} \tag{A.11}$$

I follow the same steps as with a benevolent fiscal authority in proving Claim 1. The first order condition for the monetary authority with a self-interested fiscal authority is

$$\frac{\partial \Gamma_\theta(B)}{\partial P} = \begin{cases} \left[\frac{\epsilon \tau_\theta(\frac{B}{P})}{1-\tau_\theta(\frac{B}{P})(1+\epsilon)}\right] \frac{B}{nP^2}, & \text{if } B > C_\theta \\ 0, & \text{if } B < C_\theta \end{cases} \tag{A.12}$$

If $\frac{B}{P} > C_\theta$ the self-interested fiscal authority's problem is identical to the benevolent fiscal authority's problem hence the derivative is equal. When $\frac{B}{P} < C_\theta$ the derivative can be taken directly from the definition of $v(B)$. Increasing the price level causes no change in taxes or government spending which are pegged at τ^*, g^* respectively.

The mechanism behind this result is that increasing the price level decreases the real value of debt and thereby decreases the wealth of all n citizens. Revenue previously used to repay the debt is freed and the self-interested fiscal authority redirects it into transfers to the m citizens in the coalition. Because utility is linear taking 1 unit of wealth from n citizens while giving n/m to m citizens results in identical welfare from the perspective of the benevolent monetary authority.

To establish the full pricing function I need to show that the value function is constant for all $B \leq C_\theta$. The derivative establishes that $v(B)$ is maximized on $B < C_\theta$, I need to show the value is identical on the boundary C_θ. By definition at C_θ and below the tax rate, public good spending and bond issuance are

(τ^*, g^*, B'^*). As explained above, a lower amount of bonds means less wealth but more transfers. The two effects offset hence the set of maximizers of $v(B)$ includes the bound C_θ.

Claim 3 says that a self-interested fiscal authority will issue C_h bonds. Revenue from issuing bonds is used to either lower the current tax rate or increase transfers. Both of these result in gains for the self-interested fiscal authority. Hence the self-interested fiscal authority will attempt to maximize bond revenue. Claim 3 is equivalent to stating that revenue is maximized by issuing C_h bonds. The core of the argument is that issuing more bonds than C_h will result in no additional revenue due to an offsetting rise in the price level, issuing fewer bonds than C_h will result in foregone revenue if tomorrow has high productivity.

Assume the self-interested fiscal authority issues $B_0 \in (C_l, C_h)$ bonds. There are two possibilities for the next period. If the shock is w_h, The price level P' will be 1 hence the real value of the bonds will be B_0. If the shock is w_l, the price level will be $P' = \frac{B_0}{C_l}$ hence the real amount of bonds will be C_l. Thus issuing B_0 bonds results in revenue of $\beta(\pi B_0 + (1-\pi)C_l)$.

Compare this revenue level to the revenue level that would result if the self-interested fiscal authority issued C_h bonds. If the shock is w_h, the price level P' will be 1 hence the real value of the bonds will be C_h. If the shock is w_l, the price level will be $P' = \frac{C_h}{C_l}$ hence the real amount of bonds will be C_l. Thus issuing C_h bonds results in revenue of $\beta(\pi C_h + (1-\pi)C_l)$.

Issuing C_h bonds raises the maximum possible amount of revenue. From the perspective of the benevolent monetary authority welfare (i.e. the value function at the beginning of next period) is identical at B_0 and C_h. There is no harm to welfare from issuing C_h bonds and there is a gain to the coalition of the self-interested fiscal authority in doing so.

Proposition 1 is proved by comparing the optimal pricing functions of Claims 1 and 3. The benevolent fiscal authority can issue either 0 bonds or must immediately issue the Samuelson level $\underline{B}$. In the former case there is autarky period to period. In the latter case distortionary labor taxes will be 0 forever.

To prove Proposition 2 I need to show that with price level commitment the tax level will deviate from the minimum τ^* for a single period. The model with price level commitment is equivalent to a simplified version of Barseghyan et al. (2013). See the paper for an in-depth description of the dynamics of the model. Without a monetary authority to keep debt at the bond cutoff C_θ, debt will exceed the cutoff. Specifically it will do so in periods of low realizations of the productivity shock. A self-interested fiscal authority will attempt to fund transfers today by counting on a good realization w_h of the shock tomorrow. The good realization would allow bond repayment with the minimum labor tax τ^*. If tomorrow productivity is low at w_l, taxes will exceed the minimum value.

Appendix A.1.4. Proof of Claim 4

I follow the outline of Barseghyan et al. (2013) (specifically Propositions 1, 2 and 3) and Battaglini and Coate (2008) to show the value functions are properly defined and converge. Note that the value functions in this paper are almost identical to those in Barseghyan et al. (2013). The addition of the monetary authority and nominal bonds effectively restricts the domain of possible bonds to $[\underline{B}, C_h]$.

Define $\tilde{v}_\theta$ as the value function and $\tilde{B}'$ as the bond level such that the value function solves the optimization problem given $\tilde{B}'$ while the bond level solves the appropriate optimality condition given $\tilde{v}_\theta$. Define $\{\tilde{\tau}(\frac{B}{P}), \tilde{g}(\frac{B}{P}), \tilde{B}'(\frac{B}{P})\}$ to be the fiscal policy choices conditional on the value function $\tilde{v}_\theta$ and bond level $\tilde{B}'$.

Because we're looking at an equilibrium where the first proposal is identical and accepted in every proposal round I don't include superscripts to denote the round in which a proposal takes place. Define transfers for each round $r \in \{1, \ldots, T-1\}$ as

$$T_\theta^r = \frac{S_\theta(\tau, g, B'; \frac{B}{P})}{n} \tag{A.13}$$

and for round T where failure to approve a proposal results in the appointment of a dictator and a default proposal

$$T_\theta^T = v_\theta^{T+1}(B) - W_\theta(\tau, g) - \beta \left[\pi v_H\left(B'\right) + (1-\pi) v_L\left(B'\right)\right] \tag{A.14}$$

where $v_\theta^{T+1}(B)$ is the default proposal.

By construction the value functions for each proposal round are identical and equal to the proposed $\tilde{v}_\theta(B)$

We can now show that the fiscal proposals and value functions describe an equilibrium by showing the joint optimality of the value functions and fiscal choices. In each round, the fiscal policy proposals must solve

$$v_\theta(B) = \max_P \left[\begin{array}{c} \max_{\tau,g,B'} W_\theta(\tau,g) + \left[S_\theta(\tau,g,B';\frac{B}{P}) - (m-1)T \right] + \beta \left[\pi v_H\left(B'\right) + (1-\pi) v_L\left(B'\right) \right] \\ \text{s.t.} \quad \begin{array}{l} W_\theta(\tau,g) + T + \beta \left[\pi v_H\left(B'\right) + (1-\pi) v_L\left(B'\right) \right] \geq \Gamma_\theta^{r+1}(b) \\ S_\theta(\tau,g,B';\frac{B}{P}) \geq (m-1)T, T \geq 0 \end{array} \end{array} \right] \tag{A.15}$$

where $\Gamma^r = \tilde{v}_\theta^r(b)$ for $r \in \{1,\ldots,T-1\}$, $\Gamma^{T+1} = v_\theta^{T+1}(B)$ is the set of possible continuation values if a proposal is not approved. The first constraint on the proposal is the incentive compatibility constraint for citizens. It ensures citizens vote for a proposal if it makes them at least as well off as they expect to be if they wait for the next round and next proposal.

For a given proposal round suppose $(\hat{\tau},\hat{g},\hat{B}',\hat{T})$ is the proposal. This means the proposal solves

$$\max_{\tau,g,B',\{T_i\}_1^n} W_\theta(\tau,g) + \frac{S_\theta(\tau,g,B';\frac{B}{P})}{m} + \beta \left[\pi v_H\left(B'\right) + (1-\pi) v_L\left(B'\right) \right] \tag{A.16}$$

$$\text{s.t. } S_\theta(\tau,g,B';\frac{B}{P}) \geq 0 \tag{A.17}$$

which defines the remaining surplus as

$$\hat{T} = \tilde{v}_\theta(B) - W_\theta(\hat{\tau},\hat{g}) - \beta \left[\pi \tilde{v}_H(\hat{B}) + (1-\pi)\tilde{v}_L(\hat{B}) \right] \tag{A.18}$$

Suppose there is a fiscal proposal $(\tau^\circ, g^\circ, B'^\circ, T^\circ)$ that results in a higher value for the proposer. I will construct a contradiction using this new set of proposals and the definition of T°. Since the new proposals result in larger values, we know that

$$T^\circ \geq \tilde{v}_\theta(B) - W_\theta(\tau^\circ, g^\circ) - \beta \left[\pi \tilde{v}_H(B'^\circ) + (1-\pi)\tilde{v}_L(B'^\circ) \right] \tag{A.19}$$

where the round's continuation value $\tilde{v}_\theta(B)$ has remained the same. Applying this definition to the proposer's problem

$$W_\theta(\tau^\circ, g^\circ) + S_\theta(\tau^\circ, g^\circ, B'^\circ; \frac{B}{P}) - (m-1)T^\circ + \beta\left[\pi\tilde{v}_H(B'^\circ) + (1-\pi)\tilde{v}_L(B'^\circ)\right] \tag{A.20}$$

$$\leq q\left(W_\theta(\tau^\circ, g^\circ) + \beta\left[\pi\tilde{v}_H(B'^\circ) + (1-\pi)\tilde{v}_L(B'^\circ)\right]\right) + S_\theta(\tau^\circ, g^\circ, B'^\circ; \frac{B}{P}). \tag{A.21}$$

But the last equation (without the multiplication by q) is the objective function $(\hat{\tau}, \hat{g}, \hat{B}', \hat{T})$ are defined as solving. To show the equilibrium exists we need to show that v_θ and the fiscal proposals are jointly optimal. This means that v_θ is the solution to

$$v_\theta(B) = \max_P \begin{bmatrix} \max\limits_{\tau,g,B'} W_\theta(\tau, g) + \dfrac{S_\theta(\tau, g, B'; \frac{B}{P})}{n} + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right] \\ \text{s.t.} \;\; \tau \geq \tau^*, g \leq g^*, S_\theta(\tau, g, B'; \dfrac{B}{P}) \geq 0 \end{bmatrix} \tag{A.22}$$

given the fiscal proposals (τ^*, g^*, B'^*) and that given v_θ the fiscal proposals solve the requisite optimality conditions.

Let F be the set of real valued, continuous, concave functions v over the domain of possible bond values $\left[\underline{B}, \overline{B}\right]$. The upper bound of debt $\overline{B}$ and lower bound of debt $\underline{B}$ are defined in the model's description of the government in Section 2.3.

For $z_\theta \in \left[\mathrm{Rev}_L(\tau^*) - g^*, \overline{B}\right]$ define $N^\theta_{z_\theta}$ from $F \times F \to F$ as

$$N^\theta_{z_\theta}(v_h, v_l)(B) = \max_P \begin{bmatrix} \max\limits_{\tau,g,B'} W_\theta(\tau, g) + \dfrac{S_\theta(\tau, g, B'; \frac{B}{P})}{n} + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right] \\ \text{s.t.} \;\; \tau \geq \tau^*, g \leq g^*, S_\theta(\tau, g, B'; \dfrac{B}{P}) \geq 0 \end{bmatrix} \tag{A.23}$$

For conciseness let $\mathbf{z} = (z_H, z_L)$ be the vector of possible bond levels for either realization of the productivity shock. Define $N_{\mathbf{z}}(v_H, v_L)(B) = (N^H_{z_H}(v_H, v_L)(B), N^L_{z_L}(v_H, v_L)(B))$

from $F \times F \rightarrow F \times F$ as the optimal choices for either realization of the productivity shock. For any $\mathbf{z}$, $N_{\mathbf{z}}$ is a contraction with a unique fixed point $v_{\mathbf{z}}$. We can use this fixed point to define

$$M_{\theta}(\mathbf{z}) = \arg\max_{B'} \left[\frac{qB'}{m} + \beta \left[\pi v_{H\mathbf{z}}\left(B'\right) + (1-\pi) v_{L\mathbf{z}}\left(B'\right) \right] \right] \tag{A.24}$$

where the fixed point is used for computing the possible continuation values. Let $M(\mathbf{z}) = M_H(\mathbf{z}) \times M_L(\mathbf{z})$. An equilibrium is a fixed point of $M(\mathbf{z})$ that takes a bond level $\mathbf{z}$ to itself given the fixed point $v_{\mathbf{z}}$. Applying Kakutani's Fixed Point Theorem proves the result.

Differentiability of the value function comes from a similar construction as the proof of Claim 1. Using our fixed point $v_{\mathbf{z}}$ we can choose a non-optimal bond level B_0 and show differentiability. In the region with transfers, this is direct, in the region without transfers the construction proceeds identically to Claim 1.