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INFLATING THE BEAST:
POLITICAL INCENTIVES UNDER UNCERTAINTY

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ABSTRACT

The standard view of the political economy of public debt is that myopic and unconstrained politicians prefer to disregard intertemporal smoothing considerations and extract political rents as fast as possible. From this perspective, it seems that the world has much to celebrate, as most emerging market economies -- often suspect of having weak political institutions -- have chosen to save rather than waste most of their exceptional income from high commodity prices. Unfortunately, the optimistic conclusion that these countries may have turned the corner with respect to public resource management may be premature. In this paper we show that while it is true that in the long run there is a negative connection between the level of public debt and the quality of political institutions, this needs not be the case in the short run. Quite the opposite, in the short run, governments with weak political institutions are likely to save more than governments with better institutions facing the same uncertainty. This is due to an option value of rent-seeking whereby the prospect of potentially squandering funds in the future makes governments more "precautionary" today. We show that this result relies on three assumptions: Economic risk is high relative to political risk, markets are sufficiently incomplete, and there exists a rent-less policy-making regime.

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1 Introduction

The standard view of the political economy of public debt is that myopic and unconstrained politicians prefer to disregard intertemporal smoothing considerations and extract political rents as fast as possible.[1] The experience of Venezuela's government, with its chronic squandering of fiscal resources during times of oil bonanza, is a stark case in point. From this perspective, it seems that the world has much to celebrate, as most emerging market economies–often suspect of having weak political institutions–have chosen to save rather than waste most of their exceptional income from high commodity prices. For example, Russia's government debt declined from 59 percent of GDP in 2000 to 7 percent of GDP in 2007. Over the same period, Chile's government debt declined from 14 percent of GDP to less than 4 percent of GDP in 2007.[2] Is it the case that after years of disregarding external advice, political institutions in these countries have turned the corner with respect to public resource management?

Unfortunately, a positive answer to this question may be premature. In this paper we explain why, by presenting a model where rent-seeking politicians balance their incentives to protect the economy from shocks and their desire for rents. In this context, we show that while it is true that in the long run there is a negative connection between the level of public debt and the quality of political institutions, this need not be the case in the short run. Quite the opposite, governments with weak political institutions are likely to save *more* than governments with better institutions facing the same uncertainty. This is due to an *option value of rent-seeking* whereby the prospect of potentially squandering funds in the future makes governments more "precautionary" today.

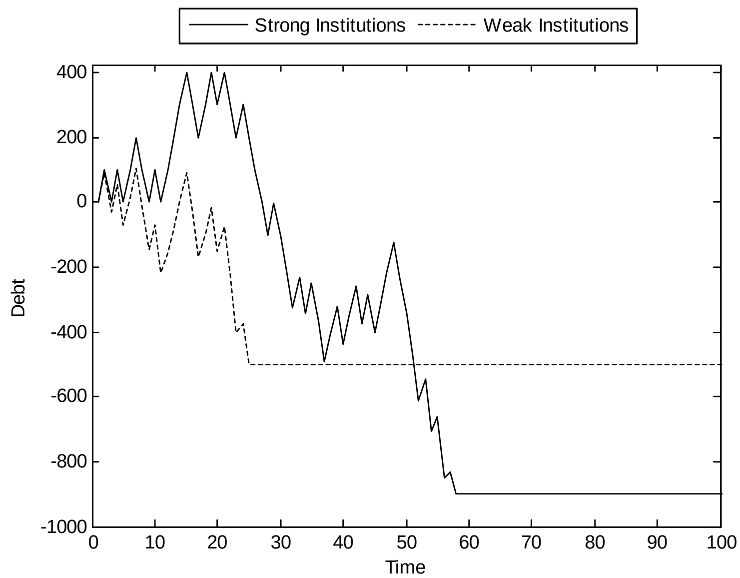
In particular, weak political institutions promote over-saving starting from an intermediate level of debt but promote over-borrowing once the government has reached a low enough level of debt. These two effects are related. Politicians facing low constraints on rent-seeking have an incentive to keep taxes high and save, that is "inflate the beast," since they look forward to squandering these savings in a future boom while simultaneously protecting the economy in the event of a future downturn. In contrast, if politicians are very constrained in their ability to squander these savings in future booms, they save less in the short run, but they also squander less in the long run. Eventually, more constrained politicians reach lower levels of debt than less constrained politicians, who would have otherwise squandered accumulations. This characterization is displayed in Figure

[1] Alesina and Perotti (1994) provide a survey of this literature. Also see Battaglini and Coate (2008).

[2] These statistics refer to gross public debt. If one nets governments' assets (sovereign wealth funds, in particular), then the improvements are even more dramatic. The 2000 data are from Jaimovich and Panizza (2006) and the 2007 data are from Central Intelligence Agency (2008).

1, which compares the simulated path of debt implied by our model under a strongly institutionalized government relative to the path of debt under a weakly institutionalized government (see Section 4 for details).

Figure 1: Path of Debt



The mechanism behind the option value of rent-seeking is as follows: Whenever political institutions become weaker, politicians begin to overweight the value of rent-seeking in their policy objective. Moreover, the increase in the value of funds is strongest in a future boom since rent-seeking is concentrated in this period. Consequently, a reduction in the quality of political institutions creates a motivation for politicians to over-save because of the improved prospect of extracting rents at a future date. This additional motivation to save is even more pronounced if it is combined with high economic uncertainty, since high economic uncertainty raises the prospect of being able to extract even greater resources as rents in a future boom.

Our over-saving result builds on three central assumptions: First, economic uncertainty is high relative to political risk. This ensures that politicians are sufficiently motivated by the prospect of future rent-seeking. In the absence of this assumption, a rent-seeking government is likely to over-borrow since there is only a small chance of it being able to extract more rents in the future. Second, markets are sufficiently incomplete, so that the premium charged for a reduction in economic volatility is high. Thus, extracting rents too soon is dangerous because it exposes the economy to negative shocks, whereas increasing public savings raises economic protection *and* boosts the incentive and ability to extract rents in the future in an economic boom. In the absence of this assumption, a rent-seeking government over-borrows since rent-seeking activity in the future can be decoupled from tax smoothing by the use of contingent claims, reducing any incentive for the government to over-save. Third, there exists a rent-less policy-making regime, which means that for a given level of institutions, the government collects zero rents if resources are sufficiently scarce. This assumption implies that as the government accumulates assets, future rents are concentrated during booms, so that a reduction in institutional quality increases the government's return on saving by facilitating rent extraction during these booms.

This paper builds on the literature on optimal fiscal policy and debt management dating back to the classical work of Barro (1979) and Lucas and Stokey (1983).[3] We depart from this work by relaxing the assumption of a benevolent government and by assuming that the economy is managed by politicians who derive partial utility from rents and who face potential replacement. In this regard, this paper is most closely related to and complements the work of Battaglini and Coate (2008). As in our work, they consider a setting in which current governments face economic risk and political risk. They show that the presence of political risk implies that in the long run, a rent-seeking government holds a non-degenerate distribution of government debt which exceeds that of the benevolent government. We depart from their work (i) by focusing on the effect of institutional quality as opposed to political risk in generating political economy distortions and (ii) by focusing on the short run implications of political economy distortions. In the process, we describe a novel over-saving mechanism driven by the option value of rent-seeking and we relate this option value to the institutional quality of a government.[4] Finally, our over-saving result is related to the work of Yared (2008) who argues that prescribing high levels of savings in the presence of rent-seeking politicians is distortionary since it is associated with the anticipation of future rents.[5] In contrast, in the current paper we explain these high savings as an endogenous mechanism to extract future rents when effective economic uncertainty is high.

This introduction is followed by five sections and an appendix. Section 2 describes a simple environment where economic uncertainty is concentrated in one period, while

[3]See also Aiyagari, Marcet, Sargent, and Seppala (2002), Bohn (1990), and Chari and Kehoe (1993a,1993b).

[4]For additional work on the political economy of debt, see for example Aghion and Bolton (1990), Alesina and Perotti (1994), Alesina and Tabellini (1990), Amador (2003), Lizzeri (1999), Persson and Svensson (1989), and Song, Storesletten, and Zilibotti (2008).

[5]Acemoglu, Golosov, and Tsyvinski (2008) also study the effect of political economy distortions on taxes in a Mirleessian economy, though they do not consider the effect on government debt.

Section 3 describes the corresponding equilibrium and the role played by the quality of political institutions. Section 4 extends the model to incorporate ongoing uncertainty. Section 5 explains the role of three important assumptions behind our results. Section 6 concludes. The Appendix contains the proofs.

2 Model

In this section, we describe a simplified version of the incomplete market economy originally studied by Barro (1979) and more recently studied by Aiyagari, Marcet, Sargent, and Seppala (2002). In contrast to this work which assumes the presence of a benevolent government, we allow for the existence of rent-seeking politicians. In Section 5.2, we examine the effect of adding insurance markets.

2.1 Economic Environment

There are time periods $t = \{0, ..., \infty\}$. In every period, the government finances exogenous public spending $g > 0$, rents $x_t \geq 0$, and debt $b_t \gtreqless 0$ by raising revenue $\tau_t \geq 0$ and borrowing $b_{t+1} \gtreqless 0$ from the private sector at a price $\beta \in (0, 1)$ which equals the social rate of discounting. In addition, the government experiences an exogenous endowment shock $y_t = \{-\sigma, \sigma\}$ for $\sigma > 0$. b_0 and y_0 are given. The government's dynamic budget constraint is

$$b_t = \tau_t - g + y_t - x_t + \beta b_{t+1} \tag{1}$$

with $\lim_{t\to\infty} \beta^t b_{t+1} = 0$. In order to simplify our discussion, we assume for now the following simple process for y_t:

$$\Pr\{y_1 = ... = y_\infty = \sigma\} = \Pr\{y_1 = ... = y_\infty = -\sigma\} = 1/2,$$

so that all uncertainty is resolved in period 1.

2.2 Political Environment

The economy is managed by politicians who dislike the deadweight loss of taxes but who value rents conditional on being in power. The deadweight loss of raising revenue τ is quadratic and equal to $c(\tau) = \frac{\tau^2}{2} + \tau$. The utility from rents x is linear and equal to

$v(x) = x$. The period t politician in power receives the flow utility

$$-c(\tau_t) + (\theta + 1)\, v(x_t), \tag{2}$$

for $\theta \geq 0$ which parameterizes the politician's desire for rents. If a given candidate politician is out of power in period t, then his flow utility is $-c(\tau_t)$.

Politicians are replaced through an exogenous stochastic process which is independent of and occurs together with the realization of the shock to y_t. Regime changes are not insurable. To simplify our discussion, we assume that the period 0 politician remains in power from period 1 onward with probability $q \in (0, 1)$. With probability $1 - q$ he is out of power and replaced with an identical politician who remains in power from period 1 onward. As with economic uncertainty, all political uncertainty is resolved in period 1. In Section 4, we show that our insights translate to an economy in which both economic and political uncertainty are ongoing.

Note that an economy managed by a benevolent planner is subsumed in our setting. In particular, if we let $\theta = 0$ and $q \to 1$, then the implied policies will correspond to those originally studied by Barro (1979) and more recently studied in Aiyagari, Marcet, Sargent, and Seppala (2002). This is because the government is permanently in power, and rents can be interpreted as lump sum transfers to households which are made whenever the government holds sufficiently low levels of debt that taxes can be set to zero. This is because $c'(0) = 1$ and the marginal value of rents is 1 under a benevolent government.

Levels of θ which exceed 0 capture the politician's bias toward wasteful spending relative to consumers' preferences. Thus, one can interpret higher levels of θ as corresponding to a society with lower quality of political institutions. Our model of political economy subsumes the setting of Battaglini and Coate (2008) in which politicians receive a flow utility which can be represented by (2), and it builds on their work by disentangling the effect of the rent-seeking motive θ from the effect of political risk q.

Another feature of this environment is limited commitment arising from the fact that $q < 1$. Whoever acquires power in period 1 cannot commit to particular policies in period 0. Consequently, the period 0 politician must take into consideration how his choice of b_1 affects the incentives of the period 1 politician. Note that welfare losses due to limited commitment go to zero as q approaches 1, which means that limited commitment has no impact on the benevolent government benchmark with $\theta = 0$ and $q \to 1$. The main focus in this paper is on the effect of institutional quality θ and therefore we highlight economies with $q \to 1$.

2.3 Government Objective

Our simple stochastic environment implies that we can think of our economy as subsumed into two periods with the following order of events:

1. The period 0 politician chooses τ_0, x_0 , and b_1.

2. Shocks are realized:

   (a) Economic shock $y_t = \{-\sigma, \sigma\}$ for $t = 1, ..., \infty$, and

   (b) Potential replacement of the period 0 politician for $t = 1, ..., \infty$.

3. The period 1 politician chooses continuation policies $\{\tau_t, x_t, b_{t+1}\}_{t=1}^{\infty}$.

Given this structure, we can write the objective of the period 1 politician as follows:

$$V^P(b_1, y_1) = \max_{\{\tau_t, x_t, b_{t+1}\}_{t=1}^{\infty}} \sum_{t=1}^{\infty} \beta^{t-1} \left(-c(\tau_t) + (\theta + 1) v(x_t)\right) \tag{3}$$

$$\text{s.t. } (1), \tau_t, x_t \geq 0 \ \forall t \geq 1, \ b_1, \text{ and } y_t = y_1 \ \forall t \geq 1. \tag{4}$$

$V^P(b_1, y_1)$ represents the value of holding political power in period 1 as a function of debt b_1 and shock y_1, and it is associated with an optimal sequence of policies $\left\{\tau_t^*(b_1, y_1), x_t^*(b_1, y_1), b_{t+1}^*(b_1, y_1)\right\}_{t=1}^{\infty}$. Given a sequence of taxes $\{\tau_t^*(b_1, y_1)\}_{t=1}^{\infty}$ which solves $(3) - (4)$, we can define

$$V^N(b_1, y_1) = \sum_{t=1}^{\infty} \beta^{t-1} \left(-c\left(\tau_t^*(b_1, y_1)\right)\right),$$

the value of being out of power in period 1 as a function of debt b_1 and shock y_1.

This means that the objective of the period 0 politician is as follows:

$$\max_{\tau_0, x_0, b_1} -c(\tau_0) + (\theta + 1) v(x_0) + \beta \mathbf{E}_{y_1} \left[q V^P(b_1, y_1) + (1 - q) V^N(b_1, y_1)\right] \tag{5}$$

$$\text{s.t. } b_0 = \tau_0 - g + y_0 - x_0 + \beta b_1, \text{ and } \tau_0, x_0 \geq 0, \tag{6}$$

where we have taken into account that the period 0 politician becomes the period 1 politician with probability q.

Let us characterize the policies chosen by the period 1 politician. To simplify notation, let

$$x_1^H(b_1) \equiv (1-\beta)\sum_{t=1}^{\infty}\beta^{t-1}x_t^*(b_1,\sigma) \quad \text{and} \quad x_1^L(b_1) \equiv (1-\beta)\sum_{t=1}^{\infty}\beta^{t-1}x_t^*(b_1,-\sigma),$$

and define $\tau_1^H(b_1)$ and $\tau_1^L(b_1)$ analogously.[6]

Lemma 1 *The period* 1 *politician's strategy is*

$$\tau_1^j(b_1) = \max\left\{g - y_1^j + b_1(1-\beta), \theta\right\}, \text{ and} \tag{7}$$

$$x_1^j(b_1) = \max\left\{0, \theta - g + y_1^j - b_1(1-\beta)\right\} \tag{8}$$

for $j = H, L$ *and* $y^H = -y^L = \sigma$.

From period 1 onward, taxes are constant in all periods, which follows from the tax smoothing arguments originally made by Barro (1979). Moreover, if rents are positive, then taxes must be θ, and if taxes exceed θ, then rents are 0. For example, in the case of the benevolent government, $\theta = 0$ and rents–which are effectively lump sum transfers to households–are only positive once taxes have been driven down to zero.

Remark 1 $\tau_1^L(b_1) \geq \tau_1^H(b_1)$ *by* (7) *and* $x_1^H(b_1) \geq x_1^L(b_1)$ *by* (8).

The period 1 politician always consumes weakly more rents when the economy is experiencing a boom. This is because the government's budget constraint is looser, and rent-seeking is easier to achieve without additional increases in taxes.

Lemma 1 can be used to characterize $\mathbf{E}_{y_1}V^P(b_1,y_1)$ and $\mathbf{E}_{y_1}V^N(b_1,y_1)$:

$$\mathbf{E}_{y_1}V^P(b_1,y_1) = \frac{-c\left(\tau_1^L(b_1)\right) - c\left(\tau_1^H(b_1)\right) + (\theta+1)\,v\left(x_1^H(b_1)\right) + (\theta+1)\,v\left(x_1^L(b_1)\right)}{2(1-\beta)}$$

$$\text{and } \mathbf{E}_{y_1}V^N(b_1,y_1) = \frac{-c\left(\tau_1^L(b_1)\right) - c\left(\tau_1^H(b_1)\right)}{2(1-\beta)}.$$

[6] We define average rents since linearity implies that there are multiple sequences of rents which solve the objective for a given unique optimal level of average rents.

In solving $(5)-(6)$, Lemma 1 implies that there are three regions to consider with respect to the choice of b_1:

Region	**Range**	**Rents**
I	$b_1(1-\beta) \geq \theta - g + \sigma$	$x_1^H(b_1) = 0$ and $x_1^L(b_1) = 0$
II	$b_1(1-\beta) \in [\theta - g - \sigma, \theta - g + \sigma)$	$x_1^H(b_1) > 0$ and $x_1^L(b_1) = 0$
III	$b_1(1-\beta) < \theta - g - \sigma$	$x_1^H(b_1) > 0$ and $x_1^L(b_1) > 0$

In region I the government is relatively poor in period 1, so that it is inefficient to use government resources for rents in that period. For intermediate values of b_1 (region II), rents are appropriated only under a favorable y_1 shock. Finally, in region III the government is rich and rents are appropriated under both shocks.

It is apparent from $(5)-(6)$ that since $q < 1$, we can disregard region III. The date 0 politician will never leave enough resources for the date 1 politician to consume rents in both states of the world, for in such case it is strictly better for the current politician to consume with certainty a bit more rents at date 0. Thus, in the next sections we only characterize regions I and II.

3 Equilibrium

3.1 Benevolent Government Benchmark

We begin by reviewing the policies of the benevolent government which corresponds to a special case of our economy with $\theta = 0$ and $q \to 1$, so that politicians do not reap extra benefits from rents and they do not face significant political risk. We characterize our policies as a function of $z_0 \equiv b_0 - y_0$, the initial negative cash in hand of the government.

The optimal solution entails the government using assets to smooth the deadweight loss of taxation, and since the marginal deadweight loss is proportional to the tax itself, the optimal solution admits a tax which follows a random walk:

$$\tau_0 = \frac{\tau_1^H + \tau_1^L}{2}. \tag{9}$$

If $\sigma = 0$, for instance, taxes would be perfectly smooth with $\tau_0 = \tau_1^H = \tau_1^L$.

The following proposition characterizes the solution to the benevolent government's problem. All proofs are in the Appendix. We denote the policies of a benevolent government with superscript B.

Proposition 1 *The benevolent government chooses:*

$$b_1^B = \begin{cases} z_0 & \text{if } z_0 > \frac{-g+\sigma}{1-\beta} \\ \frac{g-\sigma+2z_0}{1+\beta} & \text{if } z_0 \in \left[\frac{-g-\beta\sigma}{1-\beta}, \frac{-g+\sigma}{1-\beta}\right] \\ \frac{-g-\sigma}{1-\beta} & \text{if } z_0 < \frac{-g-\beta\sigma}{1-\beta} \end{cases}.$$

If $z_0 > \frac{-g+\sigma}{1-\beta}$, the economy is in region I and the government is relatively poor. Rents are zero everywhere, taxes are positive at all dates, and the government rolls over its initial negative cash in hand into period 1 debt. This region is illustrated on the right side in Figures 2-4. These display, respectively, rents, taxes, and future debt as a function of z_0.

Figure 2: Rents

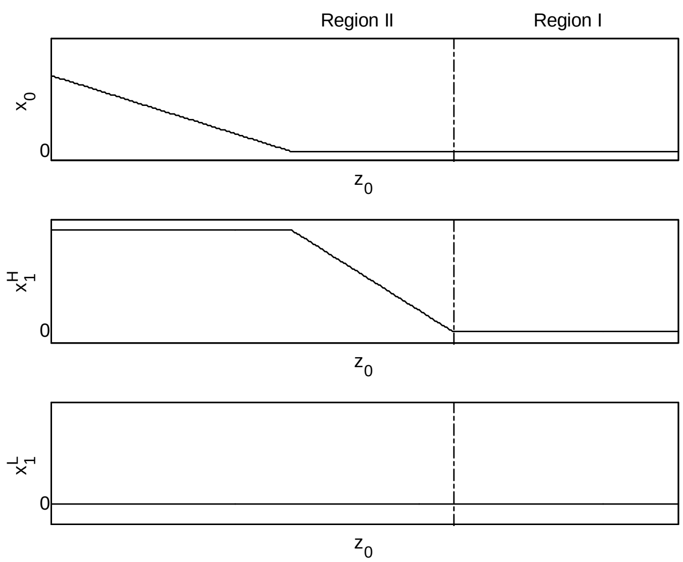


Figure 3: Taxes

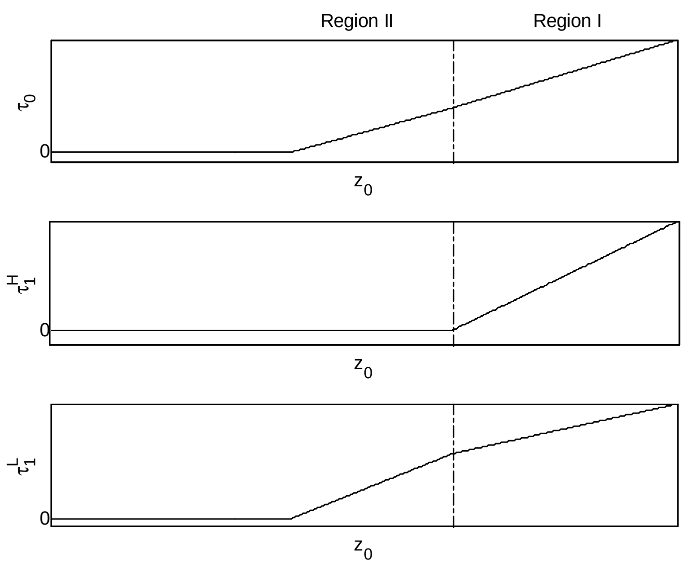
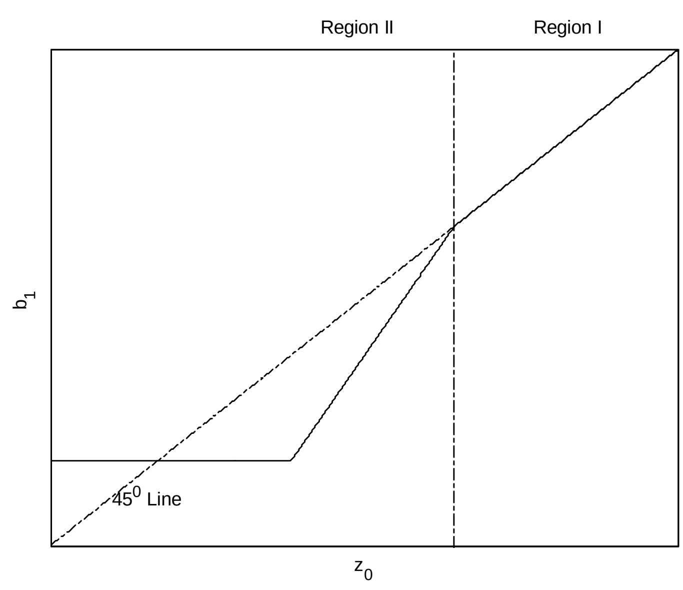


Figure 4: Debt



Once negative cash in hand decreases below $\frac{-g+\sigma}{1-\beta}$, the government has a sufficiently low level of debt to drive some taxes to zero and to pay for some rents, so that the economy enters region II. In turn, this region is divided into two subregions. Specifically, for the intermediate range $z_0 \in \left[\frac{-g-\beta\sigma}{1-\beta}, \frac{-g+\sigma}{1-\beta}\right]$, the government extracts rents only in period 1 (under the high shock), while if $z_0 < \frac{-g-\beta\sigma}{1-\beta}$, the government extracts rents both in period 1 and in period 0. Note that under the benevolent government whenever rents are positive, the corresponding taxes are equal to zero.

The critical feature in the range $z_0 \in \left[\frac{-g-\beta\sigma}{1-\beta}, \frac{-g+\sigma}{1-\beta}\right]$ is that the government begins to accumulate assets at a faster rate: We have that $b_1^B < z_0$, so that the government takes advantage of its currently low level of debt to set aside tax revenue to repay the interest on b_0 and to also reduce the size of its negative cash in hand going forward. However, once z_0 declines below $\frac{-g-\beta\sigma}{1-\beta}$, period 0 taxes reach zero, and any additional resources at the government's disposal are utilized as period 0 rents rather than to reduce debt (accumulate assets) further.[7]

3.2 Rent-Seeking Government

We now consider the effect of political institutions by letting the value of θ exceed 0. In order to focus our attention on the pure effect of institutional quality, we continue to let $q \to 1$, so that the government does not face significant political risk. We do this for expositional simplicity, as the qualitative features of its (simpler) equilibrium are shared by other q cases whenever the level of political risk embedded in q is low relative to the level of economic risk σ. We treat the general case in Section 5.1. We denote the policies of a rent-seeking government with superscript P.

Proposition 2 *The rent-seeking government with $q \to 1$ chooses:*

$$b_1^P = \begin{cases} z_0 & \textit{if } z_0 > \frac{\theta-g+\sigma}{1-\beta} \\ \frac{-\theta+g-\sigma+2z_0}{1+\beta} & \textit{if } z_0 \in \left[\frac{\theta-g-\beta\sigma}{1-\beta}, \frac{\theta-g+\sigma}{1-\beta}\right] \\ \frac{\theta-g-\sigma}{1-\beta} & \textit{if } z_0 < \frac{\theta-g-\beta\sigma}{1-\beta} \end{cases}.$$

Proposition 3 *b_1^P is strictly* ***decreasing*** *in θ for an intermediate range of $z_0 \in (\underline{z}_0, \overline{z}_0)$ and strictly increasing in θ for $z_0 < \underline{z}_0$.*

The main insight of the proposition is the existence of an intermediate range of initial debt when worse political institutions lead to more rather than less public savings. Let us explore the connection between saving (debt reduction), government resources, and

[7] Our simple model helps to understand the long run dynamics in Aiyagari, Marcet, Sargent, and Seppala (2002) in which the government reaches the natural asset limit $\frac{-g-\sigma}{1-\beta}$. At every t, the government chooses $b_{t+1}^B \leq z_t$ until some stochastic date $t+k$ where $z_{t+k} \leq \frac{-g-\beta\sigma}{1-\beta}$. After this date, debt equals $\frac{-g-\sigma}{1-\beta}$ and negative cash in hand is below $\frac{-g-\beta\sigma}{1-\beta}$, which is consistent with the description of our simple economy.

political institutions more generally. The dotted line in Figure 5 displays the reaction function of the government, with the benevolent benchmark in a solid line. For high levels of debt, a benevolent and rent-seeking government are indistinguishable from one another. This is because the high level of initial debt forces governments to act responsibly and to not squander any resources on rents. Both governments are in their respective region I.

Figure 5: Debt

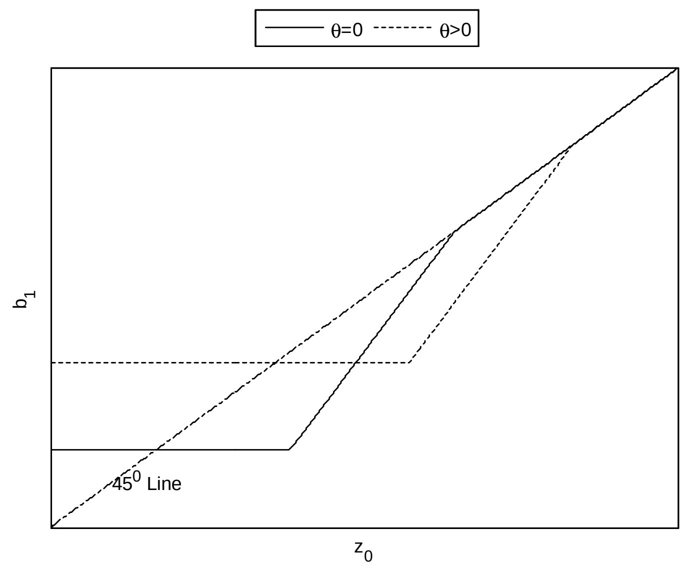


Figure 6: Rents

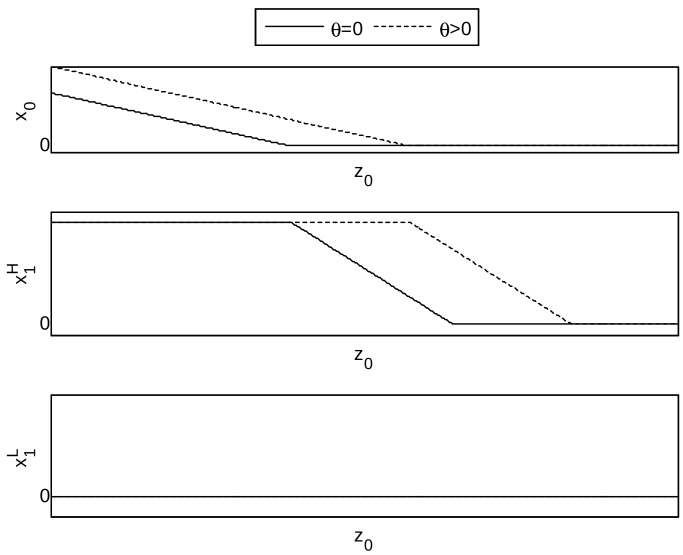
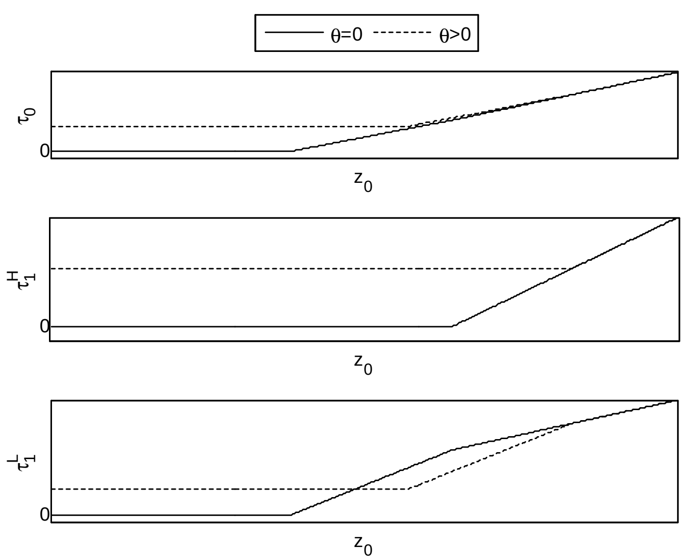


Figure 7: Taxes



As debt declines, the rent-seeking government enters the first subregion of region II. Here the rent-seeking government begins to accumulate resources at a *faster* pace than the benevolent government. However, these high savings need not represent good news for society, as they are not so much driven by tax-stabilization as they are by *future rent extraction.* Though a rent-seeking government saves *more* than a benevolent government for intermediate ranges of debt, once it reaches a sufficiently low level of debt, it saves less than the benevolent government. Hence, a rent-seeking government acts in a seemingly prudent fashion earlier than a benevolent government, but it does so because it expects to *squander* these savings in the future if aggregate conditions in the form of a future boom make it feasible. In fact, Figure 5 shows that once z_0 declines below $\frac{\theta-g-\beta\sigma}{1-\beta}$, b_1^P stops responding to z_0 since any increases in current levels of resources are squandered on current rents. In contrast, a benevolent government takes advantage of reductions in z_0 to set aside resources for the protection of the economy in the future since b_1^B decreases in z_0 until it reaches the natural asset limit.[8]

Figure 6 illustrates the corresponding rents. For high levels of debt, rents are zero everywhere. However, for $z_0 \in \left[\frac{\theta-g-\beta\sigma}{1-\beta}, \frac{\theta-g+\sigma}{1-\beta}\right]$, the economy under the rent-seeking government enters region II (positive rents at date 1 in the high state), and an increase in government assets (a reduction in z_0) leads to an increase in rents at date 1. Finally, once government assets have risen enough so that $z_0 < \frac{\theta-g-\beta\sigma}{1-\beta}$, the government stops increasing its savings in response to an increase in its resources and any additional initial assets are used on period 0 rents.

Figure 7 illustrates the value of taxes behind these rents and savings. There are three results that stand out: First, on average, taxes are higher in the presence of rent-seeking politicians. Second (bottom panel), for $z_0 \in \left[\frac{\theta-g-\beta\sigma}{1-\beta}, \frac{\theta-g+\sigma}{1-\beta}\right]$, rent-seeking governments take better advantage of reductions in z_0 to protect the economy during downturns since taxes during recessions are reduced in response to increases in z_0. Third, and most importantly (middle panel), for $z_0 < \frac{\theta-g+\sigma}{1-\beta}$, politicians fail to cut taxes during booms. Politicians extract a large amount of rents during booms (second panel of Figure 6), as they arrive to that state with high savings and unwilling to cut taxes.

In summary, while the literature on the political economy of debt, in particular the recent work of Battaglini and Coate (2008), focuses on the long run differences between a rent-seeking and a benevolent government, we focus on the transition. Our main contribution is to show that, contrary to the long run result, along the equilibrium path, a rent-seeking government may save more than a benevolent government because by doing so it raises the rent-seeking opportunities in the future. We describe the mechanism

[8] The same reasoning as in Footnote 7 implies that in a dynamic economy with ongoing uncertainty, the rent-seeking government's long run level of debt is $\frac{\theta-g-\sigma}{1-\beta}$ which exceeds that of the benevolent government.

behind this result in the next section.

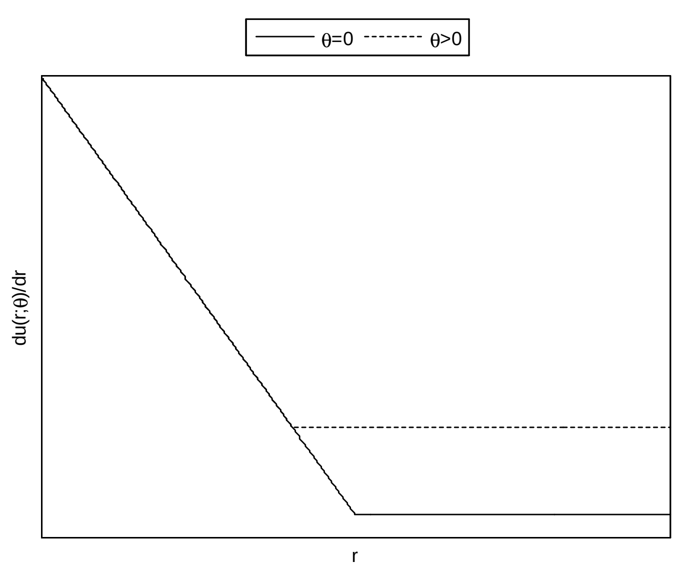
3.3 Option Value of Rent-Seeking

Consider the indirect utility function of the government as a function of "resources" $r \equiv x - \tau$, which from Lemma 1 is:

$$u(r;\theta) = -c(\max\{-r,\theta\}) + (\theta+1)\max\{0, r+\theta\}.$$

This function is increasing and weakly concave in r. For low values of r, rents are zero and $u(r;\theta) = -c(-r)$ is quadratic in r and independent of θ. In this rent-less region, politicians and benevolent governments have the same savings incentives, which do not include precautionary savings since utility is quadratic. On the opposite end, rents arise when r is very large and then $u(r;\theta) = -c(\theta) + (\theta+1)(r+\theta)$, which is linear in r so that there is also no precautionary motive. However, the important feature of $u(r;\theta)$ is the *transition* from the region in which there are zero rents to the region in which rents become positive since, as illustrated in Figure 8, marginal utility becomes convex , which gives rise to a sort of "precautionary" savings motive (e.g., Kimball, 1990 and Caballero, 1990).

Figure 8: Indirect Marginal Utility Function



Moreover, since the transition from the rent-less to the rent-extraction region occurs at lower levels of r for politicians, their "precautionary" savings take place earlier than for the benevolent government. This is what is behind our main result in Proposition 3.

While the mathematical argument is that of the precautionary savings literature, describing our mechanism as "precautionary" is somewhat of a misnomer. The extra-savings are entirely induced by rent-seeking possibilities which create a lower bound on marginal utility. The difference in the marginal utility of resources between a benevolent and rent-seeking government–which widens for an intermediate level of resources–can be more appropriately described as an *option value of rent-seeking*, a terminology which we adopt henceforth.

What do these differences in the indirect utility function imply about the behavior of government debt in a dynamic environment? Consider the government's first order condition with respect to b_1, which after substitution of (1) can be written as:

$$u'\left(-z_0 - g + \beta b_1; \theta\right) = \frac{u'\left(\left(-b_1\left(1-\beta\right) - g + \sigma\right); \theta\right) + u'\left(-b_1\left(1-\beta\right) - g - \sigma; \theta\right)}{2}. \quad (10)$$

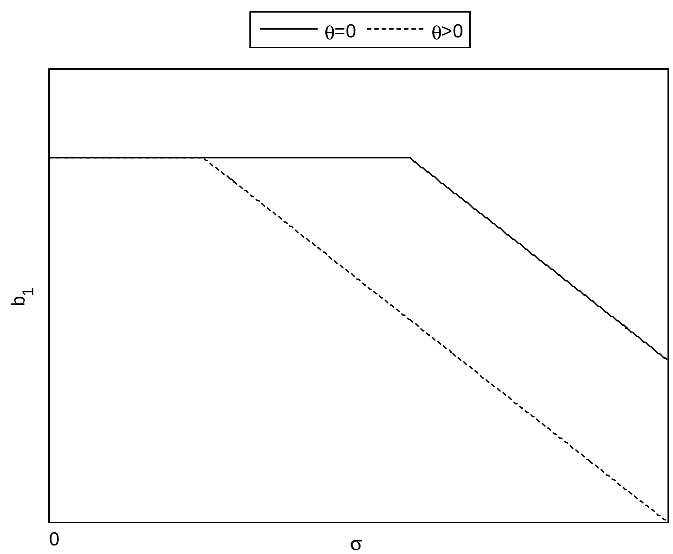
This condition states that the marginal cost of savings at date zero (left hand side) must equal the marginal benefit of savings at date 1 (right hand side), which is the average of the marginal utility of resources in the boom and in the downturn. In terms of the indirect utility function, by reducing b_1 the government increases resources r_1 in period 1 at the expense of resources r_0 in period 0. This tradeoff depends on the initial negative cash in hand of the government z_0. When z_0 is large, feasible levels of resources are low and none of the terms in (10) is affected by increases in θ since the economy is in the rent-less region in both periods.

However, for intermediate levels of z_0, rent-seeking takes place during the boom in period 1 but not otherwise. Thus, holding the level of b_1 constant, on the one hand an increase in θ raises the right hand side of (10) by increasing the marginal benefit of rent-seeking in the boom. On the other hand, the increase in θ has no effect on the marginal utility of resources for the date 0 government and the date 1 government in the downturn since these two governments are in the rent-less regime. Therefore, the increase in θ in this region enhances the incentive for a government to save because it increases the option value of rent-seeking.

Naturally, the value of this option rises with economic uncertainty. Holding b_1 constant, an increase in σ increases the right hand side of (10) by increasing the marginal value of resources at date 1 in the downturn. In the rent-less regime, this increase in the marginal value of resources in the downturn would be offset by a decrease in the marginal value of resources in the boom. However, because of the presence of rent-seeking activities at date 1 during the boom, this offsetting mechanism is no longer present, and the government responds to the rise in uncertainty by saving more, which simultaneously protects the economy in the downturn while providing additional rents to politicians in the boom.

The role of uncertainty is illustrated in Figure 9, which shows the behavior of savings as a function of uncertainty for different governments. The figure shows that it is only when uncertainty–and thus the option value of rent-seeking–becomes sufficiently high that the rent-seeking government begins to save more than the benevolent government.

Figure 9: Uncertainty



In conclusion, we have argued that our economy generates a novel over-saving mechanism which emerges from the transition from a rent-less to a rent-seeking region of resources. In Section 5.3, we show that analogous arguments can be made for general utility functions $c(\cdot)$ and $v(\cdot)$ as long as the rent-less regime exists.

4 Ongoing Uncertainty

In this section, we show that the main insights of our simple economy with one-shot uncertainty resolution translate to an economy with ongoing uncertainty. We show that a rent-seeking government is left with higher levels of debt in the long run than a benevolent government. However, the new insight in our paper is that along the equilibrium path, a rent-seeking government places more value on future rents than a benevolent government, and it therefore accumulates resources at faster pace–i.e., it holds lower debt–during part of the transition phase.

Consider an economy analogous to our previous one with the modification that

$$\Pr\{y_t = \sigma\} = \Pr\{y_t = -\sigma\} = 1/2 \qquad \forall t \geq 1$$

and the probability that a given politician is able to extract rents in period t is q. Economic shocks and political shocks are i.i.d. and are independent of each other as in the one-shot economy.

The government's objective can be written recursively as a function of the state variable z_t. We let $V^P(z)$ and $V^N(z)$ represent the politician's value of holding and being out of political power, respectively, as a function of z.

$$V^P(z) = \max_{\tau,x,b'} -c(\tau) + (\theta+1)v(x) + \beta \mathbf{E}_{y'}\left[qV^P(b'-y') + (1-q)V^N(b'-y')\right]$$

$$\text{s.t.}$$

$$z = \tau - g - x + \beta b' \text{ and}$$

$$\tau, x \geq 0,$$

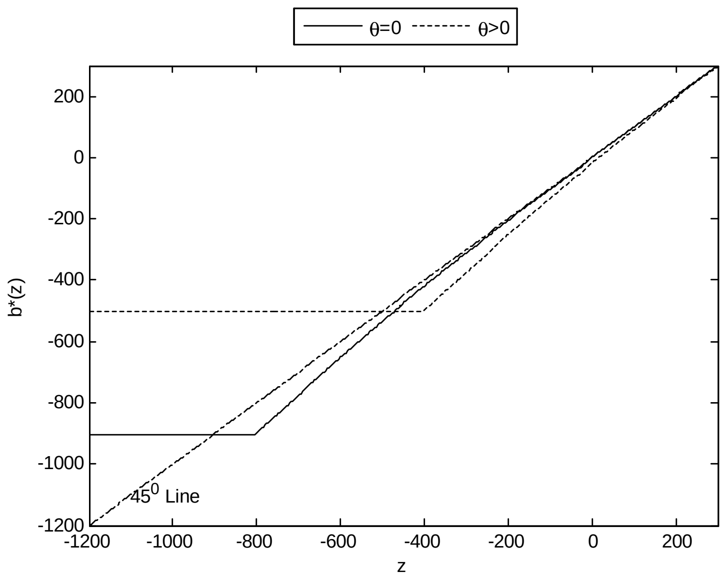
where given the solution $\{\tau^*(z), x^*(z), b'^*(z)\}$, $V^N(z)$ is defined as:

$$V^N(z) = -c(\tau^*(z)) + \beta \mathbf{E}_{y'}\left[qV^P(b'^*(z)-y') + (1-q)V^N(b'^*(z)-y')\right].$$

The only difference between $V^P(z)$ and $V^N(z)$ is that the former incorporates the benefit of current rents, whereas the latter does not. We focus on the case with $q \to 1$ for analogous reasons as in Section 3.2. Since $V^P(z)$ cannot be explicitly characterized, we present our result using a numerical simulation. For this purpose, we simulate an economy with the following parameters: $\{\beta, \sigma, g\} = \{.8, 100, 80\}$ and compare outcomes for institutional parameters $\theta = 0$ and $\theta = 80$.

Figure 10, which is analogous to Figure 5, displays the level of b' as a function of the negative cash in hand of the government z. As in the two-period economy, if z is sufficiently high, the behavior of debt is similar under a benevolent and rent-seeking government. In contrast, once z declines below a certain level, the rent-seeking government decumulates debt at a faster rate than the benevolent government. Finally, once z becomes sufficiently low, the debt of the rent-seeking government remains stable at $b' = (\theta - g - \sigma)/(1-\beta)$– the natural asset limit of the rent-seeking government–whereas the benevolent government continues to decumulate debt. For very low levels of z, both governments are in their long run steady states, with the rent-seeking government holding more debt than the benevolent government.

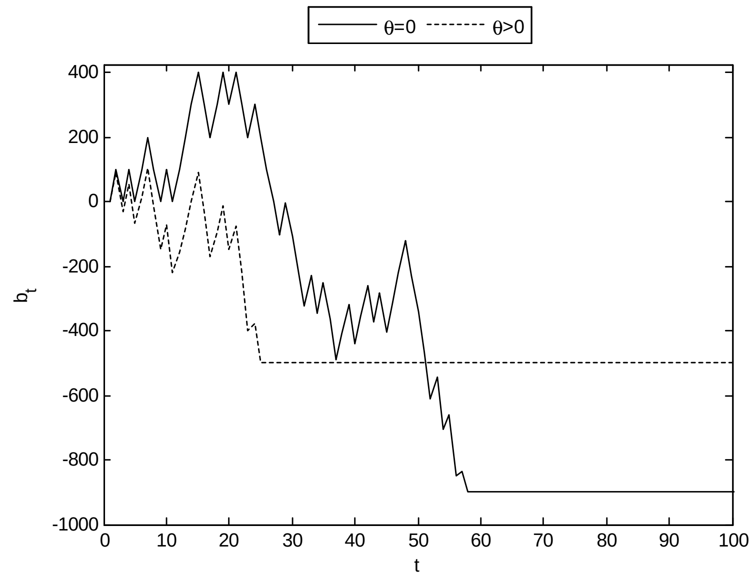
Figure 10: Debt



In Figure 11, we simulate the two economies under the same sequence of shocks starting from the same initial level of debt $b_0 = 0$. There are two important features displayed in this figure. First, note that after a sequence of favorable shocks, the rent-seeking government begins to save at a faster pace than the benevolent government so that the rent-seeking government holds a lower level of debt than the benevolent government. Second, eventually, the rent-seeking government reaches its natural asset limit and stops decumulating debt, whereas the benevolent government continues to decumulate debt until it reaches its own natural asset limit. These results are equivalent to those shown in the simpler model.

Thus, we conclude that the empirical observation that emerging markets are accumulating resources faster than in the past sheds little light on whether this is mostly due to responsible policy-making or to rent-seeking behavior in disguise.

Figure 11: Path of Debt



5 Understanding the Assumptions

In this section, we explain the importance of three assumptions in generating our over-saving result. First, we show that economic uncertainty must be high relative to political uncertainty. Second, we argue that markets must be sufficiently incomplete. We do this by allowing the government to hedge economic risk at a high enough premium, and in the process, we achieve an additional result that a rent-seeking government will *under-hedge* relative to a benevolent government. Finally, we argue that an important force behind the option value of rent-seeking is the existence of a rent-less regime: Governments only contemplate rent-seeking once resources become abundant.

5.1 High Economic and Low Political Risk

In order to highlight the importance of economic risk relative to political risk, we present a complete characterization of Section 2's economy for all $q < 1$. This allows us to show that our main over-saving result does not change as long as political risk $1 - q$ is low relative to economic risk σ. Moreover, we argue that the conventional wisdom in the political economy literature that rent-seeking induces over-borrowing emerges along the entire equilibrium path in economies in which political risk $1 - q$ is large relative to economic risk σ.

Let us define the following institutional threshold:

$$\theta^* \equiv \frac{2\sigma}{1-q}.$$

Proposition 4 *The rent-seeking government chooses:*

1. *If* $\theta < \theta^*$,

$$b_1^P = \begin{cases} z_0 & \text{if } z_0 > \frac{\theta-g+\sigma}{1-\beta} \\ \frac{\theta-g+\sigma}{1-\beta} & \text{if } z_0 \in \left(\frac{\theta\left(1-\frac{1}{2}(1-q)(1-\beta)\right)-g+\sigma}{1-\beta}, \frac{\theta-g+\sigma}{1-\beta}\right] \\ \frac{-q\theta+g-\sigma+2z_0}{1+\beta} & \text{if } z_0 \in \left[\frac{\theta(1+(1-q)\beta)-g-\beta\sigma}{1-\beta}, \frac{\theta\left(1-\frac{1}{2}(1-q)(1-\beta)\right)-g+\sigma}{1-\beta}\right] \\ \frac{\theta(2-q)-g-\sigma}{1-\beta} & \text{if } z_0 < \frac{\theta(1+(1-q)\beta)-g-\beta\sigma}{1-\beta} \end{cases}, \text{ and}$$

2. *If* $\theta > \theta^*$,

$$b_1^P = \begin{cases} z_0 & \text{if } z_0 > \frac{\theta-g+\sigma}{1-\beta} \\ \frac{\theta-g+\sigma}{1-\beta} & \text{if } z_0 \leq \frac{\theta-g+\sigma}{1-\beta} \end{cases}.$$

Proposition 5 *If* $\theta < \theta^*$, b_1^P *is strictly decreasing in* θ *for an intermediate range of* $z_0 \in (\underline{z}_0, \overline{z}_0)$ *and strictly increasing in* θ *for* $z_0 < \underline{z}_0$.

Proposition 6 *If* $\theta < \theta^*$, b_1^P *is decreasing in* q.

The introduction of political risk brings about a new element to the decision-making of the government. Consider a rent-seeking government which expects to extract positive rents in the future with probability q. If q is reduced, this implies an increase in political risk and a reduction in the probability that the current government will have access to these rents. This reduces the government's incentive to save, so that debt b_1^P increases in response.[9]

More central to our main message, the threshold θ^* determines a precise meaning to the statement that economic uncertainty is high relative to political risk, as this is linked to the institutional development of a society. Specifically, if $\theta < \theta^*$, then economic risk is high relative to political risk. Thus, as in the cases considered in Section 3, the government continues to behave in a precautionary fashion for intermediate values of z_0

[9] Note that, contrary to intuition, higher levels of q are not always good for welfare since they can promote excessive savings. It can be shown that social welfare is weakly increasing in q for low values of z_0 and weakly decreasing in q for high values of z_0. Details available upon request.

if it has lower institutional quality since it is extracting rents in period 1. The degree to which the rent-seeking government accumulates resources faster than the benevolent government depends on the interaction between q and θ, since the option value of rent-seeking is increasing in q, the probability of retaining power into the future. Moreover, for very low levels of z_0, a rent-seeking government squanders any additional improvements in its asset position whereas a benevolent government sets aside more initial resources to protect the economy in the future.

In contrast, if $\theta > \theta^*$, the rent-seeking government *always* under-saves relative to the benevolent government, and debt is always weakly decreasing in institutional quality. Rents are never extracted in period 1, since political risk is too high relative to economic volatility. Starting from a high enough level of abundance, any increase in initial resources translates into an increase in current levels of rents. Therefore, the option value of rent-seeking is non-existent because political risk is too high relative to economic risk. Moreover, this means that in the region in which z_0 is below $\frac{\theta-g+\sigma}{1-\beta}$, government debt *increases* with the level of economic volatility σ. This is because the period 0 government wishes to starve the future governments of boom rents which increase in economic volatility, and it does so by increasing government debt. Thus, the conventional wisdom in the political economy of debt literature that rent-seeking induces over-borrowing (e.g., Alesina and Perotti, 1994) holds only in the case of low economic and high political uncertainty (low σ and low q).

5.2 Incomplete Markets

The previous section highlighted that the government's motive to save depends on the relative importance of political and economic risk. In practice, the latter risk is partially endogenous. In this section we model this endogeneity by allowing the government to hedge some of the economic risk. We show that as long as political risk is low relative to *both* economic risk *and* the hedging premium, there is a region where politicians save more and hedge less than benevolent governments. Nonetheless, as the hedging premium goes to zero this region vanishes, which highlights the importance of incomplete markets behind our main transitional over-saving result.

Consider the economy of Section 2, and let us assume that in addition to b_1, the period 0 government can purchase insurance $\alpha \geq 0$ at unit price $\pi\beta/(1-\beta) \geq 0$. For all $t \geq 1$, the government receives an insurance payment equal to α if $y_1 = -\sigma$ and equal to $-\alpha$ otherwise.

We refer to α as the amount of hedging purchased by the government. Since this insurance has an expected value of 0, π effectively represents the hedging premium, and the economy analyzed in the previous sections corresponds to a case in which the hedging premium is arbitrarily large so that no government would ever choose to hedge. Note that an economy in which $\pi = 0$ corresponds to the complete market economy of Lucas and Stokey (1983).

The welfare of households and politicians along with the order of events remains unchanged, with the exception that the period 0 politician must now allocate savings across $-b_1$ and α in period 0. We characterize the behavior of all governments as $q \to 1$. Moreover, we assume that $\pi < \frac{\sigma}{\theta+\sigma}$ so that some hedging takes place. There are two main results:

Proposition 7 *If $\pi > 0$, b_1^P is strictly decreasing in θ for an intermediate range of $z_0 \in (\underline{z}_0, \overline{z}_0)$ and strictly increasing in θ for $z_0 < \underline{z}_0$.*

Proposition 8 *The amount of hedging α^P is weakly decreasing in θ.*

An important implication of Proposition 7 is that the over-saving result from Section 3 is robust to the introduction of hedging.

Proposition 8 shows that the level of hedging by a rent-seeking government is lower than that of a benevolent government. This is because of the option value of rent-seeking. Hedging ties the hands of the government during a boom whereas savings increases the scope for rent-seeking during a boom, and for this reason, the rent-seeking government is biased against hedging.

What if hedging is very cheap? It turns out that there is a critical level $1 - q$, such that if π drops below this value, the previous results are overturned and the traditional intuitions related to over-borrowing by rent-seeking governments are upheld. Due to space restrictions, we illustrate this point with $\pi = 0$.

Proposition 9 *The rent-seeking government under $\pi = 0$ chooses:*

$$\{b_1^P, \alpha^P\} = \begin{cases} \{z_0, \sigma\} & \text{if } z_0 > \frac{\theta-g}{1-\beta} \\ \left\{\frac{\theta-g}{1-\beta}, \sigma\right\} & \text{if } z_0 \leq \frac{\theta-g}{1-\beta} \end{cases}.$$

If $\pi = 0$, all governments fully insure the economy against shocks, therefore removing the precautionary motive from the government's calculus. $b_1^B \geq z_0$ everywhere since there is no incentive to accumulate resources. It is cheaper for politicians to use the hedging instrument as opposed to contingent rent-seeking in order to reduce the volatility of taxes.

Hedging serves its usual purpose as a buffer for downturns (i.e., it reduces economic risk), but it also allows the government to frontload whatever rents it could acquire during a future boom and hence it also reduces political risk. That is, the possibility for hedging economic risk disentangles the dual role for savings driving the over-accumulation of savings when markets are incomplete. Put differently, hedging economic risk also serves as proxy-hedging for political risk.[10]

5.3 Existence of a Rent-less Regime

Throughout, we have specified the politician's utility in (2) as consisting of a quadratic cost of taxes and a linear utility in rents. This allows us to shut down the precautionary motive in the benevolent and non-benevolent regions of the utility function and to highlight how the transition from one region to the other can generate "precaution" and an option value of rent-seeking. In this section, we show that our over-saving result does not depend on the quadratic cost of taxes or the linear benefit of rents, but instead relies on the existence of a region in which politicians set rents to zero.

Let us consider the economy of Section 2 under a more general set of functions $c(\cdot)$ and $v(\cdot)$ to place in (2). Assume these two functions are continuous, increasing, and defined for $\tau_t \in [\underline{\tau}, \overline{\tau})$ and $x_t \in [0, \infty)$, respectively. Moreover, $v'(0) \geq c'(0)$ so that rent-seeking can occur. $c(\cdot)$ is weakly convex and $v(\cdot)$ is weakly concave.[11]

The critical assumption behind our results is that

$$\lim_{\tau \to \overline{\tau}} c'(\tau) > (\theta + 1) v'(0). \tag{11}$$

Mathematically, (11) states that the marginal value of minimal rents is exceeded by the marginal cost of maximal taxation. In other words, governments will stop extracting rents beyond a certain threshold since taxes are too high. In our simple economy described in the text, $\overline{\tau} = \infty$ and $(\theta + 1) v'(0) = (\theta + 1) < \lim_{\tau_t \to \overline{\tau}} c'(\tau_t) = \infty$, so that this condition is satisfied. To understand the implications of this assumption, optimality for the government in a given period t requires:

$$c'(\tau_t) \geq (\theta + 1) v'(x_t), \tag{12}$$

[10] It can be shown for $0 < \pi < 1 - q$ that a rent-seeking government may also over-hedge. Details available upon request.

[11] It can be verified that in an open or closed quasi-linear economy in which households consume and work, the flow utility to households can be represented by a function $-c(\tau_t)$ which depends on the elasticity of labor. Under more general utility functions, $-c(\tau_t)$ represents household welfare in an open economy as long as households do not have access to financial markets.

with equality if $x_t > 0$. From (12), at an interior solution high taxes are associated with low rents, and rents are weakly increasing in the rent-seeking motive θ. Moreover, if taxes exceed $c'^{-1}((\theta+1)v'(0))$, then rents are zero. Therefore, rent-seeking only begins once resources become sufficiently abundant. Moreover, as the rent-seeking motive θ increases, rent-seeking becomes more likely for a given level of resources.

Arguments analogous to those we made in Section 3.3 allow us to define an indirect utility function $u(r;\theta)$ which features a transition from rent-less policy-making to rent-seeking. Moreover, this transition–which occurs for lower values of r for regimes with higher θ–induces a value of $u'(r;\theta)$ which is more convex earlier on than would be implied in the absence of rent-seeking. Therefore, the transition to rent-seeking is associated with more "precaution," as in our baseline economy.

What are the implications of the previous discussion for the level of b_1? Starting from high levels of z_0, taxes are high and there is no rent-seeking at any date. Consequently, a change in θ cannot affect savings since all governments are in the rent-less regime. However, for intermediate levels of z_0, rent-seeking will occur in period 1 under the high shock, and it will not take place otherwise. In this region, there is an option value of rent-seeking which increases with θ. To understand why, note that equation (10) under the new $u(r;\theta)$ function must hold in this context as a consequence of optimality. The marginal cost of savings at date zero must equal the marginal benefit of savings at date 1. Now consider the effect of an increase in θ. As in the simple economy we have described in the text, holding the level of b_1 constant, the marginal benefit of rent-seeking–and therefore the marginal value of resources–in an upturn increases. Furthermore, because of (11), the marginal value of resources at other dates are unaffected since there is no rent-seeking at those dates. The option value of rent-seeking rises, and the government saves more since it benefits even more from rents in a boom while simultaneously protecting the economy in a downturn. This is stated formally in the next proposition which focuses on interior solutions by considering economies with $\lim_{\tau_t \to \overline{\tau}} c'(\tau_t) = \infty$ and $c''(\tau_t) > 0$.

Proposition 10 *b_1^P is strictly decreasing in θ for an intermediate range of $z_0 \in (\underline{z}_0, \overline{z}_0)$.*

An additional insight into Proposition 10 arises if one considers a counter-example. For instance, let $-c(\tau_t) = \log(\overline{\tau} - \tau_t)$ and $v(x_t) = \log(x_t)$. In this situation, (11) is violated since $v'(0) = \infty$. Conditions (12) implies that $x_t = (1+\theta)(\overline{\tau} - \tau_t)$ so that rents are a constant fraction of government resources. Consequently, (10) can be rewritten as:

$$\frac{1}{z_0 + g - \beta b_1 - \overline{\tau}} = \frac{1}{2}\left(\frac{1}{b_1(1-\beta) + g - \sigma - \overline{\tau}} + \frac{1}{b_1(1-\beta) + g + \sigma - \overline{\tau}}\right), \tag{13}$$

which means that the b_1 that solves the above equation is independent of institutional quality θ. In this economy, there is no option value of rent-seeking. An increase in θ, holding b_1 fixed causes a government to reallocate resources towards rent extraction versus tax reduction at all dates, and this increases the marginal value of resources at all dates. Moreover, because the increase in the marginal value of resources at date 1 is exactly offset by the increase in the marginal value of resources at date 0, the government's savings behavior is unchanged.

If instead $v(x_t)$ were replaced with $\log(e + x_t)$ for some $e > 0$, then (11) would be satisfied since $v'(0) = 1/e < \infty$. Intuitively, rent-seeking would only arise once resources become sufficiently abundant. And in the transition phase to abundance, an option value of rent-seeking emerges as the government looks forward to squandering accumulated resources in a future boom.[12]

6 Final Remarks

The main insight of this paper is that high levels of public savings do not always represent improvements in fiscal management, but could instead reflect rent-seeking in disguise. This is due to an option value of rent-seeking that emerges in economies in which economic volatility is high relative to political uncertainty, financial markets are incomplete, and politicians behave responsibly whenever resources become sufficiently scarce. These forces lead governments to "inflate the beast" temporarily because of the prospect of future rent-seeking opportunities, a result which stands in opposition to the conventional wisdom in political economy that rent-seeking governments always over-borrow.

Nonetheless, there is a limit to the extent to which such accumulations can persist, since it is precisely the opportunity to eventually squander these funds which induces politicians to forgo rent-extraction in the short run. In the long run, a rent-seeking government wastes the resources which it accumulated so quickly whereas a benevolent government preserves the resources which it accumulated more slowly.

Finally, we conjecture from our framework that currently popular fiscal rules aimed at constraining fiscal surpluses and deficits are inadequate tools to deal with the rent-seeking problem we describe. The reason is that the temporary increase in public savings by politicans derives primarly from high taxation given its resources. Thus, it would seem

[12]Note that (11) is sufficient though not necessary for our over-saving result. It importantly sustains a wedge in the Euler equation in rents since $v'(x_0) > \frac{1}{2}v'\left(x_1^H\right) + \frac{1}{2}v'\left(x_1^L\right)$ in the region of interest. Because x_1^L is bounded from below by zero, the government cannot reduce future rents and increase current rents by borrowing more. This counteracting force can be strong in settings in which rents are always interior.

that a more appropriate mechanism to deal with perverse incentives in economies within the region we describe is to cap taxes rather than to target fiscal deficits and surpluses.

7 Appendix

Proof of Lemma 1

Multiply both sides of (1) by β^t and take the sum of these equations from $t = 1$ to $t = \infty$ subject to $\lim_{t\to\infty} \beta^t b_{t+1}$ to achieve the present value budget constraint of the government:

$$b_1 = \sum_{t=1}^{\infty} \beta^{t-1} \left(\tau_t - g + y_1 - x_t\right). \tag{14}$$

Consider the relaxed solution to $(3) - (4)$, which replaces each constraint (1) with (14), assigning this latter constraint a Lagrange multiplier of μ. Let ϕ_t represent the Lagrange multiplier for the non-negativity constraint on x_t and let us ignore and later verify that the non-negativity constraint on τ_t is satisfied. First order conditions imply that $c'\left(\tau_t^*\left(b_1, y_1\right)\right) = \mu = \theta + \phi_t$, so that taxes are constant and weakly greater than θ, with equality if rents are positive. This verifies that the non-negativity constraint on τ_t is satisfied. Substitution into (14) given the definitions of $\tau_1^j\left(b_1\right)$ and $x_1^j\left(b_1\right)$ implies that

$$\begin{aligned}
\tau_1^j\left(b_1\right) &= g - y_1^j + b_1\left(1-\beta\right) + x_1^j\left(b_1\right) = \theta \text{ if } x_1^j\left(b_1\right) \geq 0 \text{ and} \\
\tau_1^j\left(b_1\right) &= g - y_1^j + b_1\left(1-\beta\right) > \theta \text{ if } x_1^j\left(b_1\right) = 0
\end{aligned}$$

implying Lemma 1. It can be verified that the solution to the relaxed problem satisfies (1) for all t. **Q.E.D.**

Proof of Proposition 1

We prove Proposition 4 which is more general and consider the special case of $\theta = 0$ and $q \to 1$. To facilitate the proof, we let the period 0 government choose $\left\{\tau_0, x_0, \tau_1^H, \tau_1^L, x_1^H\right\}$ subject to feasibility and subject to behavior of the period 1 government implied by Lemma 1. Note that the solution admits $x_1^L = 0$, since otherwise b_1 can be increased by $\epsilon > 0$ arbitrarily small, x_1^L and x_1^H can be each decreased by $\epsilon\left(1-\beta\right)$, and x_0 can be increased by $\beta\epsilon$, leaving the period 0 government strictly better off since $q < 1$. Taking this into account, we combine (1) at $t = 0$ with (14) together with Lemma 1, to write the problem:

$$\max_{\tau_0, x_0, \tau_1^H, \tau_1^L, x_1^H} -c(\tau_0) + (1+\theta)v(x_0) + \frac{\beta\left(-c\left(\tau_1^H\right) - c\left(\tau_1^L\right) + q(1+\theta)v\left(x_1^H\right)\right)}{2(1-\beta)} \tag{15}$$

s.t.

$$z_0 = \tau_0 - g - x_0 + \frac{\beta\left(\tau_1^H + \tau_1^L - 2g - x_1^H\right)}{2(1-\beta)}, \tag{16}$$

$$\tau_1^L - \sigma = \tau_1^H + \sigma - x_1^H, \tag{17}$$

$$\tau_1^H \geq \theta, \tag{18}$$

$$x_0 \geq 0, \text{ and} \tag{19}$$

$$x_1^H \geq 0. \tag{20}$$

We ignore and later verify that the constraint $\tau_1^L \geq \theta$ is satisfied. We also later verify that the constraint that $\tau_1^H = \theta$ if $x_1^H > 0$ is satisfied. Let μ_0, $\frac{\beta}{2(1-\beta)}\mu_1$, $\frac{\beta}{2(1-\beta)}\varphi$, ϕ_0, and $\frac{\beta}{2(1-\beta)}\phi_1^H$ represent the Lagrange multipliers for constraints $(16)-(20)$, respectively. First order conditions yield:

$$\tau_0 \quad : \quad \tau_0 = \mu_0, \tag{21}$$

$$\tau_1^H \quad : \quad \tau_1^H = \mu_0 - \mu_1 + \varphi, \tag{22}$$

$$\tau_1^L \quad : \quad \tau_1^L = \mu_0 + \mu_1, \tag{23}$$

$$x_0 \quad : \quad \mu_0 = \theta + \phi_0, \text{ and} \tag{24}$$

$$x_1^H \quad : \quad \mu_0 - \mu_1 = q\theta + \phi_1^H. \tag{25}$$

$\mu_1 \geq 0$ from (22), (23), and Lemma 1.

Step 1. Imagine if $z_0 > \frac{\theta - g + \sigma}{1-\beta}$, and let us assume and later verify that $\varphi = 0$. In this case, substitution of $(21)-(23)$ into (16) and (17) imply that $\tau_0 = \tau_1^H + \sigma = \tau_1^H - \sigma > \theta + \sigma$, verifying that $\varphi = 0$ and implying that $\phi_0, \phi_1^H > 0$ so that $x_0 = x_1^H = 0$. Substitution of $(21)-(23)$ into (16) and (17) implies that $b_1 = z_0$, and $\tau_1^L \geq \theta$ is satisfied.

Step 2. Imagine if $z_0 \in \left(\frac{\theta\left(1-\frac{1}{2}(1-q)(1-\beta)\right)-g+\sigma}{1-\beta}, \frac{\theta-g+\sigma}{1-\beta}\right]$ and $\theta < \frac{2\sigma}{1-q}$. Imagine if $\tau_1^H > \theta$ so that $\varphi = 0$ and $x_1^H = 0$. From (17) and $(21)-(23)$, this would imply that $\tau_0 > \theta + \sigma$ so that from (21) and (24), $x_0 = 0$. However, substitution into (16) given $z_0 < \frac{\theta-g+\sigma}{1-\beta}$ violates $x_0 = x_1^H = 0$. Therefore, $\tau_1^H = \theta$. Imagine if $\phi_1^H = 0$. (21), (23), and (25) imply that $\tau_1^L = 2\tau_0 - q\theta \geq \theta$. Substitution into (16) and (17) implies that $\tau_0 \geq \theta$ and $x_0 = 0$, since $z_0 \geq \frac{\theta\left(1-\frac{1}{2}(1-q)(1-\beta)\right)-g-\beta\sigma}{1-\beta}$. Substitution into (16) and (17) yields $b_1 = \frac{-q\theta+g-\sigma+2z_0}{1+\beta}$. However, substitution into (14) for $y_1 = \sigma$ leaves the condition that $x_1^H \geq 0$ violated since

$z_0 \geq \frac{\theta\left(1-\frac{1}{2}(1-q)(1-\beta)\right)-g+\sigma}{1-\beta}$. Given that $\tau_1^H = \theta$ and $x_1^H = 0$, substitution into (14) for $y_1 = \sigma$ implies that $b_1 = \frac{\theta-g+\sigma}{1-\beta}$, and $\tau_1^L \geq \theta$ is satisfied.

Step 3. Imagine if $z_0 \in \left[\frac{\theta(1+(1-q)\beta)-g-\beta\sigma}{1-\beta}, \frac{\theta\left(1-\frac{1}{2}(1-q)(1-\beta)\right)-g+\sigma}{1-\beta}\right]$ and $\theta < \frac{2\sigma}{1-q}$. From step 2, it cannot be that $\tau_1^H > \theta$. Assume and later verify that $\phi_1^H = 0$. From step 2, this means that $b_1 = \frac{-q\theta+g-\sigma+2z_0}{1+\beta}$ and we can verify by substitution into (14) for $y_1 = \sigma$ that $x_1^H \geq 0$ since $z_0 < \frac{\theta\left(1-\frac{1}{2}(1-q)(1-\beta)\right)-g+\sigma}{1-\beta}$.

Step 4. Imagine $z_0 < \frac{\theta(1+(1-q)\beta)-g-\beta\sigma}{1-\beta}$ and if $\theta < \frac{2\sigma}{1-q}$. Let us assume and later verify that $\phi_0 = \phi_1^H = 0$, so that from (21), (23), and (25), $\tau_0 = \tau_1^H = \theta$ and $\tau_1^L = \theta\,(2-q) \geq \theta$, so that substitution into (14) for $y_1 = -\sigma$ yields $b_1 = \frac{\theta(2-q)-g-\sigma}{1-\beta}$, and $\tau_1^L \geq \theta$ is satisfied. We can verify that $x_0 > 0$ and $x_1^H > 0$ by substitution into (16) and (17), taking into account that $\theta > \frac{2\sigma}{1-q}$ and $z_0 < \frac{\theta(1+(1-q)\beta)-g-\beta\sigma}{1-\beta}$.

Step 5. We are left with the case for which $z_0 < \frac{\theta-g+\sigma}{1-\beta}$ and $\theta > \frac{2\sigma}{1-q}$. From step 2, it cannot be that $\tau_1^H > \theta$. Imagine if $x_1^H > 0$ so that $\phi_1^H = 0$. (21), (23), (24), and (25) imply that $\tau_1^L = 2\tau_0 - q\theta \geq 2\theta\,(1-q)$. Since $\tau_1^H = \theta$ and $x_1^H > 0$, substitution into (17) implies that $\tau_1^L < \theta + 2\sigma$, which contradicts $\theta > \frac{2\sigma}{1-q}$. Therefore $x_1^H = 0$. Given that $\tau_1^H = \theta$ and $x_1^H = 0$, substitution into (14) for $y_1 = \sigma$ yields $b_1 = \frac{\theta-g+\sigma}{1-\beta}$, and $\tau_1^L \geq \theta$ is satisfied. **Q.E.D.**

Proof of Proposition 2

This follows from the solution described in the proof of Proposition 1 for $\theta \geq 0$ and $q \to 1$. **Q.E.D.**

Proof of Proposition 3

This follows from the solution described in the proof of Proposition 2. **Q.E.D.**

Proof of Proposition 4

This follows from the solution described in the proof of Proposition 1 for $\theta \geq 0$ and $q < 1$. **Q.E.D.**

Proof of Proposition 5

This follows from the solution described in the proof of Proposition 4. **Q.E.D.**

Proof of Proposition 6

This follows from the solution described in the proof of Proposition 4. **Q.E.D.**

Proof of Proposition 7

We write the program as in the proof of Proposition 1 replacing (16) and (17), respectively with

$$z_0 = \tau_0 - g - x_0 - \pi\beta/(1-\beta)\,\alpha + \frac{\beta}{2(1-\beta)}\left(\tau_1^H - x_1^H + \tau_1^L - 2g\right) \text{ and} \tag{26}$$

$$\tau_1^L - \sigma + \alpha = \tau_1^H + \sigma - \alpha - x_1^H. \tag{27}$$

Let $\kappa\beta/(1-\beta)$ represent the Lagrange multiplier for the non-negativity constraint on α. The additional first order condition for α is

$$\alpha : \pi\mu_0 = \mu_1 + \kappa. \tag{28}$$

Step 1. Imagine if $z_0 > \frac{\theta\left(1+\beta\pi^2\right)/(1-\pi)-g-\beta\sigma\pi}{(1-\beta)}$. If $\kappa > 0$, then the solution corresponds to the same one described in Proposition 1 for $z_0 > \frac{\theta-g+\sigma}{1-\beta}$ which is independent of θ. If alternatively $\kappa = 0$, then $(21)-(25)$ and (28) substituted into (26) and (27) imply that $\tau_0 = \tau_1^H/(1-\pi) = \tau_1^L/(1+\pi) > \theta/(1-\pi) > \theta/(1-\pi)$ so that from $(24)-(25)$ it is the case that $\phi_0, \phi_1^H > 0$ so that $x_0 = x_1^H = 0$. Therefore, the solution is also independent of θ.

Step 2. Imagine if $z_0 \in \left[\frac{\theta(1+\beta\pi)/(1-\pi)-g-\beta\sigma}{(1-\beta)}, \frac{\theta\left(1+\beta\pi^2\right)/(1-\pi)-g-\beta\sigma\pi}{(1-\beta)}\right]$. Assume and later verify that $\kappa = 0$ and $\phi_1^H = 0$. $(21)-(23)$, (25), and (28) imply that $\tau_0 = \theta/(1-\pi)$, $\tau_1^H = \theta$, and $\tau_0 = \theta(1+\pi)/(1-\pi)$. By substitution into (26) and (27) it can be verified that all feasibility constraints are satisfied. b_1 is increasing in θ and α is decreasing in θ:

$$\begin{aligned} b_1 &= \frac{\theta\pi(1-\beta)/(1-\pi) - (1-\beta)\sigma + z_0(1-\beta)}{1-\beta} \\ \alpha &= \frac{-\theta(1+\beta\pi)/(1-\pi) + g + \beta\sigma + z_0(1-\beta)}{\beta(1-\pi)} \end{aligned}$$

Step 3. Imagine if $z_0 < \frac{\theta(1+\beta\pi)/(1-\pi)-g-\beta\sigma}{(1-\beta)}$. If $\kappa = 0$ and $\phi_1^H = 0$, then the constraint that $\alpha \geq 0$ is violated. If instead $\phi_0 = 0$, then $(21)-(24)$ and (28) contradict the fact that $q \to 1$. If $\kappa = 0$, $\phi_1^H > 0$, and $\phi_0 > 0$, then the solution corresponds to that described in step 1, but this contradicts the fact that $z_0 < \frac{\theta(1+\beta\pi)/(1-\pi)-g-\beta\sigma}{(1-\beta)}$. The solution therefore corresponds to that described in Proposition 1.

Step 4. Comparative statics with respect to θ follow from the above characterization of the solution. **Q.E.D.**

Proof of Proposition 8

This follows from the solution described in the proof of Proposition 7. **Q.E.D.**

Proof of Proposition 9

We first establish that $\alpha = \sigma$. Otherwise, the period zero government can increase b_1 by $\epsilon > 0$ arbitrarily small, increase α by $\epsilon(1-\beta)$, reduce x_1^H by $2\epsilon(1-\beta)$, and increase x_0 by $\beta\epsilon$, which leaves it strictly better off since $q < 1$. Therefore, the solution in this economy will resemble the original economy without hedging with $\sigma = 0$. We can apply Proposition 4, taking into account that $\theta > \frac{2\sigma}{1-q} = 0$ which leads to the solution. **Q.E.D.**

Proof of Proposition 10

Step 1. Define $\overline{z}_0$ as the unique value of z_0 which solves the following system of equations: (16), (17),

$$\begin{aligned} c'(\tau_0) &= \frac{1}{2}c'\left(\tau_1^L\right) + \frac{1}{2}c'\left(\tau_1^H\right), \qquad (29) \\ \tau_1^H &= c'^{-1}\left((\theta+1)\,v'(0)\right), \text{ and} \\ x_0 &= x_1^H = 0. \end{aligned}$$

Define $\underline{z}_0$ as the unique value of z_0 which solves the following system of equations: (16), (17), (29),

$$\begin{aligned} \tau_1^H &= c'^{-1}\left((\theta+1)\,v'\left(x_1^H\right)\right) \\ \tau_0 &= c'^{-1}\left((\theta+1)\,v'(0)\right), \text{ and} \\ x_0 &= 0. \end{aligned}$$

It can be verified that $\underline{z}_0 < \overline{z}_0$.

Step 2. (12), (16), (17), and (29) imply that in the range $z_0 \in (\underline{z}_0, \overline{z}_0)$, the solution admits $x_0 = x_1^L = 0$, $x_1^H > 0$, and $\tau_1^L > \tau_0 > \tau_1^H$.

Step 3. Consider an equilibrium in the range $(\underline{z}_0, \overline{z}_0)$ and consider the consequences of increasing θ by $\epsilon > 0$ arbitrarily small, so as to remain in $(\underline{z}_0, \overline{z}_0)$ under $\theta + \epsilon$. If the implied movement in b_1 were weakly positive, then from (14) and (16), this would imply that τ_0 weakly decreases and τ_1^L weakly increases. From (12) and (29), this would require τ_1^H to weakly decrease and x_1^H to strictly increase, violating (14). Therefore, b_1 strictly decreases in θ. **Q.E.D.**

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