Optimal Policy with Credibility Concerns*

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Abstract

This paper considers a reputation model of optimal taxation in which the public is unsure about the government type. A long-lived government can be trustworthy (meaning that it commits to its announced tax rate) or opportunistic (meaning that it retains the ability to change its tax rate after announcing it). Unlike in most prior studies, the committed strategy in this model is optimally chosen by the trustworthy type. We show that this change has significant consequences for the equilibrium dynamics. The optimal committed strategy is found to vary with the time preferences of the two government types, the initial reputation of the government, and the elasticity of household production. This formulation explains differences in policy responses across governments in the face of similar credibility problems.

Keywords: imperfect credibility, reputation game, optimal taxation, time inconsistency

JEL codes: E61, E62, D82

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1 Introduction

What are the optimal policies for a trustworthy government that is able to commit but suffers from public skepticism concerning its ability to commit?\(^1\) This is an important question for policymakers, but game theory and macroeconomics have not yet provided a satisfactory answer. Most of the literature on reputation focuses on the optimal strategies of opportunistic types (types that cannot commit), which may or may not mimic the strategies of trustworthy types (types that commit to particular strategies). However, there has been very little discussion of how the strategies of trustworthy types are constructed because these strategies are often assumed to be exogenous in these models.\(^2\)

This paper provides an answer to this question using a simple taxation model that is constructed in the tradition of past work on optimal policy with limited commitment by Barro and Gordon (1983), and Phelan (2006). The model is a finitely repeated reputation game in which a government that seeks to maximize the present value of its tax revenues plays against a continuum of small private-sector households. Within each period, the government first announces a tax rate. Households then decide whether to engage in production with a fixed cost. After the production, the government decides the actual tax rate. Households consider the two possible categories into which the government may fall: it may be a “trustworthy” type, which by definition is sure to enact its announced tax rate, or it may be an “opportunistic” type and retain the option of confiscating all household production. The type of government is private information and is fixed throughout the entire game. Households update their beliefs about the government type in a Bayesian fashion after observing the government’s actual tax rate at the end of each period.

The most distinguishable feature of this model is that the policy announcement to which the trustworthy government commits is endogenous. The government uses the tax announcement to influence households’ perceived likelihood that the announced tax rate will be implemented and how households’ beliefs concerning the government type will evolve once the announced tax rate is implemented. We also allow government types to differ in their time preferences, which is crucial for costly reputation-building to occur in equilibrium. We require our equilibrium to be Markov perfect and solve the model using backward induction.

\(^1\)Whether a government can commit is an issue that arises from a well-known time inconsistency problem (Kydland and Prescott, 1977). That is, it is often in the short-run best interest of a government to raise capital taxes, default on its debt obligations, or generate inflation surprises.

\(^2\)Examples include Kreps and Wilson (1982), Milgrom and Roberts (1982), Barro (1986), Fudenberg and Levine (1992), Cripps, Mailath and Samuelson (2004), Phelan (2006) and Liu (2011), in which the strategy that one commits to is the decision to employ the same action in each period. Some examples that allow for a history-dependent committed strategy include Schmidt (1993), Aoyagi (1996), Celentani, Fudenberg, Levine and Pesendorfer (1996), Evans and Thomas (1997) and Ghosh (2012).
As is well known in signaling games, equilibrium indeterminacy typically occurs when announcements are made by different sender types. One contribution of this paper is that it restores equilibrium uniqueness by proposing a refinement in the spirit of Mailath, Okuno-Fujiwara and Postlewaite (1993). The single equilibrium that survives this refinement is the one in which both types of government use the same announcing strategy that maximizes the trustworthy government’s objective.

By allowing the trustworthy government to optimally choose the strategy to which it commits, we can answer an important consistency question in the reputation literature: is the committed strategy given exogenously in most models consistent with what the trustworthy type would like to do if it were able to choose?

The answer according to our model is no. An important trade-off between current and future credibility arises when the government chooses its announced tax rate. A higher announced tax rate is more likely to be implemented by a government of the opportunistic type and is thus more credible during the current period, but enacting such a rate will convey little information about the government’s identity and, in turn, will slow the growth of future credibility. This trade-off is affected by the government reputation, the time preferences of the two government types, and the elasticity of household production. The equilibrium tax announcement is also affected by these factors.

First, because the equilibrium tax announcement varies with the government reputation, a fixed action by a trustworthy government cannot always be incentive compatible. For example, in a two-period version of the model, when both types of government are equally patient, a trustworthy government with a poorer reputation will favor a higher tax rate in the first period. Second, our model shows that the optimal committed strategy changes with the level of patience of the opportunistic government. Therefore, the inconsistency issue also applies to models that feature history-/state-dependent committed strategies because those models usually take the committed strategies as given when studying the effect of the opportunistic type’s patience on its equilibrium payoff.

In terms of dynamics, if the opportunistic government is patient, then it will be too costly for the trustworthy government to distinguish itself. As a result, the equilibrium involves little learning with high taxation throughout the entire tenure of the government. If both types of government are impatient, then it is possible that the equilibrium tax announcements, once implemented, will help the government to regain public trust. Such reputation-building occurs in equilibrium when the initial reputation of the government is sufficiently high. The equilibrium announced tax rate begins with a relatively high rate and decreases over time.

The current model also allows the trustworthy government to be more patient than the
opportunistic one. As a result, in equilibrium, a government may engage in costly reputation-
building by announcing policies that would not likely be implemented by the opportunistic
type of government. When the initial reputation of the government is not extremely low,
the equilibrium dynamics feature excessively low announced tax rates at the initial stage
of the game, which implies a rapid growth of government reputation once those rates are
implemented until full credibility is reached. This pattern of equilibrium reputation stands
in sharp contrast to what the existing literature suggests: that the equilibrium reputation
typically remains constant during the early stage and only increases gradually near the end
of the game (e.g., Barro, 1986; Cukierman and Liviatan, 1991).

History does include cases in which policymakers made announcements that were un-
likely to be carried out. George H. W. Bush stated “Read my lips, no new taxes” during
his presidential campaign, but he later raised taxes under pressure from Congress. Paul Vol-
ccker, who became the Chairman of the Federal Reserve in early 1980s, successfully carried
through tough disin‡ ation policies despite the most severe recession since WWII. Regardless
of whether these policymakers kept their promises in the end, the question remains: why did
they make commitments that would be di¢ cult to ful… ll? This model provides an explana-
tion: a patient, trustworthy policymaker will hope to use such announcements to build up
his or her reputation quickly, whereas a less patient opportunistic policymaker has to make
similar announcements, even if he or she may not necessarily follow through with them, to
hide his or her identity before the public takes action.

The current model extends Phelan (2006) by having the government strategically an-
nounce the policies to which it may commit. In addition, our model assumes that the
government type is fixed over time and the time horizon is finite, whereas in Phelan (2006),
the government type follows a Markov process, and the time horizon is infinite. Despite
all of these differences, the two models have a common feature in terms of their equilib-
rium dynamics: If reputation increases, the probability of confiscation by an opportunistic
government also increases.3 However, unlike Phelan’s model, in which the opportunistic gov-
ernment always plays mixed strategies, our model predicts that pooling equilibria can occur
if governments of both types are patient. This result is robust when we modify the model
to make it as similar to Phelan’s as possible except that the committed strategy continues
to be endogenously determined.

A few papers prior to this one have also constructed models in which both trustworthy
and opportunistic types behave strategically. Cukierman and Liviatan (1991) analyze a case
in which the optimal announcement by the trustworthy policymaker varies with his or her
imperfect credibility but in which the probability of confiscation by the opportunistic poli-

3This feature is robust to all parameterizations in this model.
cymaker is taken as a given. In this model, we show that the effect of policy announcements on the probability of confiscation is the key to an important trade-off between current and future credibility. The trustworthy policymaker’s optimization that takes this trade-off into account could result in a complete separation between types on the equilibrium path, a result that does not occur in Cukierman and Liviatan (1991). Furthermore, we allow the time discount factor to vary across types so that richer dynamics of reputation and policy, including costly reputation-building, can occur in equilibrium.

King, Lu and Pasten (2008) provide a numerical example in which reputation-building by a trustworthy central bank implies gradualism in disinflation as in “Volcker disinflation”. The opportunistic central bank in their model has a stochastic time discount factor and is on average less patient than its trustworthy counterpart. The current paper, however, assumes deterministic time discount factors for both types of government and studies how the equilibrium depends on the time preference ratio of the two government types. Kambe (1999) studies a bargaining game and allows players to strategically announce bargaining postures to which they may become committed. However, the announced postures must be constant in his model, whereas in this paper, the government can announce non-constant policies and can benefit from this additional flexibility. Wolitzky (2012) extends Kambe’s model to allow players to announce non-constant postures, but his paper studies maxmin payoffs and postures. In this paper, we follow the existing literature on reputation by focusing on sequential equilibria in announcement.

This paper shares the view of Mailath and Samuelson (2001) that reputation-building is an exercise not only in pooling with good types but also in separating oneself from bad types. Focusing on reputation-building as separation, Mailath and Samuelson (2001) abstract from the strategic behavior of the bad type, which is assumed to always engage in the same single action. In contrast, this paper allows both types to act strategically and thereby explores the interaction between incentives to separate and incentives to pool.

In the current model, the government has all of the bargaining power with respect to the households, but it also has private information about its type. This feature links the current analysis to the literature on the informed-principal problem pioneered by Myerson (1983) and Maskin and Tirole (1992). Consistent with this literature, the optimal contract is influenced by the principal’s incentive to hide or reveal its private information, which thereby leads to a pooling or separating equilibrium. The current paper, however, also includes mixed strategies used by the opportunistic type as equilibria to generate dynamics of reputation and provide a theory of reputation-building.

The design of the policy announcements relates this paper to models of strategic infor-

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4See also Horner (2002).
mation transmission developed by Crawford and Sobel (1982) and Sobel (1985). However, the announcement in this model is only cheap talk for the opportunistic type and not for the trustworthy type because the latter is committed to act as it announces. This nonstandard feature of signaling differentiates this paper from the rest of the literature. Consequently, popular refinements such as the intuitive criterion lead to counterintuitive results. Fortunately, a unique and plausible equilibrium can be reached when a refinement in the spirit of Mailath, Okuno-Fujiwara and Postlewaite (1993) is applied.

The remainder of the paper is organized as follows: Section 2 presents the setup of the game and defines the equilibrium, Section 3 uses a two-period example to illustrate the main results of the paper, Section 4 studies the equilibrium dynamics when the game has an arbitrary number of periods, Section 5 discusses several extensions of the main model, and Section 6 concludes.

2 A Reputation Game

There are two parties: a government that lives for $T$ periods and a continuum of households with costs of engaging in production. The government announces a proportional tax rate each period before households make production decisions but levies the taxes after production is complete.

The government can be of the trustworthy type (i.e., it always honors its announced tax rate), or it can be of the opportunistic type (i.e., it retains the ability to change its tax rate after the announcement). The government type is known only to the government and remains fixed throughout the game. Households only live for one period but are able to observe the entire public history of the game. Each household can either produce one unit of output with a cost $c$ or not produce. The production cost $c$ is heterogeneous across households, and the cost distribution has a c.d.f. $G(c) = c^\gamma$ with $\gamma \geq 1$ and support $[0,1]$. The parameter $\gamma$ can be interpreted as the elasticity of household production.

The timing is as follows:

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5For example, the intuitive criterion selects the worst equilibrium, in which the government announces a 100 percent tax rate and no household produces; the refinement by Grossman and Perry (1986) rules out all sequential equilibria.

6The assumption of short-lived households is not essential. As long as the rewards of production cannot be stored for multiple periods, the maximization problem for households will be identical with a longer horizon.

7The heterogeneous production costs among households generate a smooth response to household taxation, as is general practice in macroeconomics in studies of the effects of policy.

8We focus on the case with $\gamma \geq 1$ to ensure well defined density $g(c) = \gamma c^{\gamma-1}$ over the entire support $[0,1]$. In addition, $\gamma \geq 1$ guarantees that household production is a decreasing function with respect to the announced tax rate.
At the beginning of the game, nature chooses a government to be trustworthy with probability \( \rho_t \). Then, in each of the \( T \) periods,

1. The government announces a tax rate \( \tau_t \in [0, 1] \).
2. Households choose whether to produce 1 unit. Let \( \mu_t \) be the fraction that produce.\(^9\)
3. If the government is trustworthy, it must tax at the announced rate. If the government is opportunistic, it chooses whether the actual tax rate is \( \tau_t \) (in which case it would be mimicking the trustworthy type of government) or 100\% (in which case it would confiscate all household production). Let \( \pi_t \) denote the probability of confiscation.

The momentary payoff to the government of either type is \( \tau_t \mu_t \) if the government taxes at the rate of \( \tau_t \). If the opportunistic government confiscates all household production, its momentary payoff is \( \mu_t \). The objective of either government is thus to maximize its lifetime tax revenues. The two types of government are allowed to differ in how they discount future tax revenues, with \( \beta_{tr} \) and \( \beta_{op} \) denoting the time discount factors for the trustworthy type and the opportunistic type, respectively.

Households are risk-neutral with zero payoffs if they do not produce. If they produce, their payoffs are \( (1 - \tau_t) - c \) if the announced tax rate is implemented or \( -c \) if the government confiscates their production. Therefore, more households with low production costs will produce if the probability of confiscation is lower.

\[ \text{2.1 Households and the opportunistic government} \]

In this paper, we focus on Markov strategies that condition actions solely on payoff-relevant variables. In this incomplete information game, the only payoff-relevant variable is the households’ homogenous belief that the current government is of the trustworthy type.\(^10\) This belief is defined as the state variable of the game: \( \rho_t \).

Given the announced tax rate \( \tau_t \), the opportunistic government and households are essentially playing a simultaneous game: each takes the other’s action as given and chooses its best reaction. Households act before the government levies taxes but still take the opp-
portunistic government’s action as given because of their atomistic nature: the households’ individual production decisions or beliefs do not affect the actions of the government or the future values of $\rho$.

Because households make production decisions before the government levies taxes, they form expectations regarding their after-tax output. Given the action of the opportunistic type $\pi_t$, the expected after-tax output is $(1 - \tau_t)\psi_t$, where $\psi_t$ is the households’ perception of how likely it is that the government will implement the announced tax rate:

$$
\psi(\pi_t) = \rho_t + (1 - \rho_t) (1 - \pi_t) .
$$

This is the sum of two elements: the likelihood that the government is trustworthy, such that $\tau_t$ will be implemented for certain, and the likelihood that the government is opportunistic but will mimic the trustworthy type’s tax action with probability $(1 - \pi_t)$. Because $\psi_t$ is the credibility of the current tax announcement, we call it short-term credibility to distinguish it from $\rho_t$, which measures the credibility of tax announcements in the long term and is therefore called long-term credibility or reputation in this paper. Given the reputation $\rho_t$, there is a one-to-one mapping between $\pi_t$ and $\psi_t$: $\pi_t \in [0, 1]$ corresponds to $\psi_t \in [\rho_t, 1]$.

Using the expected after-tax output as a common cutoff, households will produce if they receive a cost that is lower than $(1 - \tau_t)\psi(\pi_t)$ and will not produce otherwise. This individual optimization results in an aggregate best-reaction function on the household side:

$$
\mu(\pi_t) = G[(1 - \tau_t)\psi(\pi_t)] = [(1 - \tau_t)\psi(\pi_t)]^\gamma .
$$

The parameter $\gamma$ represents the elasticity of household production with respect to the expected reward of production.

Now we turn to the strategy of the opportunistic government, which takes the household production $\pi_t$ as given and chooses whether to confiscate it at the end of each period.

If the government confiscates all household production in period $t$, it is known to be of the opportunistic type. Given that the government type is permanent in the game, the reputation $\rho$ in period $t + 1$ is zero and remains zero afterward, which implies zero production in all future periods as part of the unique Markov perfect equilibrium for the rest of the game.\footnote{The intuition underlying this result is that if the opportunistic government will certainly confiscate all household production in the last period and if the public is certain that the current government is opportunistic, then no household will produce. Given a lack of production in the last period, there will be no reason for the opportunistic government to hide its identity in the second-to-last period. The government will therefore be certain to confiscate all household production, which again will generate zero production if the government is known to be opportunistic. This logic can be applied to all preceding periods so that as long as the government reputation drops to zero, there will be no production in any future period. More precisely, consider any period with $\rho = 0$. If $\pi = 1$ or $\tau = 1$, household optimization will imply $\mu = 0$. If $\pi = 0$, the expected after-tax output is $(1 - \tau_t)\psi_t$, where $\psi_t$ is the households’ perception of how likely it is that the government will implement the announced tax rate: }
The payoff from confiscation is thus $\mu_t$.

If the opportunistic government does tax at the announced rate in period $t$ when it is expected to deviate with probability $\pi_t$, Bayes’ rule implies an updated posterior belief about the government type:

$$\rho_{t+1} = \frac{\rho_t}{\rho_t + (1 - \rho_t)(1 - \pi_t)} = \frac{\rho_t}{\psi(\pi_t)},$$

(3)

where $\rho_t$ is the prior belief in period $t$ that the government is of the trustworthy type and $\psi(\pi_t)$ is the marginal probability of taxation at rate $\tau_t$. The payoff is thus $\tau_t \mu_t + \beta_{op} V_{t+1}(\rho_t/\psi_t)$. $V_{t+1}$ denotes the value of future tax revenues.

The opportunistic government chooses $\pi_t$ to maximize $(1 - \pi_t)[\tau_t \mu_t + \beta_{op} V_{t+1}(\rho_t/\psi_t)] + \pi_t \mu_t$ given household production $\mu_t$ and the associated belief $\psi_t = G^{-1}(\mu_t) / (1 - \tau_t)$ as suggested by Equation (2). The optimal choice of $\pi_t$ should then satisfy the following “incentive compatibility constraints”:

If $\tau_t \mu_t + \beta_{op} V_{t+1}(\rho_t/\psi_t) \geq \mu_t$, the opportunistic type mimics, $\pi(\mu_t) = 0$;

If $\tau_t \mu_t + \beta_{op} V_{t+1}(\rho_t/\psi_t) \leq \mu_t$, the opportunistic type confiscates all production, $\pi(\mu_t) = 1$;

If $\tau_t \mu_t + \beta_{op} V_{t+1}(\rho_t/\psi_t) = \mu_t$, the opportunistic type plays a mixed strategy, $\pi(\mu_t) \in (0, 1)$.

For future reference, we call the first inequality the “pooling” incentive compatibility constraint and the second inequality the “separating” incentive compatibility constraint.

In equilibrium, the probability of confiscation $\pi_t$ chosen by the opportunistic government is indeed identical to that expected by the households. We define the equilibrium as follows:

**Definition 1** Given the state variable $\rho_t$ and the announced tax rate $\tau_t$, $\{\hat{\mu}_t, \hat{\pi}_t\}$ is the equilibrium of the simultaneous game played by households and the opportunistic government if $\hat{\mu}_t = \mu(\hat{\pi}_t)$ and $\hat{\pi}_t = \pi(\hat{\mu}_t)$. We denote this equilibrium as $\{\hat{\mu}_t(\tau_t, \rho_t), \hat{\pi}_t(\tau_t, \rho_t)\}$.

The equilibrium of this subgame after a given announcement regarding the tax rate is very similar to the Markov perfect equilibrium in Phelan (2006). However, the question of what tax rate the government will announce remains. This is the topic that we now consider.

### 2.2 Announcement and signaling

Because there will be no production in any future period once the government is identified as being of the opportunistic type, we can conclude that in any equilibrium, both types of $\pi < 1$ and $\tau < 1$, government optimization will require $\tau \mu + \beta_{op} V(0) \geq \mu + \beta_{op} V(0)$, which only holds for $\mu = 0$. 

\[ \text{equation} \]
\[ \text{equation} \]
government announce identical tax rates in each period $t$.\footnote{We only consider pure announcing strategies in the baseline model. Section 5 discusses mixed announcing strategies.} As a result, nothing about the current government’s identity can be learned from observing the announced tax rate $\tau_t$, and the household’s decision is based on the prior belief for the current period $\rho_t$, as described in the previous subsection.

However, we still need to determine the equilibrium tax announcement because any $\tau \in [0, 1]$ can be sustained as a sequential pooling signaling equilibrium by properly specifying the out-of-equilibrium beliefs. We call these beliefs “the supporting beliefs” for the equilibrium. The formal definition of the sequential equilibrium for the within-period signaling game in this model and the proof of the equilibrium indeterminacy are presented in the Appendix.

We use the triplet $\{m, \hat{\mu}, \phi\}$ to denote a sequential equilibrium in which $m$ and $\hat{\mu}$ are the equilibrium strategies of senders and receivers and in which $\phi$ is the receivers’ supporting beliefs for the equilibrium.

To provide a sharper prediction of the equilibrium tax announcement, we adopt a refinement based on the definition of undefeated pure sequential equilibrium developed by Mailath, Okuno-Fujiwara and Postlewaite (1993, M-OF-P hereafter). In the second paragraph on page 251 of M-OF-P, the authors summarize their criticism of the intuitive criterion and their proposed way of proceeding:

Suppose that all players are equally forward looking and that an out-of-equilibrium message is to be interpreted as a clear signal that the informed player is of some type (or types). The types not sending that message should be making their choice (in particular of not sending that message) understanding the inference that will be made in the absence of that message. But if all types are sending the out-of-equilibrium message, the original message or yet some other message, understanding the beliefs that each message choice will lead to, these beliefs must then be part of a second sequential equilibrium. The equilibrium is not particularly important in itself, but what is important is that a proposed rule for making inferences can be consistent only if the resulting beliefs are of a sequential equilibrium.

This paragraph suggests that the idea is to interpret the out-of-equilibrium messages as signals by particular types of senders and that the beliefs based on those messages should not conflict with the senders’ incentives. However, unlike other popular refinements, e.g., Grossman and Perry’s Perfect Sequential Equilibrium (1986) and Cho and Krep’s Intuitive Criterion (1987), the M-OF-P refinement requires the out-of-equilibrium message to be part
of an alternative sequential equilibrium; consequently, the incentives for sending a “signal” of this kind should be evaluated using the beliefs in the alternative equilibrium.

The refinement used in this paper employs this idea of evaluating senders’ incentives and requires the out-of-equilibrium beliefs that support a sequential equilibrium to be “strongly coherent” in the following sense:13

**Definition 2** In an economy with a set of sender types \( \Omega \), a candidate equilibrium \( \{ m_C, \mu_C, \phi_C \} \), and an alternative equilibrium \( \{ m_A, \mu_A, \phi_A \} \), the message \( \tau \) gives rise to a “strongly coherent out-of-equilibrium belief” \( \varphi \) about a subset of types if:

1. \( \forall \omega \in \Omega, m_C(\omega) \neq \tau \);

2. A nonempty set of types send \( \tau \) in the alternative equilibrium and prefer the alternative equilibrium to the candidate equilibrium:

   \[ \exists K \neq \emptyset \text{ and } K \subset \{ \omega \in \Omega | m_A(\omega) = \tau \} \text{ such that} \]

   \[ \forall \omega \in K, R(\{ m_A, \mu_A, \phi_A \}, \omega) \geq R(\{ m_C, \mu_C, \phi_C \}, \omega) \]

   \[ \text{and } \exists \omega \in K, R(\{ m_A, \mu_A, \phi_A \}, \omega) > R(\{ m_C, \mu_C, \phi_C \}, \omega), \]

   where \( R(\{ m, \mu, \phi \}, \omega) \) is the payoff to type \( \omega \) in an equilibrium \( \{ m, \mu, \phi \} \);

3. The belief upon the receipt of \( \tau \) is consistent with the set \( K \):

   \[ \forall \tilde{\omega} \in K, \varphi(\tilde{\omega}|\tau) = \frac{\rho(\tilde{\omega}) \Pr(\tau|\tilde{\omega})}{\sum_{\omega \in \Omega} \rho(\omega) \Pr(\tau|\omega)}, \]

   where \( \rho(\omega) \) is the prior belief that the sender is of type \( \omega \) and \( \Pr(\tau|\omega) \) is the probability that type \( \omega \) would send \( \tau \):

   \[ \Pr(\tau|\omega) = \begin{cases} 1 & \text{if } \omega \in K \text{ and } R(\{ m_A, \mu_A, \phi_A \}, \omega) > R(\{ m_C, \mu_C, \phi_C \}, \omega) \\ 0 & \text{if } \omega \notin K \\ [0,1] & \text{otherwise} \end{cases} \] (4)

13The author would like to thank an anonymous referee for pointing out the difference between this refinement and the M-OF-P refinement. In particular, the latter refinement requires the out-of-equilibrium message to be preferred by all types who send the message in the alternative equilibrium. However, the refinement used in this paper is based on the idea that as long as there is a nonempty set of types that send an out-of-equilibrium message in the alternative equilibrium and that prefer the alternative equilibrium, then the beliefs concerning this message should be consistent with the set. As a result, the refinement in this paper rules out more sequential equilibria than does the M-OF-P refinement. A very similar refinement can be found in Taylor (1999).
This refinement eliminates any candidate equilibrium if its supporting belief concerning an out-of-equilibrium message is not strongly coherent (when such a strongly coherent belief exists).

**Definition 3 (Strongly Coherent Sequential Equilibrium)** A candidate sequential equilibrium \( \{m_C, \mu_C, \phi_C\} \) is not “strongly coherent” if there exists a message \( \tau_A = m_A(\tilde{\omega}) \) sent by \( \tilde{\omega} \) in an alternative equilibrium \( \{m_A, \mu_A, \phi_A\} \) such that any strongly coherent belief about \( \tilde{\omega} \) upon the receipt of \( \tau_A \), if it exists, is incompatible with the supporting belief for the candidate equilibrium:

\[
\varphi(\tilde{\omega}|\tau_A) \neq \phi_C(\tilde{\omega}|\tau_A) \text{ for any } \Pr(\tau_A|\omega) \text{ satisfying (4)}.\]

If such a message \( \tau_A \) does not exist (in other words, if the supporting beliefs for the candidate sequential equilibrium are strongly coherent whenever possible), we can then say that the sequential equilibrium is “strongly coherent”.

### 2.3 Equilibrium

Using the refinement defined above, we are able to select the unique equilibrium announcement that yields the highest equilibrium payoff to the trustworthy government among all pooling sequential equilibria. In such an equilibrium, the trustworthy government is essentially a *leader* in the game because the tax announcement, regardless of the true identity of the policymaker, is set to maximize the trustworthy government’s payoff. The stage game played by the government and households in each of the \( T \) periods can thus be analyzed as if there were three players in the game: a trustworthy government choosing the announcement, households then producing accordingly, and the opportunistic government deciding whether to confiscate all household production.\(^{14}\) The following definition formally defines the equilibrium of the game.

**Definition 4** The sequence of Markov strategy triplets \( \{\tau_t^*(\rho_t), \mu_t^*(\rho_t), \pi_t^*(\rho_t)\}_{t=1}^T \) is called the Markov perfect equilibrium (MPE) if, in each period \( t \),\(^{15}\)

1. \( \tau_t^*(\rho_t) \) solves the trustworthy government’s optimization:

\[
W_t(\rho_t) = \max_{\tau_t} \left\{ \tau_t \mu_t + \beta_t W_{t+1} \left( \rho_t / \hat{\psi}_t \right) \right\},
\]

\(^{14}\)Even when the government in place is indeed trustworthy, it still needs to account for the confiscation probability under the opportunistic government because households, when making production decisions, are generally concerned about the possibility that what they produce will be confiscated by an opportunistic government.

\(^{15}\)The subindex \( t \) of each function indicates that its functional form may be time-varying because of the finite horizon of the game.
where \( \{ \hat{\mu}_t(\tau, \rho), \hat{\pi}_t(\tau, \rho) \} \) is given in Definition 1 and \( \hat{\psi}_t(\tau, \rho) = \rho_t(1 - \hat{\pi}_t(\tau, \rho)) \); 

ii) \( \mu_t^*(\rho) = \hat{\mu}_t(\tau_t^*(\rho), \rho), \pi_t^*(\rho) = \hat{\pi}_t(\tau_t^*(\rho), \rho) \); 

iii) \( \rho_{t+1} = \rho_t/\psi_t^*(\rho) \), where \( \psi_t^*(\rho) = \hat{\psi}_t(\tau_t^*(\rho), \rho) \).

The MPE in period \( t \) refers to the equilibrium strategy triplet \( \{ \tau_t^*(\rho), \mu_t^*(\rho), \pi_t^*(\rho) \} \).

To see why \( \tau_t^*(\rho) \) is the unique equilibrium announcement that survives the refinement, note that \( \tau_t^*(\rho) \) maximizes the payoff to the trustworthy government in each period \( t \) given that the households’ belief about the current government being trustworthy remains equal to \( \rho \) based on any announced rate \( \tau_t \). This implies that in the within-period signaling game in period \( t \), a pooling sequential equilibrium with \( \tau_t^*(\rho) \) is the trustworthy government’s favorite among the pooling sequential equilibria. Any candidate pooling equilibrium with a tax rate different from \( \tau_t^*(\rho) \) cannot be strongly coherent because the supporting belief upon the receipt of an out-of-equilibrium message \( \tau_t^*(\rho) \) must be strictly lower than \( \rho \), whereas the strongly coherent belief on \( \tau_t^*(\rho) \) cannot be lower than \( \rho \) because at least the trustworthy government would be better off in the alternative equilibrium \( \tau_t^*(\rho) \). In addition, the pooling sequential equilibrium with \( \tau_t^*(\rho) \) is strongly coherent because the equilibrium can be supported by beliefs that are lower than \( \rho \) if out-of-equilibrium messages are received. Such beliefs cannot contradict strongly coherent out-of-equilibrium beliefs because only the opportunistic government could be better off in an alternative pooling sequential equilibrium with a tax rate different from \( \tau_t^*(\rho) \).

As the leader in this game, the trustworthy type is able to use its tax announcements \( \{ \tau_t \}_{t=1}^T \) to influence household production \( \{ \mu_t \}_{t=1}^T \) and the opportunistic type’s confiscation probabilities \( \{ \pi_t \}_{t=1}^T \) to maximize its life-time tax revenues. Backward induction can be used to obtain a MPE solution.

### 3 A Two-period Model

This section presents the solution to a two-period version of the model, illustrating the basic trade-offs facing a trustworthy government with imperfect credibility. As a result of these trade-offs, varying time discount factor for the opportunistic government changes not only the Markov perfect equilibrium tax rate but also the type of MPE (pooling, separating, or mixed-strategy).

#### 3.1 Optimal tax announcement with full credibility

First, consider a benchmark case in which a trustworthy government possesses full credibility, \( \rho = \psi = 1 \). The expected after-tax output is \( (1 - \tau) \), and the fraction of households who
produce is $(1 - \tau)^\gamma$. Household production thus decreases with the announced tax rate. This feature replicates the celebrated Laffer curve, which traces an inverted U-shaped relationship between the announced tax rate and revenue. The revenue-maximizing tax rate is:

$$\tau^*_{UC} = \arg \max_\tau \tau (1 - \tau)^\gamma = (\gamma + 1)^{-1}.$$ 

This rate is labeled as “unconstrained optimal” because it is free of the constraints imposed by credibility concerns. We now turn to the case with imperfect credibility.

### 3.2 MPE in the final period

In the final period, $t = 2$, the opportunistic government always confiscates all household production irrespective of $\mu_2$ because there is no future revenue to reward mimicking. The MPE is thus a separating one, and the current government’s short-term credibility $\psi_2$ is equal to the predetermined state variable $\rho_2$, implying $\tau^*_2 = \tau^*_{UC}$. The optimal tax rate $\tau^*_{UC}$ yields the value functions of both types:

$$V_2(\rho_2) = (1 - \tau^*_{UC})^\gamma \rho_2^\gamma; \quad W_2(\rho_2) = \tau^*_{UC} V_2(\rho_2). \quad (5)$$

### 3.3 MPE in the first period

In the first period, the probability of confiscation depends on the announced tax rate $\tau_1$ because both the opportunistic government’s payoff from mimicking and its payoff from confiscation are affected by $\tau_1$. Given the initial reputation $\rho_1$, the announced tax rate therefore determines short-term credibility through Equation (1) and, in turn, the growth of reputation according to Bayes’ rule. These effects of the announced tax rate are not found in Cukierman and Liviatan (1991) and are the focus of this paper.

#### 3.3.1 The type of equilibrium and the announced tax rate

The announced tax rate $\tau_1$ can induce three types of equilibrium in the simultaneous game played by households and the opportunistic government defined in Definition 1:

1) a pooling equilibrium $\hat{\psi}_1 = 1$ in which $\tau_1$ satisfies:

$$\tau_1 \hat{\mu}_1 + \beta_{op} V_2 (\rho_1) \geq \hat{\mu}_1 \text{ with } \hat{\mu}_1 = (1 - \tau_1)^\gamma. \quad (6)$$

2) a separating equilibrium $\hat{\psi}_1 = \rho_1$ in which $\tau_1$ satisfies:

$$\tau_1 \hat{\mu}_1 + \beta_{op} V_2 (1) \leq \hat{\mu}_1 \text{ with } \hat{\mu}_1 = (1 - \tau_1)^\gamma (\rho_1)^\gamma. \quad (7)$$
3) a mixed equilibrium \( \hat{\psi}_1 \in (\rho_1, 1) \) in which \( \tau_1 \) satisfies:

\[
\tau_1 \hat{\mu}_1 + \beta_{op} V_2 \left( \rho_1 / \hat{\psi}_1 \right) = \hat{\mu}_1 \text{ with } \hat{\mu}_1 = (1 - \tau_1)^{\gamma} (\psi_1)^{\gamma}.
\]  

(8)

### 3.3.2 Equilibrium tax announcement

The trustworthy government chooses the announced tax rate \( \tau_1 \) that maximizes its payoff

\[
\tilde{W} (\tau_1, \rho_1) \equiv \tau_1 \hat{\mu}_1 + \beta_{tr} W_2 \left( \rho_1 / \hat{\psi}_1 \right),
\]

where \( \hat{\psi}_1 = \rho_1 + (1 - \rho_1) (1 - \hat{\pi}_1) \) and \( \{\hat{\mu}_1, \hat{\pi}_1\} \) is the equilibrium given in Definition 1. The optimal announced tax rate not only maximizes the trustworthy government’s payoff conditional on a particular type of equilibrium as defined above, but it also yields the highest payoff among the three types of equilibria. The MPE is thereby determined by the equilibrium associated with the optimal tax rate.

**Proposition 1** A unique MPE exists in period 1 with the following properties:

Given \( \beta_{tr} \) and \( \gamma \), when \( \rho_1 \in [\rho_L, \rho_H] \), the MPE changes from pooling to mixed and then to separating as \( \beta_{op} \) decreases from 1 to 0.

(i) When \( \rho_1 \to 0 \), the range of \( \beta_{op} \) for which the MPE is either pooling or separating shrinks towards the null set. Correspondingly, the set of \( \beta_{op} \) for which the MPE is mixed tends towards the set \([0,1]\).

(ii) When \( \rho_1 \to \rho_H \), the range of \( \beta_{op} \) for which the MPE is mixed tends towards the null set. Correspondingly, when \( \rho_1 > \rho_H \), the MPE is pooling if \( \beta_{op} \) is high, whereas it is separating if \( \beta_{op} \) is low.

The message of Proposition 1 is summarized in Figure 1. It fully characterizes the types of MPE that arise for alternative combinations of the initial reputation, \( \rho_1 \), and the time discount factor of the opportunistic government, \( \beta_{op} \). If we instead assume that the two government types are equally patient, the equilibrium diagram will be similar to Figure 1.\(^{16}\)

Another interesting feature of the MPE is the dependence of the equilibrium tax rate on both \( \rho_1 \) and \( \beta_{op} \).

**Proposition 2** Given \( \beta_{tr} \) and \( \gamma \), the Markov perfect equilibrium announced tax rate is \( \tau_{UC}^* \) when \( \rho_1 \) is sufficiently high, and it changes from a decreasing function with respect to \( \rho_1 \) to an increasing function as \( \beta_{op} \) decreases from 1 to 0.

\(^{16}\)Compared with Figure 2 in Cukierman and Liviatan (1991), the region in which the MPE is pooling is expanded. In other words, taking into account the effect of the tax announcement on short-term credibility, the trustworthy government will raise the announced tax rate to actively induce a pooling equilibrium in some parameter region that would otherwise have a mixed MPE.
This proposition shows not only that the equilibrium tax rate to which a government commits is a function of the state variable $\rho_1$ but also that its functional form changes with $\beta_{op}$. However, the range of $\beta_{op}$ for which the equilibrium announced tax rate is an increasing function of $\rho_1$ will disappear if $\beta_{tr}$ is assumed to be equal to $\beta_{op}$. The logic of this result will be explained in the next subsection, but essentially, a trustworthy government that is as patient as an opportunistic government does not have the incentive to separate if this separation is costly in terms of current tax revenue. Therefore, differences in the level of patience across government types are an important part of the explanation for the costly reputation-building that one may observe in the real world.

3.4 Understanding the MPE in the first period

In choosing the optimal announced tax rate, the trustworthy government faces two trade-offs: one is the intra-temporal trade-off captured by the conventional Laffer curve in Section 3.1; the other is the inter-temporal trade-off to be studied in this section, which stems from the effect of the announced tax rate on short-term credibility.

In a pooling or a separating equilibrium, only the intra-temporal trade-off is present because short-term credibility does not vary with the change in the announced tax rate. If $\tau_{UC}^*$ satisfies either the pooling or the separating incentive compatibility constraint of the opportunistic government, i.e., $\rho^*_1 \geq (1 - \tau_{UC}^*) / \beta_{op}$ or $\rho^*_1 \geq \beta_{op} / (1 - \tau^*_{UC})$, then $\tau^*_{UC}$ is the optimal tax rate that induces the pooling or the separating equilibrium.

**Lemma 1** When $\tau_{UC}^*$ satisfies the pooling incentive compatibility constraint,

$$
\tau_{UC}^* = \arg \max_{\tau_1} \tau_1 \hat{\mu}_1 + \beta_{tr} W_2 (\rho_1) \text{ where } \hat{\mu}_1 = (1 - \tau_1)^\gamma.
$$

When $\tau_{UC}^*$ satisfies the separating incentive compatibility constraint,

$$
\tau_{UC}^* = \arg \max_{\tau_1} \tau_1 \hat{\mu}_1 + \beta_{tr} W_2 (1) \text{ where } \hat{\mu}_1 = (1 - \tau_1)^\gamma (\rho_1)^\gamma.
$$

**Proof.** Notice that when $\psi_1$ is fixed at $\bar{\psi}_1$ ($\bar{\psi}_1 = 1$ in a pooling equilibrium and $\bar{\psi}_1 = \rho_1$ in a separating equilibrium), the trustworthy government’s current tax revenue, $\tau_1 (1 - \tau_1)^\gamma (\bar{\psi}_1)^\gamma$, is maximized at $\tau_{UC}^*$, and its continuation value, $\beta_{tr} W_2 (\rho_1 / \bar{\psi}_1)$, is independent of the current tax rate. This solution to the unconstrained maximization of $\bar{W} (\tau_1, \rho_1)$ does not change after the incentive compatibility constraint is imposed because the constraint is not binding at $\tau_{UC}^*$. 

This lemma implies that any deviation of the optimal tax rate from $\tau_{UC}^*$ can be attributed
solely to the inter-temporal trade-off, a convenient property provided by the homogeneity feature of the cost distribution \( G ( \cdot ) \). The effect of the inter-temporal trade-off can be studied in the type of equilibrium that cannot be induced by \( \tau_{UC}^* \) or in a mixed equilibrium.

**Lemma 2** Conditional on the type of equilibrium that cannot be induced by \( \tau_{UC}^* \) or a mixed equilibrium, the optimal tax rate can be obtained by solving:

\[
\max_{\tau \in [0,1]} \tilde{W} (\tau_1, \rho_1) = \tau_1 \hat{\mu}_1 + \beta_t W_2 \left( \rho_1 / \hat{\psi}_1 \right) \\
\text{s.t. } \tau_1 \hat{\mu}_1 + \beta_{op} V_2 \left( \rho_1 / \hat{\psi}_1 \right) = \hat{\mu}_1 \text{ with } \hat{\mu}_1 = (1 - \tau_1)^\gamma \left( \hat{\psi}_1 \right)^\gamma \text{ and } \hat{\psi}_1 \in [\rho_1, 1].
\]

**Proof.** As shown in the proof of Lemma 1, the solution to the unconstrained maximization of \( \tilde{W} (\tau_1, \rho_1) \) is \( \tau_{UC}^* \) when short-term credibility \( \psi_1 \) is fixed. In the case of a pooling or separating equilibrium, imposing the incentive compatibility constraint will alter the solution because \( \tau_{UC}^* \) is not in the constrained set. Maximization then dictates that the trustworthy type minimizes the deviation from \( \tau_{UC}^* \) to satisfy the pooling or separating incentive compatibility constraint, which implies a binding constraint in either case, i.e., the payoffs from mimicking and from confiscation are identical. In the case of a mixed equilibrium, the opportunistic government is already indifferent to the choice between mimicking and confiscation. 

Lemmas 1 and 2 together state that the Markov perfect equilibrium tax rate either is \( \tau_{UC}^* \), which induces a pooling or a separating equilibrium, or makes the opportunistic type indifferent to the choice between mimicking and confiscation.

### 3.4.1 The inter-temporal trade-off

Using the indifference condition (10), we can specify the set of tax rates that make the opportunistic type indifferent: \( \Omega (\rho_1) = \{ \tau_1 : \hat{\psi}_1 (\tau_1, \rho_1) \in [\rho_1, 1] \} = [\hat{\tau}_1 (\rho_1), \bar{\tau}_1 (\rho_1)] \) where, with some abuse of notation, \( \hat{\psi}_1 (\tau_1, \rho_1) \) is the level of short-term credibility that makes the payoff from mimicking equal to that from confiscation:

\[
\hat{\psi}_1 (\tau_1, \rho_1) \equiv \left( \frac{\beta_{op} (1 - \tau_{UC}^*)^\gamma}{(1 - \tau_1)^\gamma + 1} \right)^{\frac{1}{\gamma}} \rho_1^\gamma.
\]

Notice that \( \hat{\psi}_1 (\tau_1, \rho_1) \) is increasing in \( \tau_1 \). Intuitively, a higher announced tax rate narrows the tax-revenue gap between implementing the announced rate and deviating from it, which makes the opportunistic government less tempted to deviate and confiscate all household production. As a result, although a higher announced tax rate makes it less rewarding to produce, the announcement appears more credible to households because the risk of
confiscation after production is smaller. This credibility effect makes the marginal gain from raising the announced tax rate greater when the level of short-term credibility responds to the tax change than when the level of short-term credibility is fixed, as it is in the full credibility case:\footnote{The derivatives are positive because a reasonable tax rate should always be on the increasing side of the Laaffer curve.}

\[
\frac{\partial \hat{\mu}_1 (\tau_1, \rho_1)}{\partial \tau_1} = \frac{\partial \tau_1 G \left[(1 - \tau_1) \hat{\psi}_1 (\tau_1, \rho_1) \right]}{\partial \tau_1} \geq \frac{\partial \tau_1 G \left[(1 - \tau_1) \right]}{\partial \tau_1} \geq 0.
\]

The announced tax rate that maximizes the current tax revenue is therefore no lower than the unconstrained optimal rate \( \tau^*_U \).

Announcing a higher tax rate may increase current tax revenue, but implementing such a rate does not convey significant information about government type because the opportunistic government is likely to implement a high rate as well. The Bayesian learning equation (3) reflects this learning effect, in which higher short-term credibility \( \hat{\psi}_1 \) reduces future reputation \( \psi_2 \). Because the tax revenue of the trustworthy government in the final period increases with its reputation, a higher current tax rate imposes a loss in future revenue:

\[
\frac{\partial \beta_{tr} W_2 \left( \rho_1 / \hat{\psi}_1 (\tau_1, \rho_1) \right)}{\partial \tau_1} \leq 0.
\]

### 3.4.2 The effect of \( \beta_{tr} / \beta_{op} \) and \( \gamma \)

It is worth noting that the trustworthy government’s payoff function in period 1 differs from the opportunistic government’s payoff from mimicking only in its weight on the continuation value:

\[
\tilde{W} (\tau_1, \rho_1) = \tau_1 \hat{\mu}_1 + \left[ \frac{\beta_{tr} \beta^*_U \gamma}{\beta_{op} \beta^*_U \gamma} \right] \beta_{op} V_2 \left( \rho_1 / \hat{\psi}_1 \right).
\]

A larger time preference ratio \( \beta_{tr} / \beta_{op} \) increases the weight assigned by the trustworthy government to future revenue compared to the weight assigned by the opportunistic government, which enhances the trustworthy government’s incentive to invest in reputation growth by announcing a lower tax rate in period 1. A greater elasticity of household production \( \gamma \), however, implies a lower \( \tau^*_U \), which increases the reward that the opportunistic government will receive in the final period if its identity is not revealed until then, and conversely reduces the reward that the trustworthy government will receive in the final period. It is then not only more difficult but also less rewarding for the trustworthy government to separate itself from the opportunistic government.
If \((\beta_{tr}/\beta_{op}) \tau_{UC}^* = 1\), the trustworthy government’s payoff is identical to that of the opportunistic government from mimicking, which, in turn, equals the household production in period 1 because of the indifference condition (10). Given \(\gamma \geq 1\), household production reacts negatively to a tax increase, \(\partial \bar{\mu}_1/\partial \tau_1 \leq 0\), even after the credibility effect has been accounted for. In this case, decreasing the announced tax rate increases the payoff to the trustworthy type, and the optimal tax rate is zero. At another extreme, if the trustworthy type is myopic, i.e., \((\beta_{tr}/\beta_{op}) \tau_{UC}^* = 0\), then the optimal tax rate that maximizes the momentary tax revenue \(\tau_1 \hat{\psi}_1\) must be greater than \(\tau_{UC}^*\) because of the credibility effect of the tax announcement discussed in the subsection above.

When \(\beta_{tr}\) remains fixed, decreasing \(\beta_{op}\) increases \((\beta_{tr}/\beta_{op}) \tau_{UC}^*\) and, in turn, changes the payoff function \(\tilde{W}(\tau_1, \rho_1)\) over \([\hat{\tau}_1 (\rho_1), \tilde{\tau}_1 (\rho_1)]\) from an increasing function to a hump-shaped one and then to a decreasing one. This change is the intuition behind the result that we obtain in Proposition 1 when the type of MPE changes from pooling to mixed and then to separating as \(\beta_{op}\) decreases because \(\hat{\tau}_1 (\rho_1)\) and \(\tilde{\tau}_1 (\rho_1)\) correspond to \(\hat{\psi}_1 = \rho_1\) and 1, respectively.

If the two types of government are assumed to be equally patient, then a costly separation with a tax rate lower than \(\tau_{UC}^*\) cannot be in equilibrium because \(\tilde{W}(\tau_1, \rho_1)\) is weakly increasing in \(\tau_1\) at \(\tau_1 = \tau_{UC}^*\) when \((\beta_{tr}/\beta_{op}) \tau_{UC}^* = (1 + \gamma)^{-1}\).\(^{18}\) Intuitively, because the opportunistic type gains more in the last period from having a positive reputation than the trustworthy type does, the former has a stronger incentive to trade its current tax revenue for its future reputation if both types of government value their future payoffs equally. Therefore, if the current tax revenue associated with the announced rate is so low that the opportunistic government would give up its future reputation for higher revenue in this period, then the tax revenue would also be too low for the trustworthy government in the sense that the trustworthy type would be better off achieving fewer gains in its future reputation but higher tax revenue in this period.

### 3.4.3 The effect of initial reputation

Conditional on a pooling or a separating MPE, recall that \(\tau_{UC}^*\) is the equilibrium tax announcement if \(\rho_1\) is sufficiently high because \(\tau_{UC}^*\) maximizes the current tax revenue. From the pooling incentive compatibility constraint (6), a lower \(\rho_1\) decreases the continuation value \(\beta_{op} V_2(\rho_1)\) but leaves the temptation for confiscation \((1 - \tau_1)^{\gamma+1}\) unchanged. Thus, as \(\rho_1\) decreases, the required tax rate that induces a pooling equilibrium increases, which imposes a higher cost on the trustworthy type because larger deviations of the required rate from \(\tau_{UC}^*\)

\(^{18}\)We call such a separation "costly" because a tax rate lower than \(\tau_{UC}^*\) imposes a loss in the current tax revenue of the trustworthy government.
generate more substantial losses in current tax revenue. As a consequence, the range of $\beta_{op}$ for which the MPE is pooling shrinks as $\rho_1$ decreases. Similarly, the separating incentive compatibility constraint (7) shows that a lower $\rho_1$ decreases the temptation for confiscation $(1 - \tau_1)^{\gamma + 1} (\rho_1)^{\gamma}$ but leaves the continuation value $\beta_{op} V_2 (1)$ unchanged. The announced tax rate must be lowered to induce a separating equilibrium if the initial reputation $\rho_1$ decreases. Committing to the lower rate imposes a higher cost on the trustworthy government because the rate deviates further from the current revenue-maximizing rate $\tau^*_UC$. As a result, the range of $\beta_{op}$ for which the MPE is separating also shrinks as $\rho_1$ decreases.

Finally, the range of $\beta_{op}$ for which the MPE is mixed tends to the null set before $\rho_1$ reaches one because there is a range of $\beta_{op}$ for which the trustworthy government, with a sufficiently high $\rho_1$, chooses between inducing a separating equilibrium with $\tau^*_UC$ and inducing a pooling equilibrium with a rate strictly higher than $\tau^*_UC$. In addition, as $\rho_1$ approaches one, the MPE changes from pooling to separating because the trustworthy government’s revenue loss due to imperfect credibility in the separating equilibrium approaches zero, whereas the loss in the pooling equilibrium remains strictly positive (since the pooling-inducing tax rate is always strictly higher than the current revenue-maximizing rate $\tau^*_UC$).

4 The Dynamics

This section reports the results concerning the equilibrium dynamics when governments have a $T$-period horizon.

**Proposition 3** i) When $\beta_{op} \geq 1 - \tau^*_UC$, the equilibrium tax announcement begins with a constant rate $\tau^*_UC$ and induces pooling MPE if $T$ is sufficiently large. The equilibrium announced tax rate then increases over time, which induces pooling MPE, and then decreases over time toward $\tau^*_UC$, which induces mixed MPE.

ii) When $\beta_{tr} [\gamma / (1 + \gamma)] < \beta_{op} < 1 - \tau^*_UC$, the equilibrium tax announcement begins with a rate higher than $\tau^*_UC$. With a lower $\rho_1$, the equilibrium announced tax rate first increases over time, which induces pooling MPE, and then decreases over time toward $\tau^*_UC$, which induces mixed MPE. With a higher $\rho_1$, the equilibrium announced tax rate converges to $\tau^*_UC$ over time, which induces (possibly) an initial stage of pooling MPE and a stage of mixed MPE until a separation occurs.

iii) Only if $\beta_{op} \leq \beta_{tr} [\gamma / (1 + \gamma)]$,\footnote{The sufficient condition for the costly reputation-building process to occur in equilibrium is $\beta_{tr} / \beta_{op} > B_2 > (\gamma + 1) / \gamma$, where $B_2$ is defined as a cutoff in $\beta_{tr} / \beta_{op}$ in period $\tilde{t}$ ($T - \gamma - 1 < \tilde{t} \leq T - \gamma$), above which the MPE is not pooling at moderate values of $\rho_1$.} with an initial reputation $\rho_1$ that is not extremely
When the opportunistic type is patient, $\beta_{op} \geq 1 - \tau_{UC}^*$, a pooling equilibrium can be sustained by $\tau_{UC}^*$ that maximizes the current tax revenue if the government has many periods to look forward to in its tenure. As time elapses, fewer future periods remain to reward the opportunistic government for maintaining its reputation, which means that the trustworthy government has to raise the announced tax rate from $\tau_{UC}^*$ to reduce the opportunistic government’s temptation for confiscation. When the deviation from $\tau_{UC}^*$ costs too much in terms of the current tax revenue, the trustworthy type stops inducing the pooling equilibrium, and the MPE becomes mixed, with the equilibrium tax rate declining over time toward $\tau_{UC}^*$.

Figure 2 plots the equilibrium time series $\{\tau_t, \rho_t, \pi_t, \mu_t, \tau_t^i\mu_t^i\}$ from a numerical example of Case i) with parameters $\gamma = 3$, $\beta_{tr} = \beta_{op} \geq 1 - \tau_{UC}^*$, $T = 20$ and $\rho_1 = 0.1$. Associated with an equilibrium path for tax rates as described above, government reputation remains constant at its initial level until the mixed MPE stage begins at the very end of the game. As the government’s reputation improves during that stage, the opportunistic government takes greater chances in confiscating household production. Household production thus reaches its highest level in the early stage of the game and subsequently decreases over time in concert with the dynamics of tax revenue.

A better initial reputation $\rho_1$ lengthens the amount of time before the equilibrium tax rate increases from $\tau_{UC}^*$ while also shortening the mixed MPE stage. A greater elasticity of household production $\gamma$ reduces the equilibrium tax rates and lengthens the mixed MPE stage. In addition, the equilibrium tax rates are lower when the trustworthy government is more patient (higher $\beta_{tr}$). Finally, a longer tenure (larger $T$) prolongs the pooling MPE stage.

When $\beta_{tr}^i \gamma / (1 + \gamma) < \beta_{op} < 1 - \tau_{UC}^*$, a pooling equilibrium must be induced using a rate higher than the current revenue-maximizing rate $\tau_{UC}^*$ under any circumstances. In contrast, a separating equilibrium can be induced using $\tau_{UC}^*$ if the government’s reputation is sufficiently high, which creates an incentive for the trustworthy government to improve its reputation.

If the government’s initial reputation $\rho_1$ is low, it will cost the government too much tax revenue to acquire a reputation such that a separating equilibrium can be induced by $\tau_{UC}^*$. Thus, there will be no separating MPE during the entire tenure of the government. The equilibrium dynamics resemble those in Case i) and are illustrated in the left panel of Figure 3.

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20 If $\rho_1$ is extremely low, the MPE is pooling in the early part of the game ($t \leq T - \gamma$) and mixed in the later part. Because an extremely low $\rho_1$ is unlikely, we omitted this scenario from the main text.
If the initial reputation $\rho_1$ is high, however, then a separating equilibrium induced by $\tau_{UC}^*$ will occur on the equilibrium path after a reputation-building stage (i.e., after a stage of mixed MPE) with the equilibrium tax rate converging to $\tau_{UC}^*$ from above.\textsuperscript{21} It is possible for the reputation-building stage to be preceded by a stage of pooling MPE. The right panel of Figure 3 plots the equilibrium dynamics of this case, which differs from the left panel only with regard to $\rho_1$. Reputation improves over time along with household production. The general pattern for the probability of confiscation and for tax revenue is increasing over time with some fluctuations along the path. A better initial reputation $\rho_1$ results in the more rapid convergence of the equilibrium tax rate to $\tau_{UC}^*$. As in Case i), higher $\gamma$ and $\beta_t$, decrease the equilibrium tax rates. Finally, a longer tenure (a larger $T$) adds more periods in which the trustworthy government can enjoy full credibility after the separation. However, this extra payoff does not vary with the policy choices made before the separation and therefore has no effect on the equilibrium dynamics.

In Case iii), the opportunistic type is sufficiently less patient than the trustworthy type that the equilibrium involves costly reputation-building at the initial stage of the game, which leads to a separating MPE if the tenure is not too short. Figure 4 plots the equilibrium time series from a numerical example that has the same parameterization as the example plotted in Figure 2 except that $\beta_{op}$ is reduced to 0.6. This single change generates significant differences in the equilibrium dynamics. The equilibrium announced tax rate begins with a rate of zero, which implies a tax revenue of zero once the announced rate is enacted. It is in the best interest of the trustworthy government to announce such a low rate because the forgone tax revenue helps to signal its commitment to fulfilling its promise and, in turn, can lead to rapid improvements in its reputation, as can be seen from the second panel of Figure 4. As the government’s reputation improves, household production gradually increases despite the increasing announced tax rate and the rising probability of confiscation by an opportunistic government if such a government is in place. As a result of the increasing household production and tax rate, the amount of tax revenue rises over time and reaches its peak when the separation occurs.

If the government’s initial reputation is better, then the equilibrium tax rate will converge more quickly to $\tau_{UC}^*$. A greater elasticity of household production $\gamma$ reduces the equilibrium tax rates but simultaneously slows the reputation-building process. When the trustworthy government is more patient, that government invests more aggressively in its reputation, which leads to more rapid improvements in reputation and lower equilibrium tax rates during

\textsuperscript{21}It is possible that the tenure will be so short that by the end of the game, the government reputation will not yet have improved sufficiently to sustain a separating equilibrium induced by $\tau_{UC}^*$. However, the equilibrium dynamics are similar except for the lack of a separating MPE.
the initial stage of the game. The duration of tenure, $T$, does not affect the equilibrium dynamics if a separating MPE occurs on the equilibrium path (for the same reason as in Case ii when $\rho_1$ is high).

5 Discussion

In the baseline model, we have assumed that the game has finite periods, that the announcing strategies must be pure, and that the government type is fixed. This section demonstrates that those assumptions, although helpful in simplifying the analysis, are not crucial to the equilibrium dynamics of policy and reputation that are generated by the baseline model.

5.1 Infinite horizon

Suppose that there is no terminal period in this game. In a MPE, the state variable $\rho$ must remain constant in a steady state because it is a bounded variable and can only increase in this model. This implies that the MPE is either pooling or separating in the steady state. If the MPE is pooling in the steady state, then the two government types have identical payoffs for each period, and those payoffs are the same as in a pooling MPE for the baseline model when $T$ approaches infinity. If the MPE is separating in the steady state, then we have what is essentially a complete information game in which the opportunistic government receives zero and the trustworthy one receives $\tau_{UC}^* (1 - \tau_{UC}^*)$ for each period. These values are also the same as in a separating MPE for the baseline model when $T$ approaches infinity. Using these payoffs in the steady state as continuation values, we can solve the infinite-horizon model using backward induction, and we see that the MPE is the limit of the unique MPE in the baseline model as $T$ approaches infinity.

5.2 Mixed strategies in announcement

There exists a semi-separating sequential equilibrium if we allow for mixed signaling strategies in the within-period signaling game. For example, let us take the game in the final period and let $\gamma = 1$. A semi-separating equilibrium can be such that the trustworthy government is indifferent to the choice between $\tau_1$ and $\tau_2$ where $\tau_1 < \tau_2$; the opportunistic type

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22When the only state variable is $\rho$ and when $\rho$ always remains one or zero, the strategies cannot be history dependent. Without history-dependent strategies, only the repetition of a one-shot equilibrium is possible.

23The refinement is used for the within-period signaling game and is not affected by whether there is a terminal period in the game.
sends $\tau_1$; and the supporting beliefs are as follows:

\[
\phi(TR|\tau_1) = \frac{\tau_2(1 - \tau_2)}{[\tau_1(1 - \tau_1)]} < \rho;
\]

\[
\phi(TR|\tau_2) = 1, \text{ and } \phi(TR|\tau \neq \tau_1 \text{ or } \tau_2) = 0,
\]

where $\rho$ is the prior belief that the current government is trustworthy and $\phi(TR|\tau)$ is the updated belief after $\tau$ is announced.

An equilibrium of this kind is also ruled out by the proposed refinement. Using the aforementioned example again, we can see that the trustworthy type’s favorite pooling sequential equilibrium is the one with $\tau = 0.5$. First, suppose that $\tau = 0.5$ is an out-of-equilibrium message in the semi-separating equilibrium. Note that the trustworthy type’s payoff in the candidate equilibrium is strictly lower than its payoff in a pooling equilibrium with $\tau = \tau_1$ because $\phi(TR|\tau_1) < \rho$. This finding implies that the strongly coherent belief upon the receipt of $\tau = 0.5$ must be no lower than the prior belief $\rho$ because the trustworthy type strictly prefers the alternative pooling sequential equilibrium with $\tau = 0.5$. This belief cannot support the candidate equilibrium because the trustworthy type will be better off deviating from the equilibrium message $\tau_1$ to the out-of-equilibrium message $\tau = 0.5$. Next, suppose that $\tau = 0.5$ is the equilibrium message in the semi-separating equilibrium. It must be true that $\tau_1 = 0.5$. Consider an out-of-equilibrium message $\tau_3$ that is slightly below $\tau_1$ such that $\tau_3(1 - \tau_3)\rho > \tau_1(1 - \tau_1)\phi(TR|\tau_1)$. $\tau_3(1 - \tau_3)\rho$ is the equilibrium payoff to the trustworthy type in a pooling sequential equilibrium with $\tau = \tau_3$, so the strongly coherent belief upon the receipt of $\tau_3$ is no lower than $\rho$, which cannot support the semi-separating equilibrium because the trustworthy type would be better off sending $\tau_3$.

### 5.3 Government type as a Markov process

Phelan (2006) has shown that letting government type follow a Markov process significantly alters the equilibrium dynamics in a reputation model with a fixed-action trustworthy government. This variation, however, does not result in qualitatively different equilibrium dynamics in our baseline model in which the trustworthy government optimally chooses its committed strategy. More specifically, the results summarized in Proposition 3 remain identical after we introduce switching types as in Phelan (2006) except that the equilibrium tax rate for pooling MPE becomes always strictly higher than $\tau^*_{UC}$ and first decreases over time in the early stage of the game.\(^{24}\)

Unlike Phelan’s model in which the opportunistic government always mimicking the

\(^{24}\)The plots for the equilibrium dynamics for all three cases are available in the online appendix.
trustworthy one cannot be an equilibrium, our model with switching government types has pooling MPE because the announced tax rate can vary with the government reputation (whereas it is fixed in Phelan’s model). Suppose that the opportunistic government’s reputation will decrease to $\varepsilon$ in the next period if it confiscates all household production but that its reputation will remain identical if it mimics a trustworthy government with certainty.\footnote{This assumption implies that the current reputation is strictly higher than $\varepsilon$ because if the current reputation equals $\varepsilon$, then mimicking with certainty will result in an improvement in government reputation.}

The trustworthy government can induce a pooling equilibrium by committing to a higher tax rate if the government reputation drops to $\varepsilon$.

6 Conclusion and Remarks

This paper has presented a simple reputation game in which a trustworthy government can use policy announcements to affect its current and future credibility. The unique Markov perfect equilibrium of the game reveals that a trustworthy government separates itself from an opportunistic one only when the latter’s time discount factor is sufficiently low. Such reputation-building by the trustworthy government involves policy announcements that are unlikely to be implemented by an opportunistic government if the trustworthy one is sufficiently patient. Otherwise, the policy announcements will be easy to honor.

These model predictions can explain variations in policy announcements across countries and across episodes. Assuming that the trustworthy government is patient, the model predicts that governments in countries that have frequent government turnover (which implies that the opportunistic government is short-sighted) tend to announce costly policies that are unlikely to be implemented if the government is opportunistic, whereas governments in countries with stable political environments prefer credible policies. In addition, a policymaker whose predecessor recently reneged on his or her promises (and is thereby known to be opportunistic and short-sighted) is more likely to announce costly policies and therefore has a higher probability of reneging as well.

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Appendix

Definition 5 \( \{m_t, \mu_t, \phi_t\} \) is a pure “sequential equilibrium” in period \( t \) if:

D.A.1) \( m_t(\text{TR}) \) maximizes the trustworthy type’s payoff:

\[
m_t(\text{TR}) = \arg \max_{\tau_t} \tau_t \mu_t + \beta_t W_{t+1} \left( \phi_t / \hat{\psi}_t \right) ,
\]

where \( \hat{\psi}_t = \phi_t + (1 - \phi_t) (1 - \hat{\pi}_t) \) and \( \{\mu_t(\tau_t, \phi_t), \hat{\pi}_t(\tau_t, \phi_t)\} \) is given in Definition 1.

D.A.2) \( m_t(\text{OP}) \) maximizes the opportunistic type’s payoff:

\[
m_t(\text{OP}) = \arg \max_{\tau_t} \left[ 1 - \hat{\pi}_t \right] \left[ \tau_t \mu_t + \beta_{op} V_{t+1} \left( \phi_t / \hat{\psi}_t \right) \right] + \hat{\pi}_t \mu_t.
\]

D.A.3) \( \phi_t \) is defined from the signaling strategies \( m_t \) by Bayes’ rule whenever possible:

\[
\phi_t(\text{TR}|\tau_t) \equiv \frac{\rho_t \Pr(\tau_t|\text{TR})}{\rho_t \Pr(\tau_t|\text{TR}) + (1 - \rho_t) \Pr(\tau_t|\text{OP})} \quad \text{if the denominator is positive},
\]

where \( \Pr(\tau_t|\text{TR}) = \begin{cases} 1 \text{ if } m_t(\text{TR}) = \tau_t \\ 0 \quad \text{otherwise} \end{cases} \) and \( \Pr(\tau_t|\text{OP}) = \begin{cases} 1 \text{ if } m_t(\text{OP}) = \tau_t \\ 0 \quad \text{otherwise} \end{cases} \).

Lemma 3 In any pure sequential equilibrium, \( m_t(\text{TR}) = m_t(\text{OP}) = \bar{a} \) and \( \phi_t(\bar{a}) = \rho_t \). In addition, \( \bar{a} \) can take any value from \([0, 1]\).

Proof. Suppose that \( m_t(\text{TR}) \neq m_t(\text{OP}) \). The opportunistic type’s identity is revealed if households observe the message \( m_t(\text{OP}) \). In turn, the opportunistic type will certainly confiscate all household production because its future reputation will never improve again. Anticipating this confiscation, no household will produce, which will generate a zero payoff for the opportunistic type. Thus, the opportunistic type is better off sending the same message as the trustworthy one, which makes distinct messages from the two types of government impossible in equilibrium. When \( m_t(\text{TR}) = m_t(\text{OP}) \), Bayes’ rule implies that the belief on the equilibrium path is \( \rho_t \).

Take any arbitrary message \( \bar{a} \) and let it be the announced tax rate for both types. Note that the definition of the sequential equilibrium only specifies the belief on the equilibrium path and leaves the beliefs off the equilibrium path unrestricted. We can then endow households with the belief that if the announced tax rate is different from \( \bar{a} \), then the government must be opportunistic, \( \phi_t(\text{TR}|\tau_t \neq \bar{a}) = 0 \). Thus, \( \mu_t \) is positive only if \( \tau_t = \bar{a} \) and is zero otherwise, making it optimal for both types to choose \( \tau_t = \bar{a} \).

Proofs of Propositions 1 and 2. We proceed with a number of steps.
We call an equilibrium “constrained pooling” if the equilibrium tax rate is equal to 
\( \bar{\tau}_1 (\rho_1) = 1 - \left[ \beta_{op} (1 - \tau_{UC}^*) \rho_1 \right]^{1/\gamma} \) such that the pooling incentive compatibility constraint is binding. We call an equilibrium “constrained separating” if the equilibrium tax rate is equal to 
\( \bar{\tau}_1 (\rho_1) = 1 - \left[ \beta_{op} (1 - \tau_{UC}^*) \rho_1 \right]^{1/\gamma} \) such that the separating incentive compatibility constraint is binding. Correspondingly, an “unconstrained” pooling or separating equilibrium is a pooling or separating equilibrium with \( \tau_{UC}^* \). Based on Lemma 2, if the equilibrium is mixed, the optimal tax rate is \( \bar{\tau}_1 \) where

\[
\bar{\tau}_1 = \frac{2 - \beta_{tr}/\beta_{op}}{\gamma + 1 - \beta_{tr}/\beta_{op}} \text{ if } \beta_{tr}/\beta_{op} < 2; \quad \bar{\tau}_1 = 0 \text{ otherwise.}
\]

Claim 1 i) \( \bar{\tau}_1 (\rho_1) \) increases in \( \rho_1 \) and \( \bar{\tau}_1 (\rho_1) \) decreases in \( \rho_1 \).

 ii) \( \bar{\tau}_1 (1) = \bar{\tau}_1 (1) \leq \tau_{UC}^* \) if and only if \( \beta_{op} \geq 1 - \tau_{UC}^* \).

 iii) \( \bar{\tau}_1 \geq \tau_{UC}^* \) if and only if \( \beta_{tr}/\beta_{op} \leq (\gamma + 1)/\gamma \).

Claim 2 A unique MPE exists in period 1 with the following properties:

 i) If \( \beta_{op} \geq 1 - \tau_{UC}^* \), the MPE is mixed when \( \rho_1 \in (0, \rho_{min}) \), constrained pooling when \( \rho_1 \in [\rho_{min}, \rho_{max}] \), and unconstrained pooling when \( \rho_1 \in [\rho_{max}, 1] \);

 ii) If \( \beta_{op} \leq [\gamma/ (\gamma + 1)] \beta_{tr} \), the MPE is mixed when \( \rho_1 \in (0, \rho_{min}^{-1}) \), constrained separating when \( \rho_1 \in [\rho_{min}^{-1}, \rho_{max}^{-1}] \), and unconstrained separating when \( \rho_1 \in [\rho_{max}^{-1}, 1] \);

 iii) If \( [\gamma/ (\gamma + 1)] \beta_{tr} < \beta_{op} < 1 - \tau_{UC}^* \), there exists a \( \rho^* (\gamma, \beta_{op}, \beta_{tr}) \) such that the MPE is mixed when \( \rho_1 \in (0, \min(\rho_{min}, \rho^*)) \), constrained pooling when, if any, \( \rho_1 \in [\rho_{min}, \rho^*] \), and unconstrained separating when \( \rho_1 \in [\rho^*, 1] \).

\[
\rho_{min} = \left[ \frac{(1 - \bar{\tau}_1)^{\gamma+1}}{\beta_{op} (1 - \tau_{UC}^*)^\gamma} \right]^{1/\gamma}; \rho_{max} = \left[ \frac{1 - \tau_{UC}^*}{\beta_{op}} \right]^{1/\gamma}.
\]

Proof. Based on Lemmas 1 and 2, the tax rate in a MPE either is \( \tau_{UC}^* \), which induces a pooling or separating equilibrium, or makes the opportunistic government indifferent to the choice between mimicking and confiscation. \( \bar{\tau}_1 \) is the solution to the optimization in Lemma 2 if we remove the constraint \( \bar{\psi}_1 \in [\rho_1, 1] \). Claim 1 implies that \( \bar{\tau}_1 (1) = \bar{\tau}_1 (1) \) is the lower bound for \( \bar{\tau}_1 (\rho_1) \) and the upper bound for \( \bar{\tau}_1 (\rho_1) \).

Case i: \( \beta_{op} \geq 1 - \tau_{UC}^* \) implies \( \bar{\tau}_1 (1) \leq \tau_{UC}^* \) by Claim 1. There must exist a \( \rho_1 \) such that \( \bar{\tau}_1 (\rho_1) \leq \tau_{UC}^* \) and, in turn, \( \tau_{UC}^* \) is optimal among the rates that induce pooling equilibria. Given \( \beta_{tr} \leq 1, \beta_{op} \geq 1 - \tau_{UC}^* \) implies that \( \beta_{tr}/\beta_{op} \leq (\gamma + 1)/\gamma \), and in turn, \( \tau_{UC}^* \leq \bar{\tau}_1 \) based on Claim 1. Therefore, \( \bar{\tau}_1 (\rho_1) \leq \bar{\tau}_1 \) and \( \bar{\tau}_1 (\rho_1) \) is optimal among the rates that make the opportunistic government indifferent. These two results then imply that \( \tau_{UC}^* \) is the Markov perfect equilibrium tax rate when \( \rho_1 \in [\rho_{max}, 1] \) with \( \rho_{max} \) defined by \( \bar{\tau}_1 (\rho_{max}) = \tau_{UC}^* \).
When \( \rho_1 < \rho_{\text{max}} \), \( \tau_{UC}^* \) cannot induce either a pooling or a separating equilibrium. The optimization in Lemma 2 implies that the MPE is mixed when \( \tau_1 \in (\hat{\tau}_1 (\rho_1), \bar{\tau}_1 (\rho_1)) \), i.e., when \( \rho_1 \in (0, \rho_{\text{min}}) \) with \( \rho_{\text{min}} \) defined by \( \hat{\tau}_1 (\rho_{\text{min}}) = \bar{\tau}_1 \), and the MPE is constrained pooling when \( \rho_1 \in [\rho_{\text{min}}, \rho_{\text{max}}] \).

Case ii: \( \beta_{op} \leq \gamma / (\gamma + 1) \beta_{tr} \) implies \( \beta_{op} \leq 1 - \tau_{UC}^* \) given \( \beta_{tr} \leq 1 \). Thus, \( \tau_1 (1) \geq \tau_{UC}^* \) and there must exist a \( \rho_1 \) such that \( \hat{\tau}_1 (\rho_1) \geq \tau_{UC}^* \), i.e., \( \rho_1 \in [\rho_{\text{max}}^{-1}, 1] \), and, in turn, \( \tau_{UC}^* \) is optimal among the rates that induce separating equilibria. In addition, \( \beta_{op} \leq \gamma / (\gamma + 1) \beta_{tr} \) implies \( \tau_{UC}^* \geq \tau_1 \), and therefore, \( \hat{\tau}_1 (\rho_1) \geq \tau_1 \). \( \hat{\tau}_1 (\rho_1) \) is thus optimal among the rates that make the opportunistic government indifferent. This case is then analogous to Case i: \( \tau_{UC}^* \) is the Markov perfect equilibrium rate when \( \rho_1 \in [\rho_{\text{max}}^{-1}, 1] \); when \( \rho_1 < \rho_{\text{max}}^{-1} \), \( \tau_1 \) is the Markov perfect equilibrium rate if \( \tau_1 \in (\hat{\tau}_1 (\rho_1), \bar{\tau}_1 (\rho_1)) \), i.e., \( \rho_1 \in (0, \rho_{\text{min}}^{-1}) \), and \( \hat{\tau}_1 (\rho_1) \) is the Markov perfect equilibrium rate when \( \rho_1 \in [\rho_{\text{min}}^{-1}, \rho_{\text{max}}^{-1}] \).

Case iii: \( \gamma / (\gamma + 1) \beta_{tr} < \beta_{op} < 1 - \tau_{UC}^* \) implies \( \hat{\tau}_1 (1) = \bar{\tau}_1 (1) > \tau_{UC}^* \) and \( \bar{\tau}_1 > \tau_{UC}^* \). When \( \rho_1 \in (0, \rho_{\text{max}}^{-1}) \) so that \( \hat{\tau}_1 (\rho_1) < \tau_{UC}^* \), \( \tau_{UC}^* \) cannot induce either a separating or a pooling equilibrium, and the MPE is determined using the optimization in Lemma 2. If \( \hat{\tau}_1 (1) > \bar{\tau}_1 \), the MPE is always mixed because \( \hat{\tau}_1 > \tau_{UC}^* \) and \( \hat{\tau}_1 (\rho_1) < \tau_{UC}^* \) imply \( \hat{\tau}_1 (\rho_1) < \bar{\tau}_1 \) so that \( \tau_1 \in (\hat{\tau}_1 (\rho_1), \bar{\tau}_1 (\rho_1)) \). If \( \hat{\tau}_1 (1) < \bar{\tau}_1 \), there exists a \( \rho_1 \) such that \( \hat{\tau}_1 (\rho_1) \leq \bar{\tau}_1 \), i.e., \( \rho_1 \geq \rho_{\text{min}} \). Therefore, the MPE is constrained pooling when, if any, \( \rho_1 \in [\rho_{\text{min}}, \rho_{\text{max}}] \). When \( \rho_1 \in (0, \min(\rho_{\text{min}}, \rho_{\text{max}}^{-1})) \), i.e., \( \bar{\tau}_1 < \hat{\tau}_1 (\rho_1) \), the MPE is mixed.

When \( \rho_1 \in [\rho_{\text{max}}^{-1}, 1] \) so that \( \hat{\tau}_1 (\rho_1) \geq \tau_{UC}^* \), \( \tau_{UC}^* \) is optimal among the rates that induce separating equilibria. The MPE is determined by comparing the trustworthy government’s payoff in this unconstrained separating equilibrium with its payoff in the equilibrium in which the opportunistic government is indifferent. If \( \hat{\tau}_1 (1) > \bar{\tau}_1 \), at \( \rho_1 \) such that \( \hat{\tau}_1 (\rho_1) \geq \bar{\tau}_1 \), i.e., \( \rho_1 \in [\rho_{\text{min}}^{-1}, 1] \), \( \hat{\tau}_1 (\rho_1) \) is optimal among the rates that make the opportunistic government indifferent. However, because \( \hat{\tau}_1 (\rho_1) \geq \bar{\tau}_1 > \tau_{UC}^* \) implies \( \rho_{\text{min}}^{-1} > \rho_{\text{max}}^{-1} \), \( \tau_{UC}^* \) dominates \( \hat{\tau}_1 (\rho_1) \) as the rate that induces a separating equilibrium. If \( \hat{\tau}_1 (1) < \bar{\tau}_1 \), at \( \rho_1 \) such that \( \hat{\tau}_1 (\rho_1) \leq \bar{\tau}_1 \), i.e., \( \rho_1 \in [\rho_{\text{min}}, 1] \), \( \hat{\tau}_1 (\rho_1) \) is optimal among the rates that make the opportunistic government indifferent. The comparison over \( \min(\rho_{\text{min}}, \rho_{\text{max}}^{-1}) \) is thus between a constrained pooling equilibrium and an unconstrained separating equilibrium. For other values of \( \rho_1 \in [\rho_{\text{max}}^{-1}, 1] \), the comparison is between a mixed equilibrium and an unconstrained separating equilibrium. It can be shown that the payoff to the trustworthy type increases with \( \rho_1 \) most rapidly in the unconstrained separating equilibrium so that we denote \( \rho^* \) as the single cutoff above which the unconstrained separating equilibrium yields a higher payoff.

Proposition 1 follows from graphing the results in Claim 2 on the \((\rho_1, \beta_{op})\) space. \( \rho_L = \rho_{\text{min}} (\beta_{op} = 1) \) and \( \rho_H \) is the intersection of \( \rho_{\text{min}} (\beta_{op}) \) and \( \rho^* (\beta_{op}) \).

Proposition 2 can be obtained from Claim 1 and Claim 2.
Figure 1: Types of MPE corresponding to alternative configurations of $\rho_l$ and $\beta_{op}$
Figure 2: Equilibrium dynamics in the case of equally patient government types

- Optimal tax announcement $\tau$
- Reputation and probability of confiscation
- Household production $\mu$
- Tax revenue $\tau\mu$

Parameters used:
- $\beta_{tr} = 0.85$
- $\beta_{op} = 0.85$
- $\gamma = 3$
- $\rho_1 = 0.1$
Figure 3.1
Equilibrium dynamics in the case of equally impatient government types
Low initial reputation

Figure 3.2
Equilibrium dynamics in the case of equally impatient government types
High initial reputation
Figure 4: Equilibrium dynamics in the case of a less patient opportunistic government

\[ \beta_t = 0.85 \beta_{op} = 0.6 \gamma = 3 \rho_1 = 0.1 \]

optimal tax announcement \( \tau \)

reputation and probability of confiscation

household production \( \mu \)

tax revenue \( \tau \mu \)