

Debt, Inflation, And Government Reputation

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¹The opinions expressed in this presentation are mine and do not necessarily reflect those of Banco de México or its Board of Governors.

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Motivation

FINANCIAL TIMES

“Central banks warn over surge in global sovereign debt levels”



How Inflation eroded governments' debts and why it matters |

THE WALL STREET JOURNAL.
Rising Government Debt Threatens
Financial Stability, Inflation, BIS Says

IMF BLOG

The Fiscal and Financial Risks of a
High-Debt, Slow-Growth World

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- **Government Reputation: probability agents assign to be facing a government that is committed to low inflation.**

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 - ▶ Monotonicity of inflation with respect to reputation: higher reputation translates into lower inflation and a lower incidence of debt on inflation.
- Recent increase in the correlation between debt and inflation in emerging economies can be explained by a decrease in government reputation more than a regime change.

Related Literature

- Positive Theories of Inflation: Barro and Gordon (1983), Canzoneri (1985), and Bassetto and Miller (2023).
- Fiscal and Monetary Policy Interaction: Diaz Gimenez et. al. (2008), Sargent et. al. (2009), Kocherlakota (2012), Bianchi and Melosi (2017).
- Reputation in Policy Games: Backus and Driffill (1985), Dovis and Kirpalani (2021), Amador and Phelan (2021), Fourakis (2023).

Today's Talk Roadmap

- ① **Model**
- ② **Theoretical Characterization**
- ③ **Calibration to the Mexican Case**

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 - ▶ This stimulates output and employment.
 - ▶ Agents understand this incentive and hence expect higher inflation, until a point such that even surprise inflation does not stimulate the economy further.
- In the presence of elevated public real debt, inflation also serves as a tool to dilute it.
- Upon observing high debt, in order for agents to correctly anticipate the government's actions, they need to assess how committed is the government to low inflation.

Model

- Two players:

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- In each period, both players choose their actions simultaneously:
 - ① Wage setter $i \in [0, 1]$ choose w_t^i .

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 - ① Wage setter $i \in [0, 1]$ choose w_t^i .
 - ② The government chooses inflation (π_t) and deficit (d_t).
- The choice of these variables determines the aggregate wage w_t , price level p_t , output y_t , and the evolution of debt in the economy b_t .

Model

- The government has its desired inflation and deficit levels, however, the economy may be influenced by exogenous factors that affect these variables.
- Hence, the realized inflation and deficits levels are given by:

$$\tilde{\pi} = \pi + \epsilon_{\pi}, \quad \tilde{d} = d + \epsilon_d,$$

where ϵ_x are i.i.d. random variables with mean zero and variance $\sigma_x^2 \geq 0$.

- Whenever $\sigma_x^2 = 0$, I say that the government is in perfect control over variable $x \in \{\pi, d\}$.

Model: Government Reputation

- Wage setters do not know the type of government they are facing.
- The government may be of two types:
 - ① Type P (Prudent): a government that cares about having both low inflation and low debt levels.
 - ② Type I (Imprudent): a government that cares less about managing debt and inflation.
- Let $\rho_0 \in [0, 1]$ be the prior probability that the government is of type P .
- Upon observing the history of policies implemented by the government, wage setters update their beliefs on the type of government they are facing.
 - ▶ Let ρ_t be the posterior belief that the government is of type P .
 - ▶ I will refer to this posterior as the current **government reputation**.

Model: Benchmark

- Complete information framework: no reputational concerns.
- Perfect control over inflation and deficit: $\sigma_{\pi}^2 = \sigma_d^2 = 0$.
- Dynamic game, since debt is a state variable.
- In every period, both players observe the entire history of policies implemented by the government as well as the wage setters' behavior up until that period.

Model: One Period Payoffs Role γ

- Wage setter $i \in [0, 1]$ chooses w_t^i to maximize:

$$UW_t^i = - \left(\frac{w_t^i - p_t}{p_{t-1}} \right)^2$$

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- Government chooses π_t, d_t : G Problem

$$UG_t = -(y_t - k\bar{y})^2 - s(\pi_t - \bar{\pi})^2$$

where:

$$y_t = \bar{y} + \theta \left(\frac{p_t - w_t}{p_{t-1}} \right) = \bar{y} + \theta(\pi_t - \pi_t^e)$$

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$$y_t = \bar{y} + \theta \left(\frac{p_t - w_t}{p_{t-1}} \right) + d_t = \bar{y} + \theta(\pi_t - \pi_t^e) + d_t,$$

$$b_t = d_t + \frac{(1+r)(1+\pi_t^e)b_{t-1}}{1+\pi_t} - \bar{m}\pi_t.$$

Model: Intertemporal Incentives

- Since there is a continuum of wage setters and the government only observes aggregate behavior, they choose their wage myopically.
- The government chooses inflation and debt taking into account future implications of its decisions.
 - ▶ The government discounts the future with factor $\delta \in [0, 1)$.

Equilibrium Definition Benchmark Game

Existence

- I restrict attention to Markov strategies, which are functions of the current state of the economy.

Equilibrium Definition Benchmark Game Existence

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Definition Non-Markovian Equilibria

A Markov perfect equilibrium of this game are functions (π^e, π, d) such that:

- 1 (π^e, π, d) are Markov strategies.
- 2 Given (π, d) , wage setters choose π^e to maximize their payoffs. WS Problem
- 3 Given π^e , the government chooses (π, d) to maximize its payoffs. G Problem

Model: Government's Problem

- Given the current debt b and a conjecture on wage setters' behavior $\hat{\pi}^e$, the government's best reply is the solution of the following problem:

$$V(b) = \max_{\pi, d, b'} (1 - \delta) [-(y - k\bar{y})^2 - s(\pi - \pi^*)^2 - \gamma(b')^2] + \delta V(b')$$

$$y = \bar{y} + \theta(\pi - \hat{\pi}^e(b)) + d,$$

$$b' = d + \frac{(1+r)(1+\hat{\pi}^e(b))b}{1+\pi} - \bar{m}\pi,$$

$$0 \leq b' \leq \bar{b}.$$

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- This creates a mapping $\hat{\pi}^e(\cdot) \rightarrow \pi(\cdot)$, in which an equilibrium is a fixed point.

Proposition

In every Markov perfect equilibrium of this dynamic game:

- 1 $\pi^*(\cdot)$ is an increasing function of b .
- 2 $d^*(\cdot)$ is a decreasing function of b .
- 3 No surprise inflation: $\pi^{e*}(b) = \pi^*(b)$ for all b , which implies:

$$y = \bar{y} + \theta (\pi^*(b) - \pi^e(b)) + d^*(b) = \bar{y} + d^*(b),$$

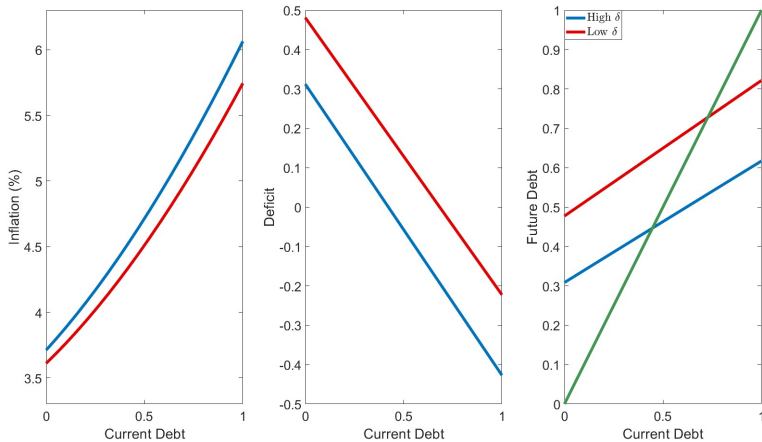
$$b' = d^*(b) + \frac{(1+r)(1+\pi^e(b))b}{1+\pi^*(b)} - \bar{m}\pi^*(b) = d^*(b) + (1+r)b - \bar{m}\pi^*(b)$$

Two Important Parameters

- Now, I highlight the role of two parameters in the model: δ and s .
- The discount factor heavily influences debt dynamics.
- The disutility for inflation parameter s determines inflation dynamics.
- I use variation in both parameters to motivate the types of governments I consider in my reputation framework.

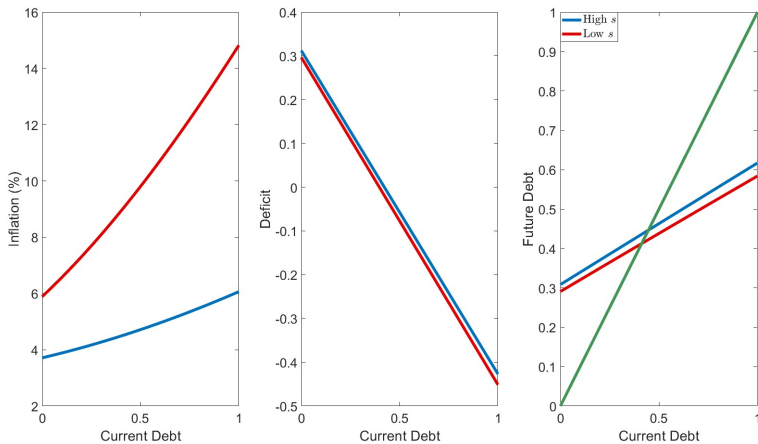
The Role of δ Details

$$\delta = 0.1 < \delta = 0.9.$$



The Role of s Details

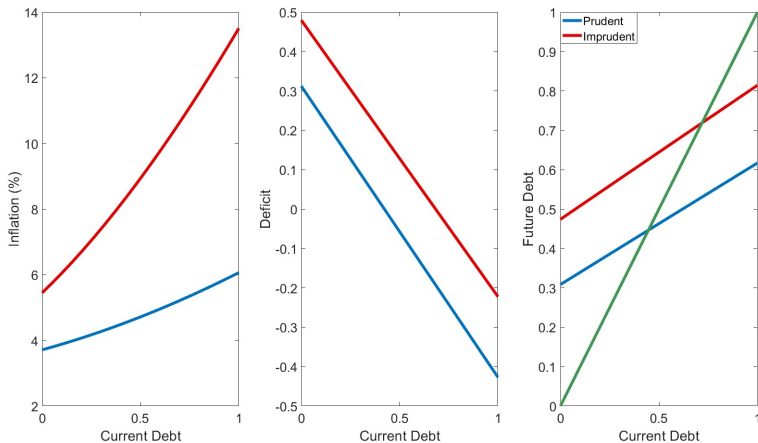
$$s = 1 < s = 10.$$



Prudent vs Imprudent Governments

Details

$$\delta = 0.1, s = 1 < \delta = 0.9, s = 10.$$



Takeaways of Benchmark Game

- A government with higher δ generates a lower debt policy function and a lower long-run debt level.
- A government with higher s generates a lower inflation policy function and a lower long-run inflation level.
- This model can explain, by varying δ and s , how a government can generate high inflation with high debt levels, or low inflation with low debt levels.
- The model has problems in explaining why a government would generate low inflation with high debt levels as well as slow transition between regimes.
- Solution: introduce reputational concerns.

Reputation Framework

- Wage setters now interact with a government that may be of two types:
 - ① Type P (Prudent): a government that has a discount factor $\delta_P \in (0, 1)$ and a disutility for inflation parameter s_P .
 - ② Type I (Imprudent): a government that has a discount factor $\delta_I = 0 < \delta_P$ and $s_I < s_P$.

Reputation Framework: Perfect Control

- Perfect control: $\sigma_{\pi}^2 = \sigma_d^2 = 0$.
- Since in equilibrium wage setters know the action chosen by each type of government, then one of two things can happen:
 - ① The two governments choose different policies, which allows wage setters to perfectly identify the type of government they are facing.
 - ② The two government always choose the same policy, which makes it impossible for wage setters to identify the type of government they are facing.
- Hence, in order to have non-trivial reputation dynamics, I need to assume that there is an imperfect control over inflation and deficit.

Reputation Framework: Markov Strategies

- Once again, I restrict attention to analyze pure Markov strategies.
- In this dynamic game, there are two state variables:
 - ① The current debt level b .
 - ② Government reputation ρ , i.e., the belief of wage setters that the government is of type P given the observed history of play up until that point.

Reputation Framework: Equilibrium Definition

Definition

A Markov perfect equilibrium of this game are functions $(\pi^e, \pi^P, d^P, \pi^I, d^I, \rho')$ such that:

- ➊ Given (π^P, d^P, π^I, d^I) , wage setters choose π^e to maximize their payoffs. WS Problem
- ➋ Given $(\pi^e, \pi^I, d^I, \rho')$ type P chooses (π^P, d^P) to maximize its payoffs. P Problem
- ➌ Given $(\pi^e, \pi^P, d^P, \rho')$ type I chooses (π^I, d^I) to maximize its payoffs. I Problem
- ➍ The updating rule ρ' is consistent with Bayes' Rule. Updating Rule

Reputation Framework: Type I 's Problem

- Taking as given (b, ρ) and a conjecture on wage setters $\hat{\pi}^e$, the government of type I 's best reply is characterized by the following problem:

$$V^I(b, \rho) = \max_{\pi, d, b'} \mathbb{E}_{\epsilon_\pi, \epsilon_d} \left[-(\tilde{y} - k\bar{y})^2 - s_I(\tilde{\pi} - \bar{\pi})^2 - \gamma(\tilde{b}')^2 \right],$$

$$\tilde{y} = \bar{y} + \theta(\tilde{\pi} - \hat{\pi}^e(b, \rho)) + \tilde{d},$$

$$\tilde{b}' = d + \frac{(1+r)(1+\hat{\pi}^e(b, \rho))b}{1+\tilde{\pi}} - \bar{m}\tilde{\pi},$$

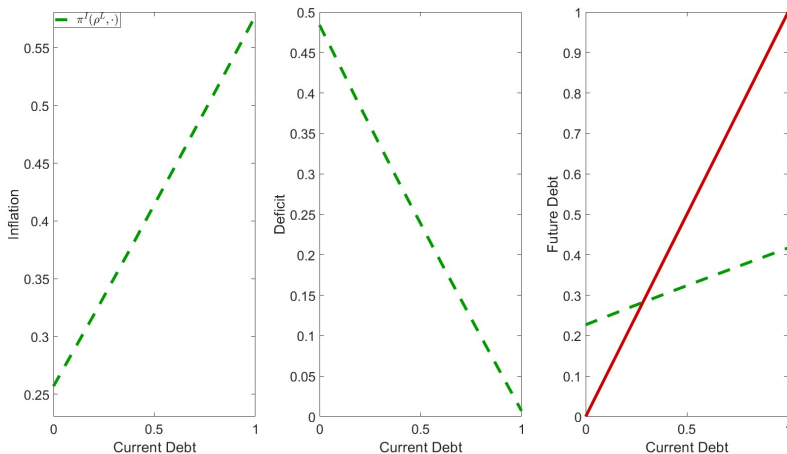
$$\tilde{\pi} = \pi + \epsilon_\pi,$$

$$\tilde{d} = d + \epsilon_d.$$

$$0 \leq \tilde{b}' \leq \bar{b}.$$

Reputation Framework: Type I 's Behavior

- The imprudent government is myopic, but it is not a behavioral type, its behavior is endogenous.



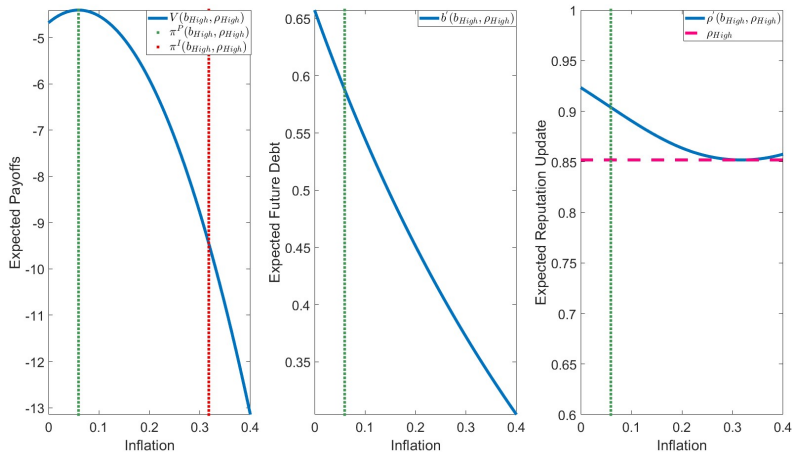
Reputation Framework: Type P 's Problem

- Taking as given (b, ρ) and a conjecture on wage setters $\hat{\pi}^e$ as well as the behavior of the government of type I , the government of type P 's best reply is characterized by the following problem:

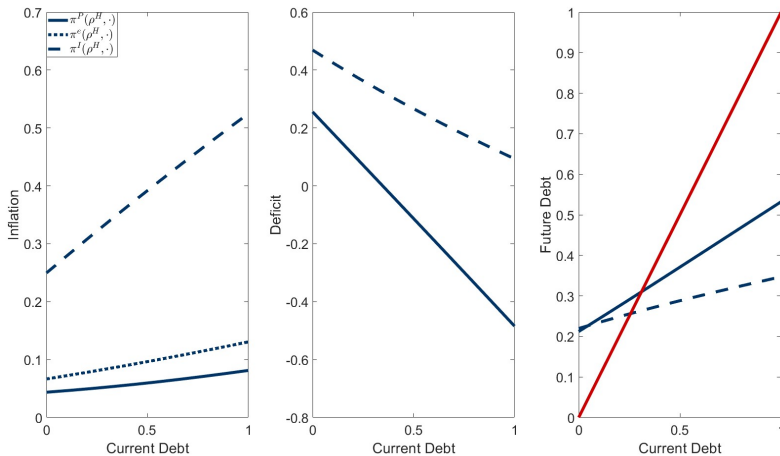
$$\begin{aligned}
 & V^P(b, \rho) = \\
 & \max_{\pi, d, b'} \mathbb{E}_{\epsilon_\pi, \epsilon_d} \left[(1 - \delta) \left[-(\tilde{y} - k\bar{y})^2 - s_P(\tilde{\pi} - \bar{\pi})^2 - \gamma(\tilde{b}')^2 \right] + \delta V^P(b', \rho') \right], \\
 & \tilde{y} = \bar{y} + \theta(\tilde{\pi} - \hat{\pi}^e(b, \rho)) + \tilde{d}, \\
 & \tilde{b}' = d + \frac{(1 + r)(1 + \hat{\pi}^e(b, \rho))b}{1 + \tilde{\pi}} - \bar{m}\tilde{\pi}, \\
 & \tilde{\pi} = \pi + \epsilon_\pi, \\
 & \tilde{d} = d + \epsilon_d, \\
 & 0 \leq \tilde{b}' \leq \bar{b}, \\
 & \rho' = \frac{\rho g_\pi(\tilde{\pi} - \pi) g_d(\tilde{d} - d)}{\rho g_\pi(\tilde{\pi} - \pi) g_d(\tilde{d} - d) + (1 - \rho) g_\pi(\tilde{\pi} - \hat{\pi}^I) g_d(\tilde{d} - \hat{d}^I)}.
 \end{aligned}$$

Reputation Framework: Equilibrium

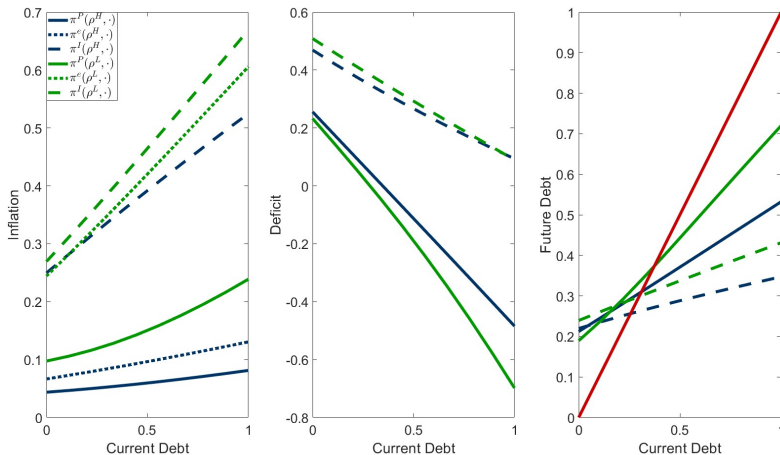
- The prudent government faces a trade-off of either increasing reputation or decreasing future debt.



Equilibrium: High Reputation



Equilibrium: High vs Low Reputation



- Why does a prudent government choose high inflation and deficit levels when it has low reputation?
- In equilibrium, whenever ρ is low, inflation expectations are close to $\pi^l(b, \rho)$.
- If the prudent government were to choose an inflation level that is considerably lower than $\pi^l(b, \rho)$, it would generate both a lower output and a higher debt:

$$y = \bar{y} + \theta (\pi^P(b, \rho) - \pi^e(b, \rho)) + d^P,$$

$$b' = d^P(b, \rho) + \frac{(1+r)(1+\pi^e(b, \rho))b_t}{1+\pi^P(b, \rho)} - \bar{m}\pi^P(b, \rho).$$

Reputation Framework: Equilibrium

Theorem Proof

In every Markov perfect equilibrium of this game:

❶ For all (b, ρ) :

$$\pi^e(b, \rho) = \rho \pi^P(b, \rho) + (1 - \rho) \pi^I(b, \rho).$$

Reputation Framework: Equilibrium

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$$\pi^e(b, \rho) = \rho \pi^P(b, \rho) + (1 - \rho) \pi^I(b, \rho).$$

❷ The behavior of the prudent government has the following characteristics for all (b, ρ) :

$$\frac{\partial \pi^P}{\partial b}(b, \rho) > 0,$$

Reputation Framework: Equilibrium

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$$\frac{\partial \pi^P}{\partial b}(b, \rho) > 0, \quad \frac{\partial \pi^P}{\partial \rho}(b, \rho) < 0,$$

Reputation Framework: Equilibrium

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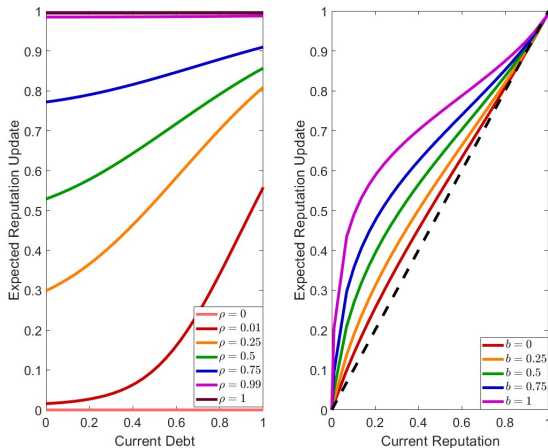
- ❸ Similar inflation and deficit dynamics for the imprudent government, as well as inflation dynamics for wage setters' equilibrium behavior.
- ❹ For all (b, ρ) the actions chosen by each type of government are different.

Updating Rule Dynamics

3D Updating Rule

Long Run Learning

- The prudent government is more likely to earn reputation in “bad times”.



Model Predictions and Mexican Data

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- Then, I compare the model's predictions for deficit, output and expectations with the available data.

Model Predictions and Mexican Data

- I consider inflation data reported by Banco de México.
- For the debt data, I use the gross real internal public debt dataset, which was constructed in collaboration with Banco de México
 - ▶ I then compare the data with the debt data reported in "A Monetary and Fiscal History of Latin America, 1960–2017" by Kehoe and Nicolini (2022).
- Since my main interest is to focus on the correlation between these variables, I normalized the data to be in the $[0,1]$ interval.

Model Predictions and Mexican Data: Calibration Procedure

- I follow closely the methodology of Chatterjee et. al. (2023).
- The calibrated parameters are $\omega = (s_P, s_I, \delta_P, \epsilon_\pi, \epsilon_d, \kappa, \theta, \gamma)$.
- I used a simulated method of moments and calibrate:

$$\omega \in \operatorname{argmax}_{\hat{\omega} \in \Omega} \sum_{t=1}^T (\pi_t^{\text{data}} - \pi_t^e(\hat{\omega}))^2.$$

- Instead of standard errors, I consider a local sensitivity analysis as in Andrews et. al. (2017) and assess the impact of a 1% variation in each parameter on the model's predictions.

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- For the reputation update, I considered the likelihood of receiving shocks of size $\pi_t^{data} - \pi_t^P(b_t^{data}, \rho_t)$, $d_t - d_t^P(b_t^{data}, \rho_t)$

Model Predictions and Mexican Data

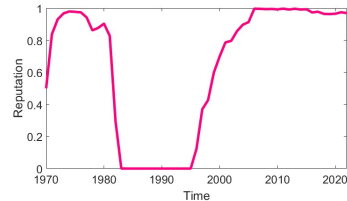
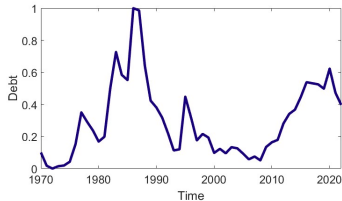
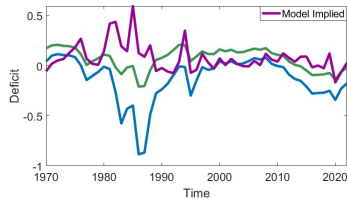
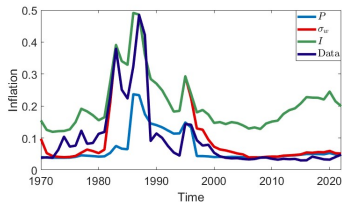
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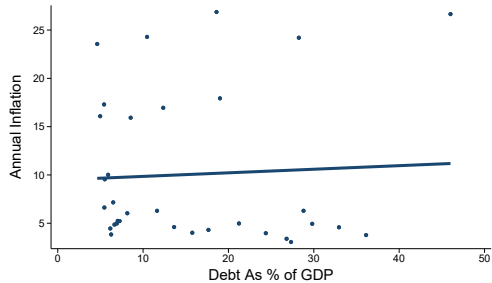
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Model Predictions and Mexican Data

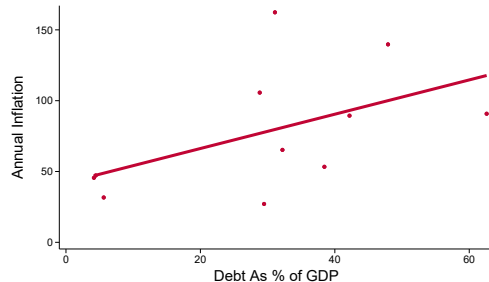
Parameter Values



Debt, Inflation, And Government Reputation in Mexico



High Reputation



Low Reputation

In Sample Prediction's Validation

- I considered data on inflation and debt to calibrate the model.
- I now compare the model's predictions with the (available) data on output gap (1970-2022), fiscal deficit (1990-2022), and inflation expectations (2000-2022).

Variable	M. Data/M. Model	Corr. Data and Model
Output Gap	1.23	0.47
Fiscal Deficit	0.94	0.89
Inflation Expectations	1.57	0.87

Key Takeaways of Reputation Model

- As reputation increases, we should expect a disconnection between inflation and debt.
- The value of reputation is crucial to determine government behavior.
 - ▶ Even a prudent government finds it optimal to choose high inflation and deficits when it has low reputation.
 - ▶ Importance of not only having high reputation, but also to maintain it.
- Accumulating reputation takes time, as Mexico's experience during the 90s shows.
- The recent increase in the correlation between inflation and debt is consistent with a decrease in government reputation.

Debt, Inflation, And Government Reputation

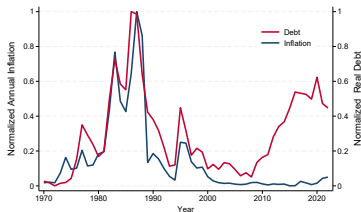
Alberto Ramirez de Aguilar

Banco de México²

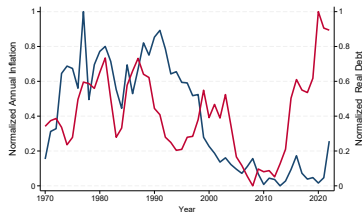
El Colegio de México, October 2025

²The opinions expressed in this presentation are mine and do not necessarily reflect those of Banco de México or its Board of Governors.

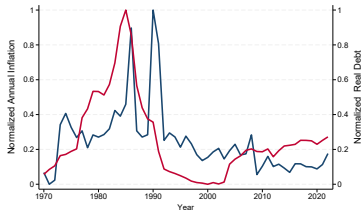
Debt and Inflation in Latin America

[Back](#)

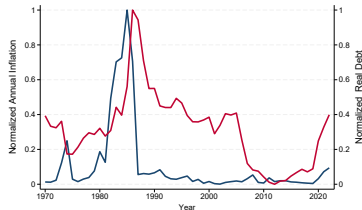
(a) Mexico.



(b) Colombia.

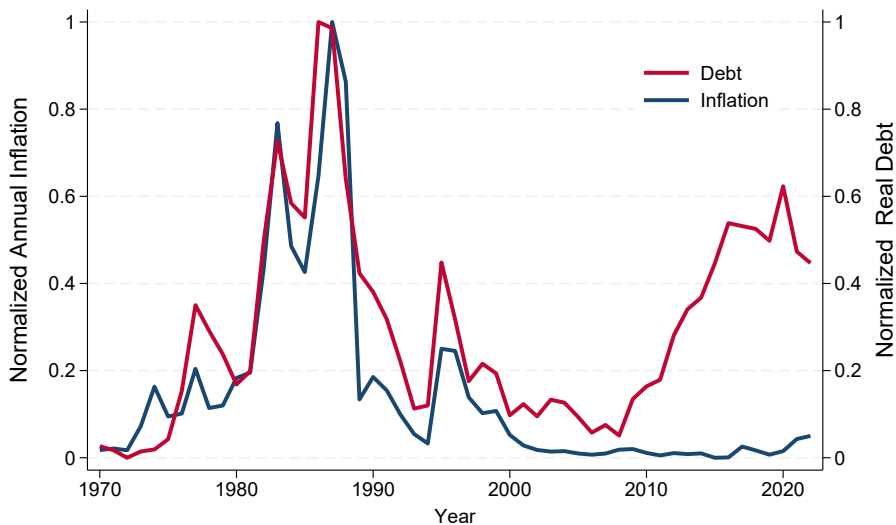


(c) Guatemala.



(d) Bolivia.

Debt and Inflation in Mexico

[Back](#)

Model: Wage Setters

- I model the labor market as a monopolistic competition market, in which there is a continuum of wage setters, indexed by $i \in [0, 1]$.
- Wage setter i chooses w_t^i having as an objective a constant real wage over time:

$$UW_t^i = - \left(\frac{w_t^i - p_t}{p_{t-1}} \right)^2 .$$

- Each i knows their wage decision does not affect p_t , and hence their expected utility maximizing wage choice is i 's expected price level, $w_t^i = p_t^{e,i}$.
- Since, by assumption, every wage setter has the same information when deciding w_t , then $w_t = p_t^{e,i} = p_t^e$ for all i .

- If we define inflation as $\pi_t = (p_t - p_{t-1})/p_{t-1}$, and $\pi_t^{e,i} = (p_t^{e,i} - p_{t-1})/p_{t-1}$ then we can re-write the wage setters payoffs as:

$$UW_t^i = - \left(\frac{w_t^i - p_t}{p_{t-1}} \right)^2 = - \left(\frac{p_t^{e,i} - p_{t-1} + p_{t-1} - p_t}{p_{t-1}} \right)^2 = - (\pi_t^{e,i} - \pi_t)^2.$$

- From now on, I consider $\pi_t^{e,i}$ to be the relevant variable for wage setters, which is pin downed by their wage decision.

- The government makes decisions on both the fiscal and monetary aspects of the economy.
- Each period, the government inherits a debt level b_{t-1} , and must decide on the deficit level d_t (government expenditures minus income) and growth rate of money g_t .
- The government is interested in pegging output, inflation, and debt to a target level:

$$UG_t = -(y_t - k\bar{y})^2 - s(\pi_t - \bar{\pi})^2 - \gamma b_t^2,$$

where $k > 1, s > 0, \gamma > 0$, $\bar{y}$ is the natural output level, and $\bar{\pi}$ is the inflation target of the government.

- Following the Neo-Keynesian tradition, output varies around a natural level $\bar{y}$.
- These fluctuations are driven by the labor market.
 - ▶ In an economy with sticky wages, higher prices attract more firms and workers to the market, increasing output.
- Hence, output is given by:

$$y_t = \bar{y} + \theta(p_t - w_t) + d_t = \bar{y} + \theta(\pi_t - \pi_t^e) + d_t,$$

where $\theta > 0$ measures the effect of the labor market on output.

- The evolution of government debt will be determined by:
 - ① Real (primary) deficit d_t : the difference between government expenditures and income.
 - ② Real service of debt: the amount of previous debt that the government must pay.
 - ③ Seigniorage: the revenue that the government gets from printing money.
- Importantly, according to the Fisher equation, the interest rate that the government faces is:

$$1 + i_t = (1 + r)(1 + \pi_t^e),$$

where $r > -1$ is the natural interest rate.

- The evolution of debt in real terms is given by:

$$b_t = d_t + \frac{(1 + i_t)b_{t-1}}{1 + \pi_t} - S_t = d_t + \frac{(1 + r)(1 + \pi_t^e)b_{t-1}}{1 + \pi_t} - S_t.$$

- Then, higher inflation (as a result of higher money growth) generates a lower real interest rate and hence a higher seigniorage, which in turn will reduce the real value of debt.

- I restrict debt to be non-negative, i.e., $b_t \geq 0$.
- Also, I assume that the government has a bound on the amount of debt it can issue $\bar{b}$. [Restrictions](#)
- I focus on the case $\bar{b}$ is large and not-binding, although future work where $\bar{b}$ is binding could be interesting.
- Let $\mathcal{D} = [0, \bar{b}]$ be the set of feasible debt levels.

- To close up the model, I need to specify how prices are determined.
- Again, following the Neo-Keynesian tradition, I assume that prices and money are related through a money demand function.
- To keep the model simple, I assume that the government faces the following money demand function:

$$\frac{m_t}{p_t} = \bar{m},$$

which has two implications:

- ① $g_t - \pi_t = 0$, i.e., by choosing g_t the government is pinning down inflation.
- ② Seigniorage is then given by $S_t = \bar{m}\pi_t$.

- I make a restriction to stationary Markov pure strategies.
 - ▶ Wage setters choose a strategy $\pi^e : \mathbb{R} \rightarrow \mathbb{R}$, where $\pi^e(b)$ represents inflation expectations upon observing a previous debt level b .
 - ▶ The government chooses $\sigma_g : \mathbb{R} \rightarrow \mathbb{R}^3$, where

$$(\pi(b), d(b), b'(b))$$

represent the inflation, deficit, and debt decisions upon observing b and given the strategy σ_w of wage setters.

- I restrict the strategy of wage setters to be a concave and twice differentiable function with uniformly bounded first derivatives.

- Given the current debt b and a conjecture on government inflation behavior $\hat{\pi}$, the wage setters best reply is such that:

$$\pi^e(b) = \operatorname{argmax}_{\pi^e} -(\pi^e - \hat{\pi}(b))^2.$$

- Given the current debt b and a conjecture on wage setters' behavior $\hat{\pi}^e$, the government's best reply is the solution of the following problem:

$$V(b) = \max_{\pi, d, b'} (1 - \delta) [-(y - k\bar{y})^2 - s(\pi - \pi^*)^2 - \gamma(b')^2] + \delta V(b')$$

$$y = \bar{y} + \theta(\pi - \hat{\pi}^e(b)) + d,$$

$$b' = d + \frac{(1+r)(1+\hat{\pi}^e(b))b}{1+\pi} - \bar{m}\pi,$$

$$0 \leq b' \leq \bar{b}.$$

Proposition

In a Markov Perfect Equilibrium of this dynamic game:

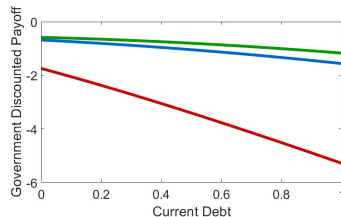
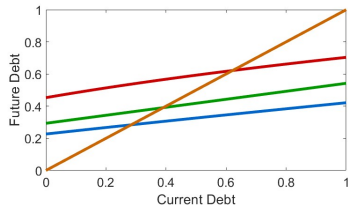
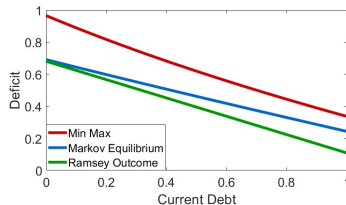
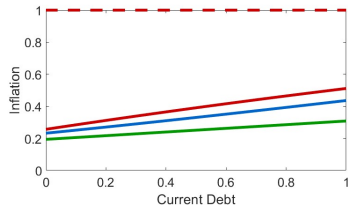
- 1 No surprise inflation: $\pi^{e*}(b) = \pi^*(b)$ for all $b \in [0, \bar{b}]$.
- 2 V^* is a strictly concave and decreasing function of current debt $b \in [0, \bar{b}]$.
- 3 π^{e*} is an increasing function of $b \in [0, \bar{b}]$.
- 4 $\pi^*(b)$ is an increasing and differentiable function of $b \in [0, \bar{b}]$.
- 5 $d^*(b)$ is a decreasing and differentiable function of $b \in [0, \bar{b}]$.
- 6 Let $s > s'$. Then, $\pi^*(b|s) \leq \pi^*(b|s')$ for all $b \in [0, \bar{b}]$.
- 7 Let $k > k'$. Then, $\pi^*(b|k) \geq \pi^*(b|k')$ for all $b \in [0, \bar{b}]$.

- Given σ_w , the government's (inflation) best reply is π .
- Under convexity and differentiability assumptions on σ_w , the government's best reply is unique.
- Therefore, the government's problem creates a best-reply mapping $\sigma_w \rightarrow \pi$.
- Given the utility of wage wetters $-(\pi - \pi^e)^2$, an equilibrium of this game is a fixed point of such mapping.
- Existence of such fixed point is guaranteed by the Schauder Fixed-Point Theorem.
- Equilibrium characterization can be done using the Implicit Function Theorem, the Envelope Theorem, and the Benveniste-Scheinkman Theorem.

- Why focus on analyzing Markov equilibria?
- In dynamic games, strategies are more complicated objects than in repeated games, and they live in a “very large” space.
- Non-Markovian “easy” strategies in repeated games, like Grim Trigger, become more complicated to handle, since now strategy has to guarantee that the player does not want to deviate to influence the state transition.
- Also, they do not require agents to coordinate on beliefs about future play, which is a feature of some Non-Markovian strategies as pointed out by Green and Porter (1984).

Markov Equilibria In My Model [Back](#)

- In the game analyzed in my paper, the Markov equilibrium yields payoffs that are close to the “first-best”, which would be achieved if the government could commit to a policy rule.



- For the restriction $b' \leq \bar{b}$ to be not binding, I need to impose some parameter restrictions.

Assumption

Let $\bar{y} = 1$. Then, for $b' \leq \bar{b}$ in the stage game for all possible values of $b \in \mathcal{D}$, the parameters must satisfy:

$$r\bar{b} \leq \frac{\bar{b}\gamma(r(s-1) - s) + \gamma k}{\gamma(1+s+\theta) + s}.$$

- All the examples presented in this presentation satisfy this restriction.

- Recall that the flow payoffs for the government are:

$$UG_t = -(y_t - k\bar{y})^2 - s(\pi_t - \bar{\pi})^2 - \gamma b_t^2.$$

- The parameter γ captures the government's aversion to debt.
- Some have suggested to consider $\gamma = 0$ in order to simplify the analysis.
- However, this leads to an uninteresting equilibrium where the government chooses a constant inflation rate.

Proposition

Suppose $\gamma = 0$ and $\bar{y}(1 + \bar{\pi} - k) \leq r\bar{b}$. Then, in the unique Markov equilibrium of the dynamic game $\pi(b) = \bar{\pi}$, $d(b) = (k - 1)\bar{y}$, and $V(b) = 0$ for all $b \in \mathcal{D}$.

Proof

- Since $\pi^e(b) = \bar{\pi}$, then $y = \bar{y} + \theta(\pi - \bar{\pi}) + d$.
 - Then, since the government's flow payoffs are $-(y - k\bar{y})^2 - s(\pi - \bar{\pi})^2$, the government will choose $\pi = \bar{\pi}$ and $d = (k - 1)\bar{y}$.
 - This gives the government a flow payoff of zero, which is the highest achievable flow payoff.
 - In order for the Bellman equation to hold, the value function must be zero.
 - Notice that in this case $b' = (k - 1)\bar{y} + (1 + r)b - \bar{y}\bar{\pi}$, which converges to $b = \max\{0, \frac{\bar{y}(1 + \bar{\pi} - k)}{r}\} \leq \bar{b}$ as long as $\bar{y}(1 + \bar{\pi} - k) \leq r\bar{b}$.
-
- Hence, the term $-\gamma b_t^2$ creates a trade-off between inflation and deficit, which is also impacted by the current debt level.

- Taking as given (b, ρ) and a conjecture on government behavior $\hat{\pi}^P, \hat{\pi}^I$, wage setters' best reply is characterized by the following problem:

$$\pi^e(b, \rho) = \underset{\pi^e}{\operatorname{argmax}} \quad \mathbb{E} \left[-\rho(\pi^e - \tilde{\pi}^P(b, \rho))^2 - (1 - \rho)(\pi^e - \tilde{\pi}^I(b, \rho))^2 \right],$$

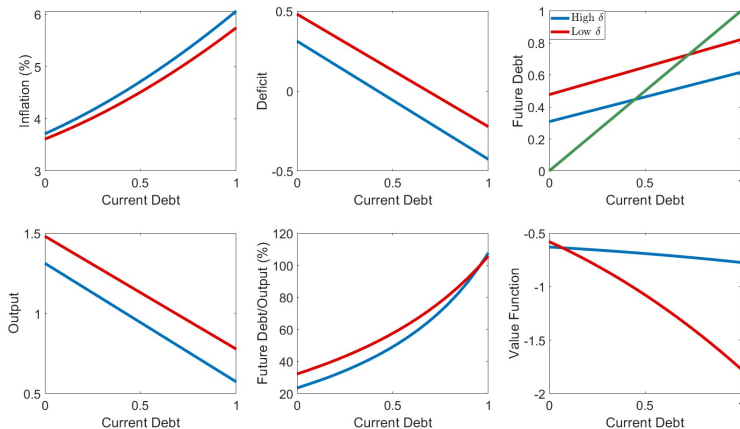
where $\tilde{\pi}^P(b, \rho) = \hat{\pi}^P(b, \rho) + \epsilon_\pi^P$ and $\tilde{\pi}^I(b, \rho) = \hat{\pi}^I(b, \rho) + \epsilon_\pi^I$.

- Then, the best reply of wage setters is given by:

$$\pi^e(b, \rho) = \rho \hat{\pi}^P(b, \rho) + (1 - \rho) \hat{\pi}^I(b, \rho).$$

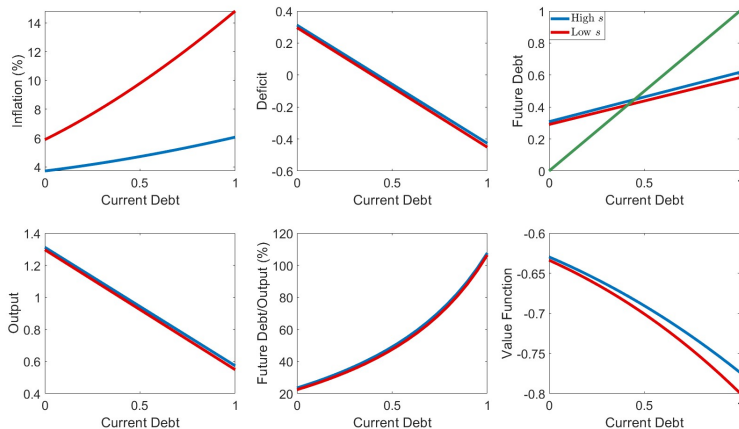
Equilibrium Example: The Role of δ [Back](#)

$$V(b) = \max_{\pi, d, b'} (1 - \delta) [-(y - k\bar{y})^2 - s(\pi - \bar{\pi})^2 - \gamma(b')^2] + \delta V(b').$$



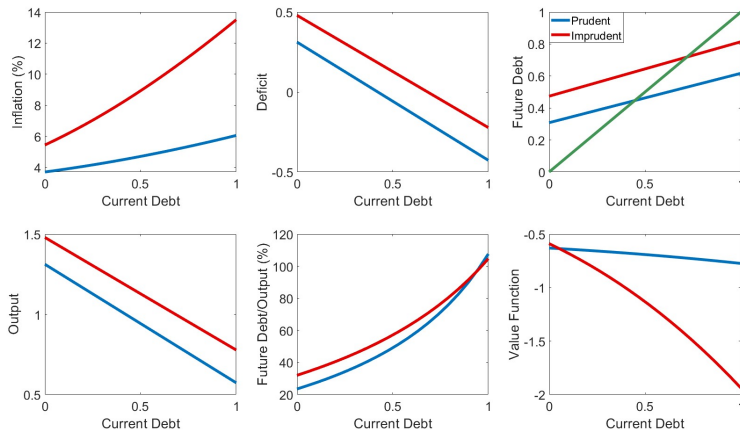
Equilibrium Example: The Role of s [Back](#)

$$V(b) = \max_{\pi, d, b'} (1 - \delta) [-(y - k\bar{y})^2 - s(\pi - \bar{\pi})^2 - \gamma(b')^2] + \delta V(b').$$



Example: Prudent vs Imprudent Governments [Back](#)

$$V(b) = \max_{\pi, d, b'} (1 - \delta) [-(y - k\bar{y})^2 - s(\pi - \bar{\pi})^2 - \gamma(b')^2] + \delta V(b').$$



Reputation Framework: Type P 's Problem [Back](#)

- Taking as given (b, ρ) and a conjecture on wage setters $\hat{\pi}^e$ as well as the behavior of the government of type I , the government of type P 's best reply is characterized by the following problem:

$$\begin{aligned}
 & V^P(b, \rho) = \\
 & \max_{\pi, d, b'} \mathbb{E}_{\epsilon_\pi, \epsilon_d} \left[(1 - \delta) \left[-(\tilde{y} - k\bar{y})^2 - s_P(\tilde{\pi} - \bar{\pi})^2 - \gamma(\tilde{b}')^2 \right] + \delta V^P(b', \rho') \right], \\
 & \tilde{y} = \bar{y} + \theta(\tilde{\pi} - \hat{\pi}^e(b, \rho)) + \tilde{d}, \\
 & \tilde{b}' = d + \frac{(1+r)(1+\hat{\pi}^e(b, \rho))b}{1+\tilde{\pi}} - \bar{m}\tilde{\pi}, \\
 & \tilde{\pi} = \pi + \epsilon_\pi, \\
 & \tilde{d} = d + \epsilon_d, \\
 & 0 \leq \tilde{b}' \leq \bar{b}. \\
 & \rho' = \frac{\rho g_\pi(\tilde{\pi} - \pi) g_d(\tilde{d} - d)}{\rho g_\pi(\tilde{\pi} - \pi) g_d(\tilde{d} - d) + (1 - \rho) g_\pi(\tilde{\pi} - \hat{\pi}^I) g_d(\tilde{d} - \hat{d}^I)}.
 \end{aligned}$$

- Taking as given (b, ρ) and a conjecture on wage setters $\hat{\pi}^e$, the government of type I 's best reply is characterized by the following problem:

$$V^I(b, \rho) = \max_{\pi, d, b'} \mathbb{E}_{\epsilon_\pi, \epsilon_d} \left[-(\tilde{y} - k\bar{y})^2 - s_I(\tilde{\pi} - \bar{\pi})^2 - \gamma(\tilde{b}')^2 \right],$$

$$\tilde{y} = \bar{y} + \theta(\tilde{\pi} - \hat{\pi}^e(b, \rho)) + \tilde{d},$$

$$\tilde{b}' = d + \frac{(1+r)(1+\hat{\pi}^e(b, \rho))b}{1+\tilde{\pi}} - \bar{m}\tilde{\pi},$$

$$\tilde{\pi} = \pi + \epsilon_\pi,$$

$$\tilde{d} = d + \epsilon_d.$$

$$0 \leq \tilde{b}' \leq \bar{b}.$$

- Upon observing $(\tilde{\pi}, \tilde{d})$, wage setters will update their beliefs according to Bayes' Rule:

$$\rho'(b, \rho) = \frac{\rho g_{\pi}(\tilde{\pi} - \pi^P(b, \rho)) g_d(\tilde{d} - d^P(b, \rho))}{\rho g_{\pi}(\tilde{\pi} - \pi^P(b, \rho)) g_d(\tilde{d} - d^P(b, \rho)) + (1 - \rho) g_{\pi}(\tilde{\pi} - \pi^I(b, \rho)) g_d(\tilde{d} - d^I(b, \rho))},$$

Proof Theorem

- Let Σ be the set of all functions $\sigma_w : [0, \bar{b}] \times [0, 1] \rightarrow \mathbb{R}$ that are strictly convex, uniformly bounded, and have uniformly bounded first derivatives.
- I show that an equilibrium exists by proving that the mapping $\tilde{\pi} : \Sigma_w \rightarrow \Omega$ defined by:

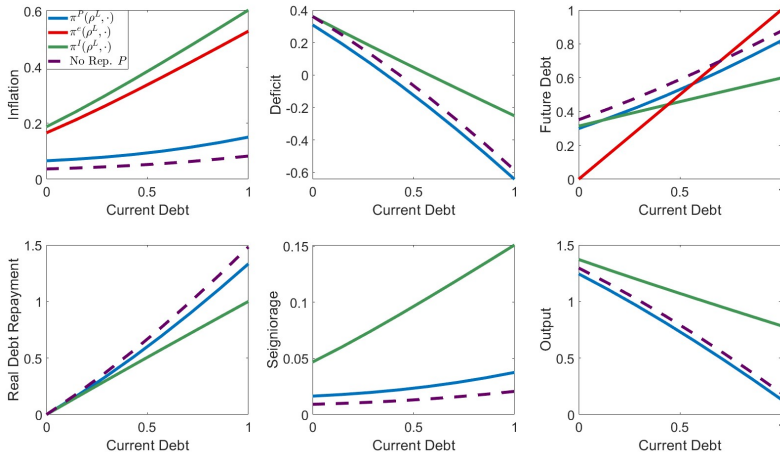
$$\tilde{\pi}(\sigma_w)(b, \rho) = \rho \pi^P(b, \rho | \sigma_w) + (1 - \rho) \pi^I(b, \rho | \sigma_w),$$

has a fixed point.

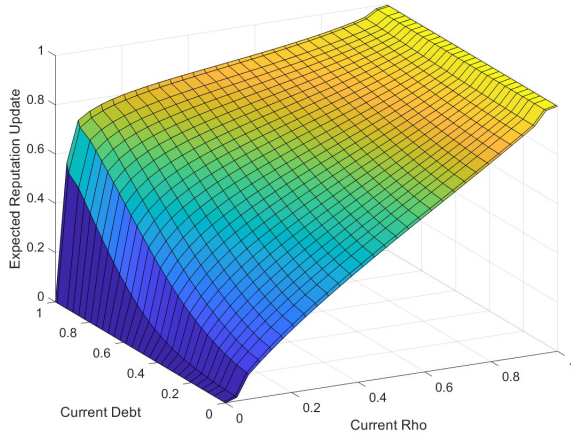
- I consider the Schauder Fixed Point Theorem, and hence I need to show:
 - 1 Σ_w is a non-empty, convex, and compact subset of a Banach space.
 - 2 $\tilde{\pi}$ is a continuous mapping with $\Omega \subseteq \Sigma_w$.

Equilibrium: Low Reputation [Back](#)

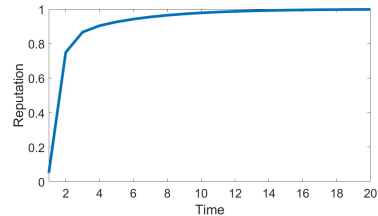
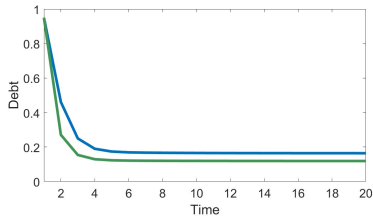
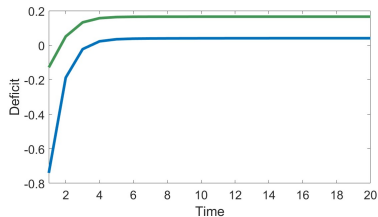
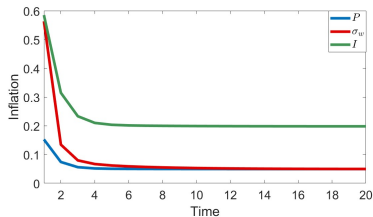
- If the prudent government had no reputation concerns, it would choose lower inflation, which would lead to higher debt, higher real interest rates, and lower seigniorage.



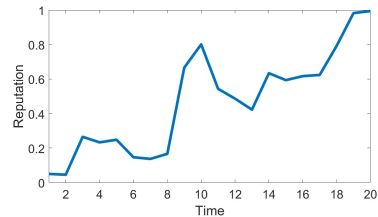
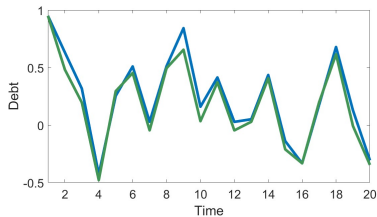
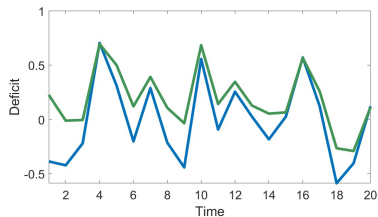
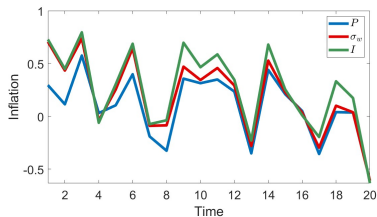
Updating Rule Dynamics [Back](#)



Equilibrium: Long-Run Learning

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Equilibrium: Long-Run Learning

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Parameter Values for Mexico 1970-2022 [Back](#)

Parameter	Interpretation	Value
s_P	Inflation Target Weight Prudent Government	80
s_I	Inflation Target Weight Imprudent Government	5
δ_P	Discount Factor Prudent Government	0.45
δ_I	Discount Factor Imprudent Government	0
ϵ_π	Standard Deviation Inflation Shock	0.15
ϵ_d	Standard Deviation Deficit Shock	0.20
θ	Sensitivity of Output to Inflation	0.50
k	Time Inconsistency Parameter	2
γ	Debt Weight	2
$\bar{y}$	Natural Level of Output	1
$\bar{\pi}$	Inflation Target	3%
r	Interest Rate	5%