Optimal Time-Consistent Debt Maturity

Davide Debortoli
UPF and Barcelona GSE

Ricardo Nunes
Fed Board

Pierre Yared
Columbia & NBER

May 2015

Motivation

- How should government debt maturity be structured?

Motivation

- How should government debt maturity be structured?

- One motive: Hedge against shocks

Motivation

- How should government debt maturity be structured?
- One motive: Hedge against shocks
- Results in Angeletos (2002) and Buera and Nicolini (2004):
  - Governments purchase short-term assets, and issues long-term debt
  - Positions are very large (several multiples of GDP)
  - Debt positions are constant, not actively managed

This paper

- Conclusions of previous research not robust to lack of commitment

This paper

- Conclusions of previous research not robust to lack of commitment

- In practice, government chooses debt and taxes sequentially
  $\Rightarrow$ Commitment problem

  - Government can change market value of outstanding debt ex-post
  - Ex-post policy not optimal ex-ante

This paper

- Conclusions of previous research not robust to lack of commitment
- In practice, government chooses debt and taxes sequentially
  $\Rightarrow$ Commitment problem
  - Government can change market value of outstanding debt ex-post
  - Ex-post policy not optimal ex-ante
- This paper: Optimal debt maturity under lack of commitment
  - Focus on Markov Perfect Equilibrium

Preview of the Model

- Standard model of optimal fiscal policy [Lucas-Stokey (1983)]

Preview of the Model

- Standard model of optimal fiscal policy [Lucas-Stokey (1983)]
- Add two frictions: non-contingent bonds and no gov't commitment

Preview of the Model

- Standard model of optimal fiscal policy [Lucas-Stokey (1983)]
- Add two frictions: non-contingent bonds and no gov't commitment
- Debt maturity can solve either problem separately

Non-contingent Bonds vs. Lack of Commitment

Preview of the Model

- Standard model of optimal fiscal policy [Lucas-Stokey (1983)]
- Add two frictions: non-contingent bonds and no gov't commitment
- Debt maturity can solve either problem separately

Non-contingent Bonds	vs.	Lack of Commitment
$\Downarrow$		$\Downarrow$
Large and Tilted Positions		Flat Maturity

Main Results

- If debt positions are large and titled $\longrightarrow$ Lack of commitment is costly
  - Expectation of future deviation raises ex-ante borrowing costs
  - $\longrightarrow$ High average tax/spending distortions

Main Results

- If debt positions are large and titled $\longrightarrow$ Lack of commitment is costly
  - Expectation of future deviation raises ex-ante borrowing costs
  - $\longrightarrow$ High average tax/spending distortions
- If debt positions are flat $\longrightarrow$ Lack of insurance is less costly
  - Flat debt position $\longrightarrow$ Low fluctuation in market value of debt
  - $\longrightarrow$ High volatility in tax/spending distortions

Main Results

- If debt positions are large and titled $\longrightarrow$ Lack of commitment is costly
  - Expectation of future deviation raises ex-ante borrowing costs
  - $\longrightarrow$ High average tax/spending distortions
- If debt positions are flat $\longrightarrow$ Lack of insurance is less costly
  - Flat debt position $\longrightarrow$ Low fluctuation in market value of debt
  - $\longrightarrow$ High volatility in tax/spending distortions
- High volatility of distortions less costly than high average distortions

Main Results

- If debt positions are large and titled $\longrightarrow$ Lack of commitment is costly
  - Expectation of future deviation raises ex-ante borrowing costs
  - $\longrightarrow$ High average tax/spending distortions
- If debt positions are flat $\longrightarrow$ Lack of insurance is less costly
  - Flat debt position $\longrightarrow$ Low fluctuation in market value of debt
  - $\longrightarrow$ High volatility in tax/spending distortions
- High volatility of distortions less costly than high average distortions
- Optimal maturity is quantitatively nearly flat
  - Reducing borrowing costs more important than insurance
  - Optimal policy approximated by active consol management

Related Literature

- Government debt maturity under lack of commitment
  - e.g., Arellano-Ramayarayanan (2012), Aguiar-Amador (2013), Arellano-Bai-Kehoe-Ramayarayanan (2013)
  - **This paper:** Economy without risk of default or surprise inflation

Related Literature

- Government debt maturity under lack of commitment
  - e.g., Arellano-Ramayarayanan (2012), Aguiar-Amador (2013), Arellano-Bai-Kehoe-Ramayarayanan (2013)
  - **This paper:** Economy without risk of default or surprise inflation
- Optimal fiscal policy under non-contingent debt and full commitment
  - e.g., Barro (1979), AMSS (2002), Faraglia-Marcet-Scott (2010)
  - **This paper:** Long-term debt. No inefficiencies under full commitment

Related Literature

- Government debt maturity under lack of commitment
  - e.g., Arellano-Ramayarayanan (2012), Aguiar-Amador (2013), Arellano-Bai-Kehoe-Ramayarayanan (2013)
  - **This paper:** Economy without risk of default or surprise inflation
- Optimal fiscal policy under non-contingent debt and full commitment
  - e.g., Barro (1979), AMSS (2002), Faraglia-Marcet-Scott (2010)
  - **This paper:** Long-term debt. No inefficiencies under full commitment
- Optimal fiscal policy under contingent debt and lack of commitment
  - e.g., Debortoli-Nunes (2013), Krusell-Martin-Rios-Rul (2006)
  - **This paper:** Long-term debt. No inefficiencies under complete markets

Outline

1. Model
2. Lack of commitment benchmark
3. Lack of insurance benchmark
4. Maturity management under both frictions

The Model

Lucas and Stokey (1983)

- $t \in \{0, 1, ...\}$. Shock $\theta_t \in \Theta$.

- $t \in \{0, 1, ...\}$. Shock $\theta_t \in \Theta$.

- Representative household. Preferences:

$$\mathbb{E} \sum_{t=0}^{\infty} \beta^t u\left(c_t, n_t\right) + \theta_t v\left(g_t\right)$$

The Model

Lucas and Stokey (1983)

- $t \in \{0, 1, ...\}$. Shock $\theta_t \in \Theta$.

- Representative household. Preferences:

$$\mathbb{E} \sum_{t=0}^{\infty} \beta^t u\left(c_t, n_t\right) + \theta_t v\left(g_t\right)$$

- Household budget constraints

$$c_t = n_t\left(1 - \tau_t\right) + \sum_{j=1}^{\infty} q_t^{t+j}\left(B_{t-1}^{t+j} - B_t^{t+j}\right) + B_{t-1}^t$$

The Model

Lucas and Stokey (1983)

- $t \in \{0, 1, ...\}$. Shock $\theta_t \in \Theta$.

- Representative household. Preferences:

$$\mathbb{E} \sum_{t=0}^{\infty} \beta^t u\left(c_t, n_t\right) + \theta_t v\left(g_t\right)$$

- Household budget constraints

$$c_t = n_t\left(1 - \tau_t\right) + \sum_{j=1}^{\infty} q_t^{t+j}\left(B_{t-1}^{t+j} - B_t^{t+j}\right) + B_{t-1}^t$$

- Government budget constraint

$$\tau_t n_t - g_t = \sum_{j=1}^{\infty} q_t^{t+j}\left(B_{t-1}^{t+j} - B_t^{t+j}\right) + B_{t-1}^t$$

Markov Perfect Competitive Equilibrium

- Government strategy: choose $\tau_t, g_t, \left\{B_t^{t+j}\right\}_{j=1}^{\infty}$ given $\theta_t, \left\{B_{t-1}^{t+j}\right\}_{j=1}^{\infty}$

Markov Perfect Competitive Equilibrium

- Government strategy: choose $\tau_t, g_t, \left\{B_t^{t+j}\right\}_{j=1}^{\infty}$ given $\theta_t, \left\{B_{t-1}^{t+j}\right\}_{j=1}^{\infty}$
- Household allocation: choose $c_t, n_t, \left\{B_t^{t+j}\right\}_{j=1}^{\infty}$ given $\tau_t, \left\{q_t^{t+j}, B_{t-1}^{t+j}\right\}_{j=1}^{\infty}$

Markov Perfect Competitive Equilibrium

- Government strategy: choose $\tau_t, g_t, \left\{B_t^{t+j}\right\}_{j=1}^{\infty}$ given $\theta_t, \left\{B_{t-1}^{t+j}\right\}_{j=1}^{\infty}$
- Household allocation: choose $c_t, n_t, \left\{B_t^{t+j}\right\}_{j=1}^{\infty}$ given $\tau_t, \left\{q_t^{t+j}, B_{t-1}^{t+j}\right\}_{j=1}^{\infty}$
- Markov Perfect Competitive Equilibrium:
  1. Government strategy optimal
  2. Household allocation optimal
  3. Bond prices q_t^{t+j} clears the market

Equilibrium conditions

Primal approach

- Intertemporal condition:

$$q_t^{t+j} = \beta^j \mathbb{E}_t \frac{u_{c,t+j}}{u_{c,t}}$$

Equilibrium conditions

Primal approach

- Intertemporal condition:

$$q_t^{t+j} = \beta^j \mathbb{E}_t \frac{u_{c,t+j}}{u_{c,t}}$$

- Intratemporal condition:

$$1 - \tau_t = -\frac{u_{n,t}}{u_{c,t}}$$

Equilibrium conditions
Primal approach

- Intertemporal condition:

$$q_t^{t+j} = \beta^j \mathbb{E}_t \frac{u_{c,t+j}}{u_{c,t}}$$

- Intratemporal condition:

$$1 - \tau_t = -\frac{u_{n,t}}{u_{c,t}}$$

- Budget Constraint (implementability condition):

$$\underbrace{\mathbb{E}_t \sum_{j=0}^{\infty} \beta^j u_{c,t} \left[c_t + \frac{u_{n,t}}{u_{c,t}} n_t \right]}_{\text{Primary Surpluses } S(\theta_t)} = \underbrace{\mathbb{E}_t \sum_{j=0}^{\infty} \beta^j u_{c,t+j} B_{t-1}^{t+j}}_{\text{Value of Debt}}$$

Benchmark: Commitment and Complete Markets

- Perfect insurance: fiscal policies only depend on θ_t, not on the history

Benchmark: Commitment and Complete Markets

- Perfect insurance: fiscal policies only depend on θ_t, not on the history
- Optimal spending:

$$u_{c,t}\left[(1+\mu)+\mu\frac{u_{cc,t}c_t+u_{cn,t}n_t}{u_{c,t}}\right]=\theta_t v_{g,t}$$

- Optimal taxes:

$$u_{c,t}=-u_{n,t}-\frac{\mu}{1+\mu}\left[\left(u_{cc,t}+u_{cn,t}\right)c_t+\left(u_{cn,t}+u_{nn,t}\right)n_t\right]$$

Benchmark: Commitment and Complete Markets

- Perfect insurance: fiscal policies only depend on θ_t, not on the history
- Optimal spending:

$$u_{c,t}\left[(1+\mu)+\mu\frac{u_{cc,t}c_t+u_{cn,t}n_t}{u_{c,t}}\right]=\theta_t v_{g,t}$$

- Optimal taxes:

$$u_{c,t}=-u_{n,t}-\frac{\mu}{1+\mu}\left[\left(u_{cc,t}+u_{cn,t}\right)c_t+\left(u_{cn,t}+u_{nn,t}\right)n_t\right]$$

- Government may choose to reduce these distortions ex-post (i.e. change μ)

Example of Three Period Economy

- $t = 0, 1, 2$. $\theta_0 > \theta_1 = \theta_2 = 1$ (high spending at date 0)

Example of Three Period Economy

- $t = 0, 1, 2.$ $\theta_0 > \theta_1 = \theta_2 = 1$ (high spending at date 0)
- Suppose that tax revenues are exogenously fixed
  - e.g., applies under GHH preference with commitment to τ

Example of Three Period Economy

- $t = 0, 1, 2$. $\theta_0 > \theta_1 = \theta_2 = 1$ (high spending at date 0)
- Suppose that tax revenues are exogenously fixed
  - e.g., applies under GHH preference with commitment to τ
- Government welfare:

$$(1-\psi)\log c + \psi\theta g$$

  - Consider the limit as $\psi \to 1$

Example of Three Period Economy (cont'd)

- The government solves the following problem

$$\min \quad \theta_0 c_0 + \beta c_1 + \beta^2 c_2$$

$$s.t.$$

Example of Three Period Economy (cont'd)

- The government solves the following problem

$$\min \quad \theta_0 c_0 + \beta c_1 + \beta^2 c_2$$

$$s.t. \quad [c_0 - n(1-\tau)] +$$

Example of Three Period Economy (cont'd)

- The government solves the following problem

$$\min \quad \theta_0 c_0 + \beta c_1 + \beta^2 c_2$$

$$s.t. \quad [c_0 - n(1-\tau)] + \beta \frac{c_0}{c_1}[c_1 - n(1-\tau)] + \beta^2 \frac{c_0}{c_2}[c_2 - n(1-\tau)] \geq 0$$

Example of Three Period Economy (cont'd)

- The government solves the following problem

$$\min \quad \theta_0 c_0 + \beta c_1 + \beta^2 c_2$$

$$s.t. \quad [c_0 - n(1-\tau)] + \beta \frac{c_0}{c_1}[c_1 - n(1-\tau)] + \beta^2 \frac{c_0}{c_2}[c_2 - n(1-\tau)] \geq 0$$

- At an optimum:

$$c_1 = c_2 = n(1-\tau) + \overline{B}$$

where $\overline{B}$ is the primary surplus at date 1 and 2.

Example of Three Period Economy (cont'd)

- The government solves the following problem

$$\begin{aligned} \min \quad & \theta_0 c_0 + \beta c_1 + \beta^2 c_2 \\ s.t. \quad & [c_0 - n(1-\tau)] + \beta \frac{c_0}{c_1}[c_1 - n(1-\tau)] + \beta^2 \frac{c_0}{c_2}[c_2 - n(1-\tau)] \geq 0 \end{aligned}$$

- At an optimum:

$$c_1 = c_2 = n(1-\tau) + \overline{B}$$

where $\overline{B}$ is the primary surplus at date 1 and 2.

- REMARK 1: It implies a bond price at date 1

$$q_1^2 = \beta \frac{c_1}{c_2} = \beta$$

Example of Three Period Economy (cont'd)

- The government solves the following problem

$$\begin{aligned} \min \quad & \theta_0 c_0 + \beta c_1 + \beta^2 c_2 \\ s.t. \quad & [c_0 - n(1-\tau)] + \beta \frac{c_0}{c_1} [c_1 - n(1-\tau)] + \beta^2 \frac{c_0}{c_2} [c_2 - n(1-\tau)] \geq 0 \end{aligned}$$

- At an optimum:

$$c_1 = c_2 = n(1-\tau) + \overline{B}$$

where $\overline{B}$ is the primary surplus at date 1 and 2.

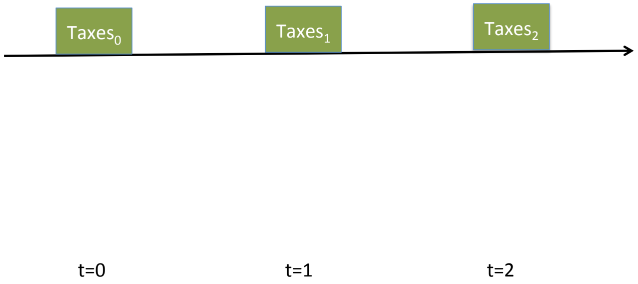
- REMARK 1: It implies a bond price at date 1

$$q_1^2 = \beta \frac{c_1}{c_2} = \beta$$

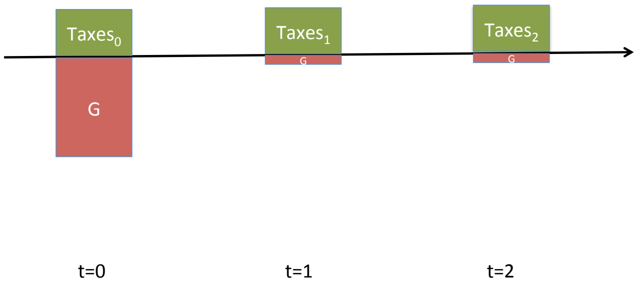
- REMARK 2: it can be implemented with any maturity structure, such that

$$B_0^1 + \beta B_0^2 = (1+\beta)\overline{B}$$

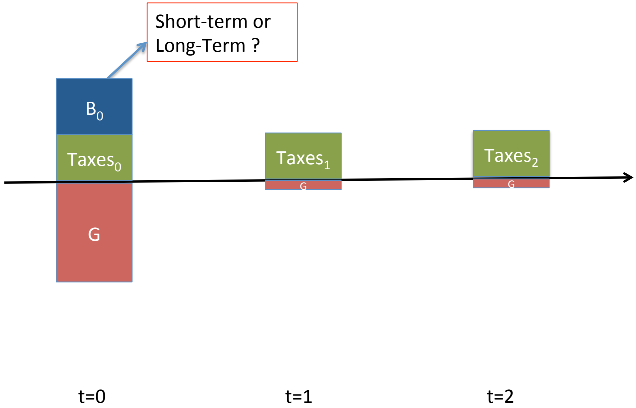
A Simple Example
No Uncertainty



A Simple Example: No Uncertainty

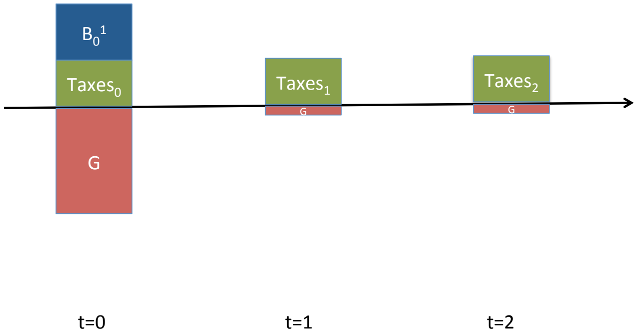


A Simple Example
No Uncertainty

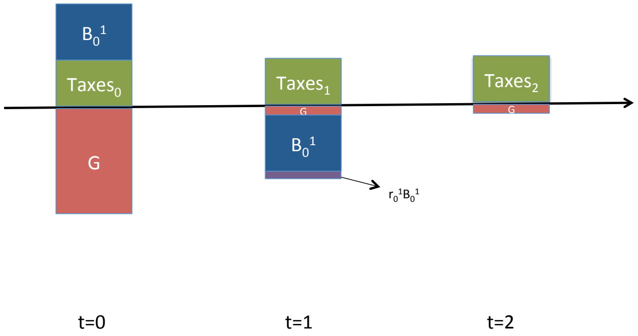


Only <u>Short –term</u> debt

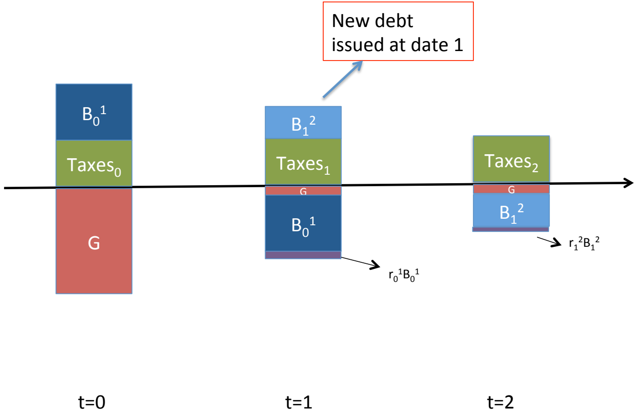
Only Short –term debt



Only Short –term debt

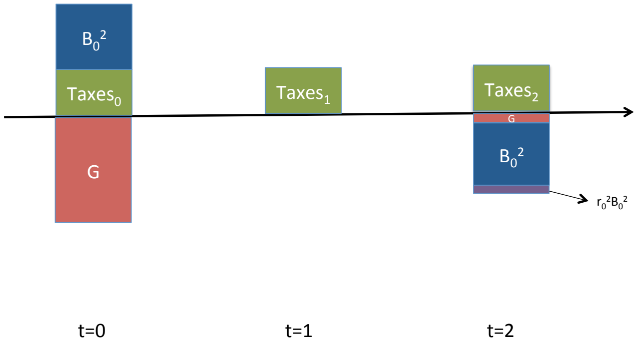


Only Short –term debt

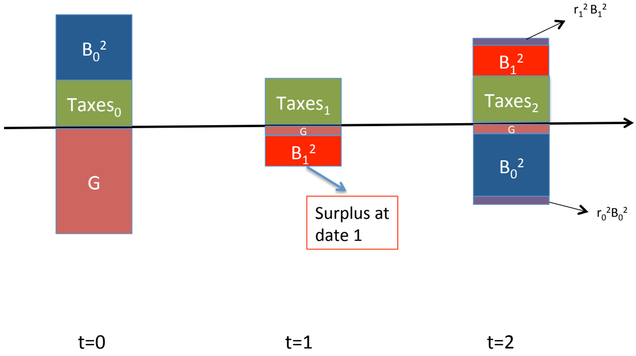


Only Long –term debt

Only Long –term debt



Only Long –term debt



Lack of Commitment

The Commitment Problem

- If government is allowed to deviate in period 1
- ... given a maturity structure B_0^1 and B_0^2

The Commitment Problem

- If government is allowed to deviate in period 1
- ... given a maturity structure B_0^1 and B_0^2

$$\min \quad c_1 + \beta c_2$$

$$s.t. \quad [c_1 - n(1-\tau)] + \beta \frac{c_1}{c_2} [c_2 - n(1-\tau)] \geq B_0^1 + \beta \frac{c_1}{c_2} B_0^2$$

The Commitment Problem

- If government is allowed to deviate in period 1
- ... given a maturity structure B_0^1 and B_0^2

$$\begin{aligned} \min \quad & c_1 + \beta c_2 \\ s.t. \quad & \left[c_1 - n\left(1-\tau\right)\right] + \beta \frac{c_1}{c_2} \left[c_2 - n\left(1-\tau\right)\right] \geq B_0^1 + \beta \frac{c_1}{c_2} B_0^2 \end{aligned}$$

- Is it still optimal to choose $c_1 = c_2$?

The Commitment Problem

- If government is allowed to deviate in period 1
- ... given a maturity structure B_0^1 and B_0^2

$$\begin{aligned} \min \quad & c_1 + \beta c_2 \\ s.t. \quad & [c_1 - n(1-\tau)] + \beta \frac{c_1}{c_2} [c_2 - n(1-\tau)] \geq B_0^1 + \beta \frac{c_1}{c_2} B_0^2 \end{aligned}$$

- Is it still optimal to choose $c_1 = c_2$?
- The FOC implies

$$\frac{c_1}{c_2} = \left(\frac{n(1-\tau) + B_0^1}{n(1-\tau) + B_0^2} \right)^{1/2}$$

The Commitment Problem

- If government is allowed to deviate in period 1
- ... given a maturity structure B_0^1 and B_0^2

$$\begin{aligned} \min \quad & c_1 + \beta c_2 \\ s.t. \quad & \left[c_1 - n\left(1-\tau\right)\right] + \beta \frac{c_1}{c_2} \left[c_2 - n\left(1-\tau\right)\right] \geq B_0^1 + \beta \frac{c_1}{c_2} B_0^2 \end{aligned}$$

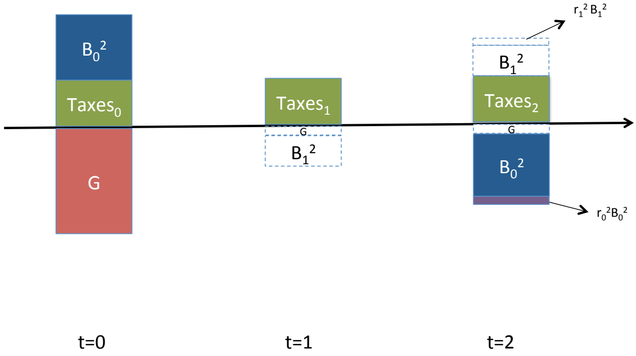
- Is it still optimal to choose $c_1 = c_2$?
- The FOC implies

$$\frac{c_1}{c_2} = \left(\frac{n\left(1-\tau\right) + B_0^1}{n\left(1-\tau\right) + B_0^2} \right)^{1/2}$$

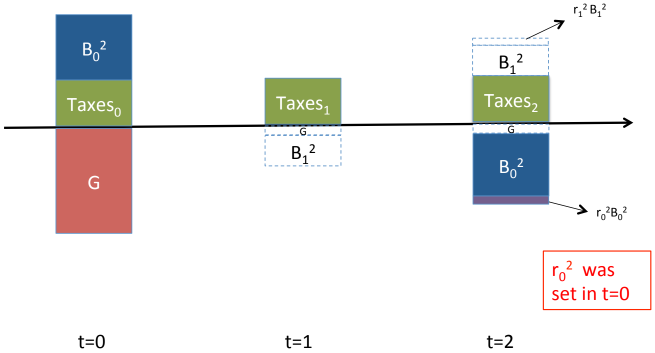
- FLAT MATURITY solves commitment problem: $c_1 = c_2 \Leftrightarrow B_0^1 = B_0^2$

A simple example: Commitment Problem
A deviation from original plan at t=1

A simple example: Commitment Problem
A deviation from original plan at t=1

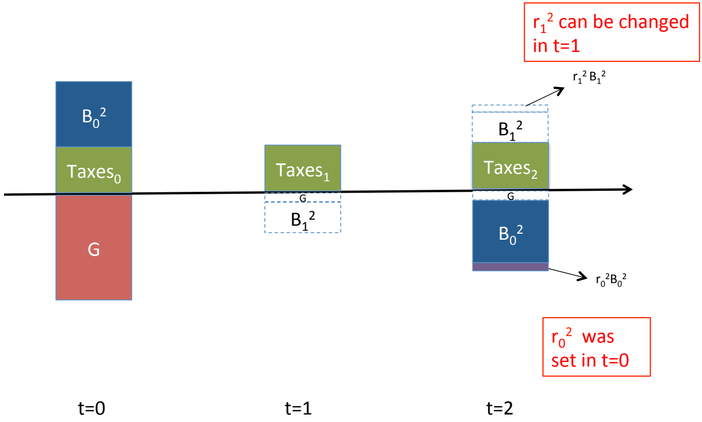


A simple example: Commitment Problem
A deviation from original plan at t=1

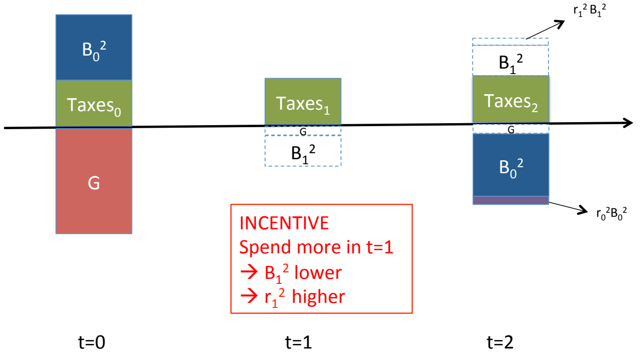


A simple example: Commitment Problem

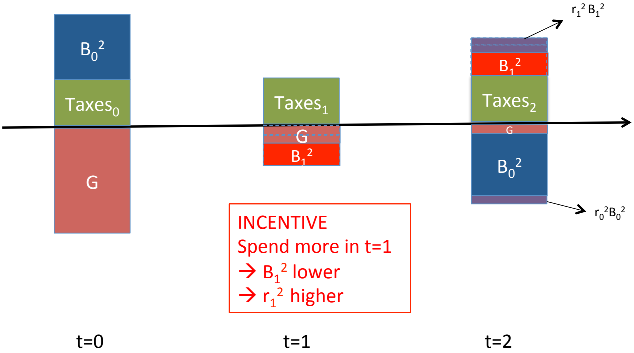
A deviation from original plan at t=1



A simple example: Commitment Problem
A deviation from original plan at t=1

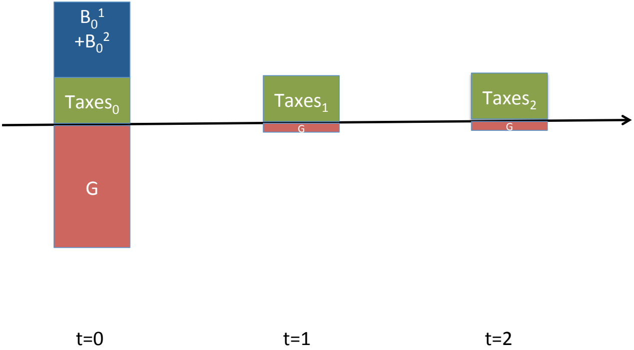


A simple example: Commitment Problem
A deviation from original plan at t=1

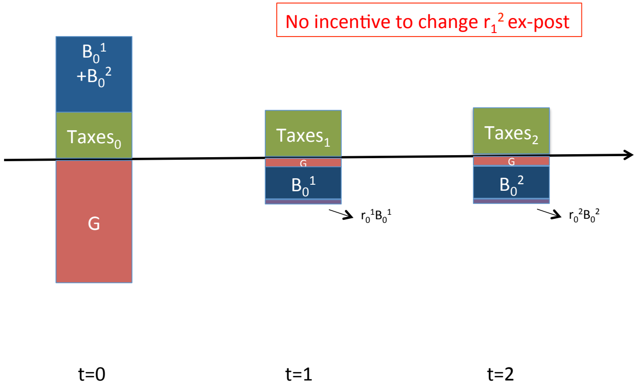


FLAT MATURITY solves COMMITMENT PROBLEM

FLAT MATURITY solves COMMITMENT PROBLEM



FLAT MATURITY solves COMMITMENT PROBLEM



Why Does a Flat Debt Position Fix Commitment?

- Government wants to reduce value of what it owes:

$$B_0^1 + \beta \frac{c_1}{c_2} B_0^2$$

  - If $B_0^1 = 0$ and $B_0^2 > 0 \Rightarrow \uparrow c_2$ and $\downarrow c_1$ (deviation: $\uparrow B_1^2$)

Why Does a Flat Debt Position Fix Commitment?

- Government wants to reduce value of what it owes:

$$B_0^1 + \beta \frac{c_1}{c_2} B_0^2$$

  - If $B_0^1 = 0$ and $B_0^2 > 0 \Rightarrow \uparrow c_2$ and $\downarrow c_1$ (deviation: $\uparrow B_1^2$)

- Government wants to increase value of what it issues:

$$\beta \frac{c_1}{c_2} B_1^2$$

  - If $B_0^1 > 0$ and $B_0^2 = 0 \Rightarrow B_1^2 > 0 \Rightarrow \downarrow c_2$ and $\uparrow c_1$ (deviation: $\downarrow B_1^2$)

Why Does a Flat Debt Position Fix Commitment?

- Government wants to reduce value of what it owes:

$$B_0^1 + \beta \frac{c_1}{c_2} B_0^2$$

  - If $B_0^1 = 0$ and $B_0^2 > 0 \Rightarrow \uparrow c_2$ and $\downarrow c_1$ (deviation: $\uparrow B_1^2$)

- Government wants to increase value of what it issues:

$$\beta \frac{c_1}{c_2} B_1^2$$

  - If $B_0^1 > 0$ and $B_0^2 = 0 \Rightarrow B_1^2 > 0 \Rightarrow \downarrow c_2$ and $\uparrow c_1$ (deviation: $\downarrow B_1^2$)

- If $B_0^2 = B_0^1 = \overline{B} \Rightarrow$ No gains from deviation
  - True since it implies $B_0^2 = B_1^2 = \overline{B}$

Cost of Lack of Commitment Depends on Maturity

- **Proposition.** Let $B_0^1 + \beta B_0^2 = \overline{B}(1+\beta)$. The higher is $|B_0^2 - B_0^1|$, the higher the cost of lack of commitment.

Cost of Lack of Commitment Depends on Maturity

- **Proposition.** Let $B_0^1 + \beta B_0^2 = \overline{B}(1+\beta)$. The higher is $|B_0^2 - B_0^1|$, the higher the cost of lack of commitment.
- Date 1 government wants to relax implementability condition:

$$\frac{c_1 - n(1-\tau)}{c_1} + \beta \frac{c_2 - n(1-\tau)}{c_2} \geq \frac{B_0^1}{c_1} + \beta \frac{B_0^2}{c_2}$$

  - e.g. if $B_0^2 > B_0^1$, reducing c_1 / c_2 reduces RHS

Cost of Lack of Commitment Depends on Maturity

- **Proposition.** Let $B_0^1 + \beta B_0^2 = \overline{B}\,(1+\beta)$. The higher is $|B_0^2 - B_0^1|$, the higher the cost of lack of commitment.
- Date 1 government wants to relax implementability condition:

$$\frac{c_1 - n\,(1-\tau)}{c_1} + \beta\frac{c_2 - n\,(1-\tau)}{c_2} \geq \frac{B_0^1}{c_1} + \beta\frac{B_0^2}{c_2}$$

  - e.g. if $B_0^2 > B_0^1$, reducing c_1/c_2 reduces RHS
- ... BUT this tightens the constraint at date 0

$$\frac{c_0 - n\,(1-\tau)}{c_0} + \beta\left(\frac{B_0^1}{c_1} + \beta\frac{B_0^2}{c_2}\right) \geq 0$$

Cost of Lack of Commitment Depends on Maturity

- **Proposition.** Let $B_0^1 + \beta B_0^2 = \overline{B}\,(1+\beta)$. The higher is $|B_0^2 - B_0^1|$, the higher the cost of lack of commitment.
- Date 1 government wants to relax implementability condition:

$$\frac{c_1 - n\,(1-\tau)}{c_1} + \beta \frac{c_2 - n\,(1-\tau)}{c_2} \geq \frac{B_0^1}{c_1} + \beta \frac{B_0^2}{c_2}$$

  - e.g. if $B_0^2 > B_0^1$, reducing c_1/c_2 reduces RHS
- ... BUT this tightens the constraint at date 0

$$\frac{c_0 - n\,(1-\tau)}{c_0} + \beta \left(\frac{B_0^1}{c_1} + \beta \frac{B_0^2}{c_2} \right) \geq 0$$

- If $|B_0^2 - B_0^1| \uparrow \Rightarrow$ deviation at time $1\uparrow$

Cost of Lack of Commitment Depends on Maturity

- **Proposition.** Let $B_0^1 + \beta B_0^2 = \overline{B}(1+\beta)$. The higher is $|B_0^2 - B_0^1|$, the higher the cost of lack of commitment.
- Date 1 government wants to relax implementability condition:

$$\frac{c_1 - n(1-\tau)}{c_1} + \beta \frac{c_2 - n(1-\tau)}{c_2} \geq \frac{B_0^1}{c_1} + \beta \frac{B_0^2}{c_2}$$

  - e.g. if $B_0^2 > B_0^1$, reducing c_1/c_2 reduces RHS
- ... BUT this tightens the constraint at date 0

$$\frac{c_0 - n(1-\tau)}{c_0} + \beta \left(\frac{B_0^1}{c_1} + \beta \frac{B_0^2}{c_2} \right) \geq 0$$

- If $|B_0^2 - B_0^1| \uparrow \Rightarrow$ deviation at time $1\uparrow$ $\Rightarrow$ the tighter the constraint at date 0 $\Rightarrow$ welfare at time $0\downarrow$.

Generalizable Insights from Example

- Government can deviate ex post to relax budget constraint
  - Method: Increase consumption in direction of maturity of debt
  - Deviation incentives larger if debt more tilted
  - Relaxing budget allows reducing ex-post tax/spending distortions

Generalizable Insights from Example

- Government can deviate ex post to relax budget constraint
  - Method: Increase consumption in direction of maturity of debt
  - Deviation incentives larger if debt more tilted
  - Relaxing budget allows reducing ex-post tax/spending distortions
- Expectation of future deviation raises ex-ante borrowing rates
  - Households expect higher future consumption in high debt periods
  - Higher borrowing rates + large debt positions tighten ex-ante budget

Generalizable Insights from Example

- Government can deviate ex post to relax budget constraint
  - Method: Increase consumption in direction of maturity of debt
  - Deviation incentives larger if debt more tilted
  - Relaxing budget allows reducing ex-post tax/spending distortions
- Expectation of future deviation raises ex-ante borrowing rates
  - Households expect higher future consumption in high debt periods
  - Higher borrowing rates + large debt positions tighten ex-ante budget
- Tighter ex-ante budget $\longrightarrow$ Higher initial tax/spending distortions

Quantitative Assessment of Lack of Commitment

- Three period environment $t = 0, 1, 2$

Quantitative Assessment of Lack of Commitment

- Three period environment $t = 0, 1, 2$
- Preferences and parameters [following Chari, Christiano and Kehoe (1995)]

$$\log c + \eta \log (1 - n) + \theta_t \log g$$

- $\beta = 0.9644$ (yearly model)
- $\eta = 3.33$ (implies $n = 0.23$)
- $\theta_1 = \theta_2 = 0.2195$ (imply $g_1/y_1 = g_2/y_2 = 0.18$)
- $\theta_0 = 0.2360$, implies $g_0/y_0 = 0.19$ (std(g)=0.07)

Quantitative Assessment of Lack of Commitment

- Three period environment $t = 0, 1, 2$
- Preferences and parameters [following Chari, Christiano and Kehoe (1995)]

$$\log c + \eta \log(1 - n) + \theta_t \log g$$

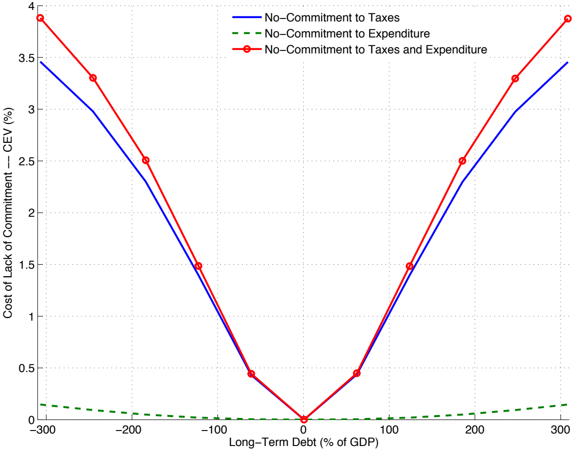
- $\beta = 0.9644$ (yearly model)
- $\eta = 3.33$ (implies $n = 0.23$)
- $\theta_1 = \theta_2 = 0.2195$ (imply $g_1/y_1 = g_2/y_2 = 0.18$)
- $\theta_0 = 0.2360$, implies $g_0/y_0 = 0.19$ (std(g)=0.07)

- Calculate welfare cost of no commitment given

$$B_0^1 + \beta B_0^2 = \overline{B}(1 + \beta)$$

  - Consider lack of commitment to spending and to taxes separately
  - Main result: Welfare cost rises in tilt of maturity structure

Cost of Lack of Commitment Rises with Tilt of Debt



Positions exceeding 100% of GDP costs more than 1% of consumption

Lack of Insurance

Tilted Maturity Fixes Lack of Insurance

Proposition (Angeletos, Buera and Nicolini):

If # available maturities equals # states of the world

$\Downarrow$

solution under incomplete markets = solution under complete markets.

Tilted Maturity Fixes Lack of Insurance

Proposition (Angeletos, Buera and Nicolini):

If # available maturities equals # states of the world

$$\Downarrow$$

solution under incomplete markets = solution under complete markets.

- Implemented with time-invariant non-contingent debt
- Insurance through fluctuations in market value of debt

Example in a three-period model

- Suppose $\theta_1 \in \{\theta_H, \theta_L\}$ is stochastic.
- Let $S^*(\theta_H)$ and $S^*(\theta_L)$ be the value of surpluses under complete markets.
- One can find B_0^S and B_0^L such that,

$$\begin{bmatrix} S^*(\theta_H) \\ S^*(\theta_L) \end{bmatrix} = \begin{bmatrix} 1 & q_0^{*,1} \\ 1 & q_0^{*,2} \end{bmatrix} \begin{bmatrix} B_0^S \\ B_0^L \end{bmatrix}$$

Example in a three-period model

- Suppose $\theta_1 \in \{\theta_H, \theta_L\}$ is stochastic.
- Let $S^*(\theta_H)$ and $S^*(\theta_L)$ be the value of surpluses under complete markets.
- One can find B_0^S and B_0^L such that,

$$\begin{bmatrix} S^*(\theta_H) \\ S^*(\theta_L) \end{bmatrix} = \begin{bmatrix} 1 & q_0^{*,1} \\ 1 & q_0^{*,2} \end{bmatrix} \begin{bmatrix} B_0^S \\ B_0^L \end{bmatrix}$$

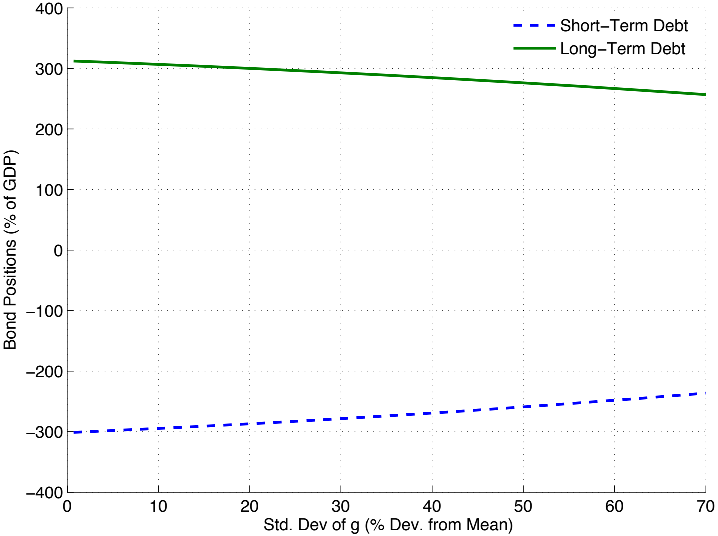
- **Lemma.** If θ_1 stochastic in three-period model, optimal policy:

$$B_0^1 < 0 \text{ and } B_0^2 > 0$$

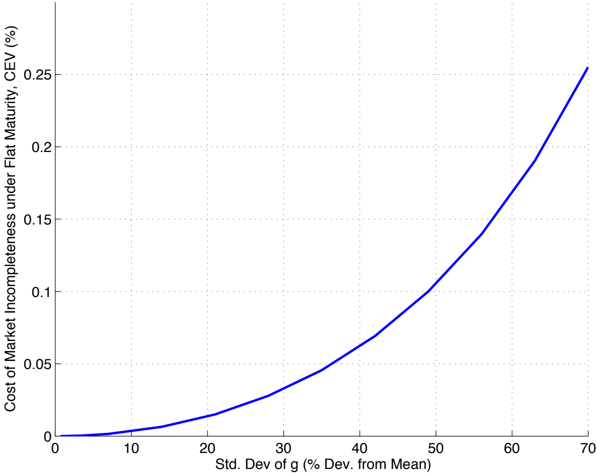
- Market value of debt declines when θ_1 high, g_1 high, and c_1 low:

$$B_0^1 + \beta \frac{c_1}{c_2} B_0^2$$

Maturity is Tilted and Large under Commitment



Welfare Cost of Flat Maturity Rises with Volatility



Cost is below 0.05% under empirical volatility of spending

Lack of Insurance Less Costly than Lack of Commitment

- Flat debt position $\longrightarrow$ Low fluctuation in market value of debt

Lack of Insurance Less Costly than Lack of Commitment

- Flat debt position $\longrightarrow$ Low fluctuation in market value of debt
- Low insurance $\longrightarrow$ High volatility in tax/spending distortions

Lack of Insurance Less Costly than Lack of Commitment

- Flat debt position $\longrightarrow$ Low fluctuation in market value of debt
- Low insurance $\longrightarrow$ High volatility in tax/spending distortions
- High volatility of distortions less costly than high average distortions
  - Similar argument to Lucas (1987)

Quantitative Analysis: Infinite Horizon

Optimal Maturity in Infinite Horizon

- Let $t = \{0, \infty\}$. $\theta_t = \left\{\theta^L, \theta^H\right\}$ with persistence ρ

Optimal Maturity in Infinite Horizon

- Let $t = \{0, \infty\}$. $\theta_t = \left\{\theta^L, \theta^H\right\}$ with persistence ρ
- Available maturities: One period bond (B^S) and a consol (B^L)

$$\tau_t n_t - g_t = -q_t^S B_t^S + q_t^L \left(B_{t-1}^L - B_t^L\right) + \left(B_{t-1}^S + B_{t-1}^L\right)$$

  - Initial debt consistent with avg. level and maturity of US (1980 - 2008)
    - Total Debt 60% of GDP, of which 30% with maturity ≤ 1 year.

Optimal Maturity in Infinite Horizon

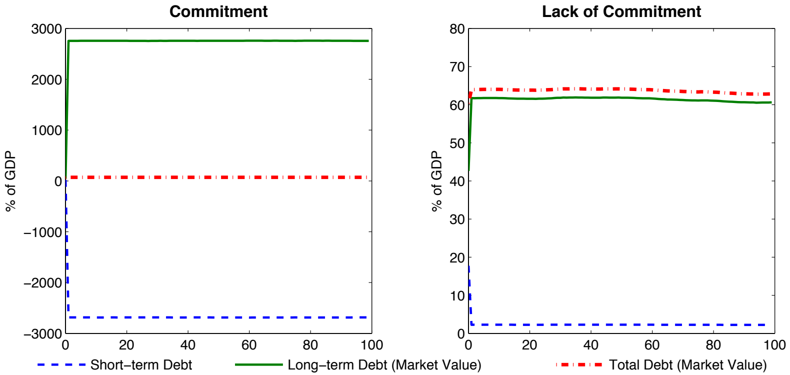
- Let $t = \{0, \infty\}$. $\theta_t = \left\{\theta^L, \theta^H\right\}$ with persistence ρ
- Available maturities: One period bond (B^S) and a consol (B^L)

$$\tau_t n_t - g_t = -q_t^S B_t^S + q_t^L \left(B_{t-1}^L - B_t^L\right) + \left(B_{t-1}^S + B_{t-1}^L\right)$$

  - Initial debt consistent with avg. level and maturity of US (1980 - 2008)
    - Total Debt 60% of GDP, of which 30% with maturity $\leq$ 1 year.
- No inefficiency under full commitment or full insurance
  - Full commitment: Angeletos and Buera-Nicolini result apply
  - Full insurance: Consol enforces perfect smoothing
    - If there is full commitment to either taxes or spending

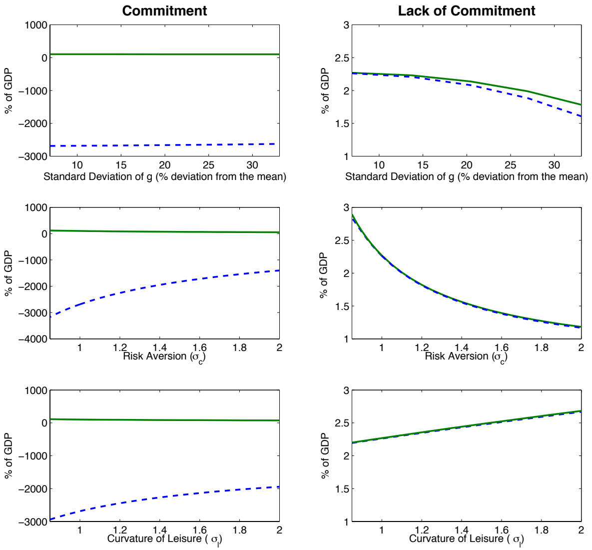
Optimal Maturity Is Nearly Flat

Average Debt Positions at Market Value (% of GDP) - Model with Exog. g



Optimal Maturity Is Nearly Flat

Average Debt Positions (% of GDP)



Why Is Optimal Maturity Is Nearly Flat?

- Cost of incompleteness low for empirical volatility of spending

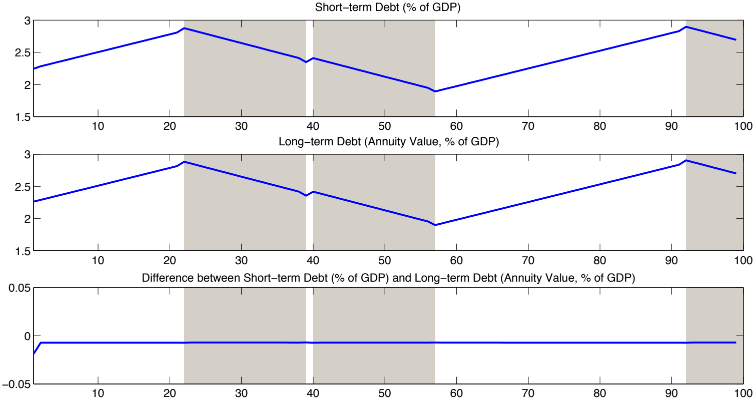
Why Is Optimal Maturity Is Nearly Flat?

- Cost of incompleteness low for empirical volatility of spending
- Cost of lack of commitment high under standard preferences
  - Incentives to deviate strong given large tilted debt needed for hedging
  - Anticipation of future deviation increases cost of financing today
  - Significant hedging would require high tax/spending distortions

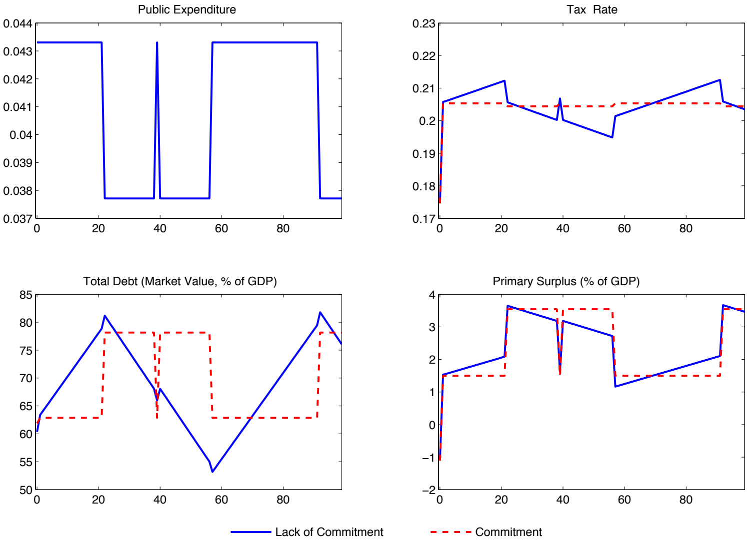
Why Is Optimal Maturity Is Nearly Flat?

- Cost of incompleteness low for empirical volatility of spending
- Cost of lack of commitment high under standard preferences
  - Incentives to deviate strong given large tilted debt needed for hedging
  - Anticipation of future deviation increases cost of financing today
  - Significant hedging would require high tax/spending distortions
- Optimal policy goal should be to minimize average distortion
  - Reducing volatility of distortions is second order

Debt Is Actively Managed

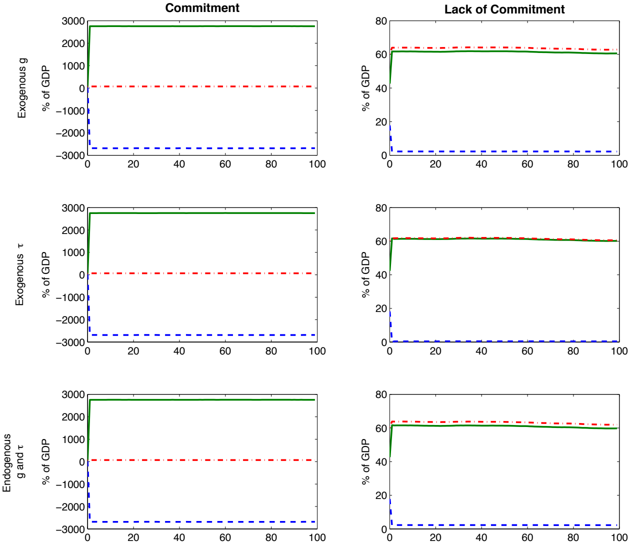


Fiscal Policy is History Dependent (no perfect insurance)



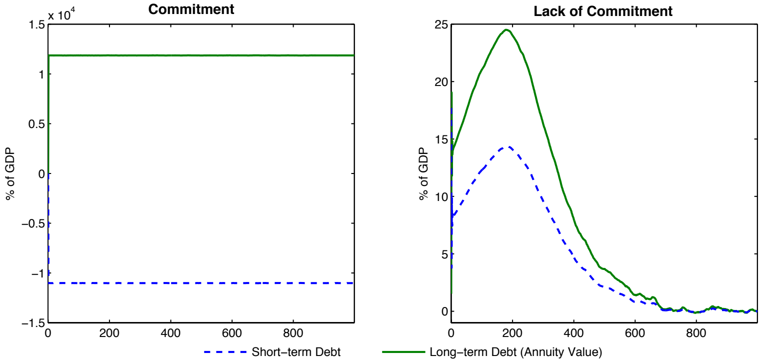
Robustness 2: Different models

Average Debt Positions at Market Value (% of GDP)



Robustness 3: Different Maturities ($\gamma = 0.5$)

Average Debt Positions (% of GDP)



Conclusion

- Results of previous literature not robust to lack of commitment
    - Tradeoff between hedging and commitment

Conclusion

- Results of previous literature not robust to lack of commitment
  - Tradeoff between hedging and commitment
- Optimal debt maturity is quantitatively nearly flat
  - Active management of consol in response to shocks

Conclusion

- Results of previous literature not robust to lack of commitment
  - Tradeoff between hedging and commitment
- Optimal debt maturity is quantitatively nearly flat
  - Active management of consol in response to shocks
- Considerations for future research
  - Monetary policy interactions
  - Debt maturity and financial frictions
  - Redistributive taxation