Government Debt Management: the Long and the Short of It

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Motivation: A Normative prospective

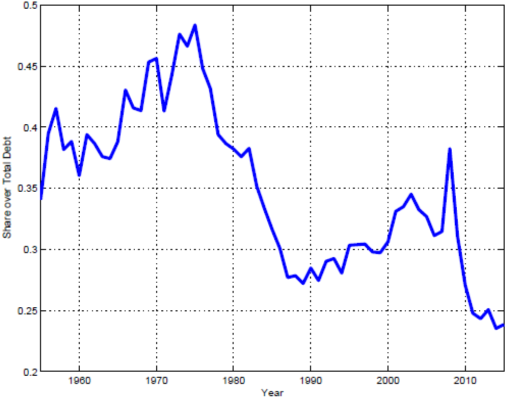
Angeletos (2002) studies optimal debt management in an economy with complete markets:

1. The optimal portfolio is to issue long term bonds and hold short term savings $\Longrightarrow$ **Government debt is long term**;
2. Positions are **several multiples of GDP** (Buera and Nicolini (2004));
3. Positions are **constant**.

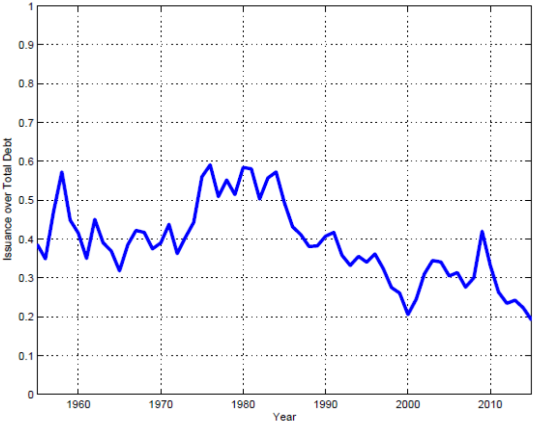
Faraglia et al (2010) find also that modifying Angeletos' framework generates **high volatility** of portfolios and reversal of the positions.

All these models assume that the government repurchases and reissues (r/r) the entire debt in every period.

Data: Share of Short Term Debt in the US



Data: Total Issuance



Data: US (1955-2015)

- The share of short term debt is sizeable : 43% on average but never below 20%;
- Positions are not large multiples of GDP;
- The shares of the different maturities are typically persistent and exhibit low volatility:
  - First order autocorrelation of short bond is 0.94;
  - Standard deviation is 0.078;
- The portfolio shares are never zero or "negative";
- Total issuance is smaller that 100% and 98% of the debt is redeemed at maturity

This Paper: Towards a Positive Theory of DM

QUESTION

Is the recommendation to issue only long term debt and engage in r/r operations robust to the introduction of reasonable market frictions?

- We generalize Aiyagari et al. (2002) introducing an N period zero coupon bondsand study two alternative environments:
  - **"buyback":** government **always** repurchases the outstanding debt in every period (with and w/o lending limits) $\Longrightarrow$ common assumption in theory;
  - **"no buyback":** government **never** repurchases the outstanding debt (with and w/o lending limits) $\Longrightarrow$ common assumption in practise;
- We introduce calibrated costs of issuance and repurchase:
  - Shadow costs calculation;
  - Optimal buyback model;
- Robustness: Introduction of coupon bonds, callable bonds, other maturities.

Summary of the Results

- The assumption of **no buyback is essential** to explain the coexistence of short and long debt/savings:
  - long bonds are still used for their fiscal insurance properties;
  - however imposing no buyback of the long bonds creates N period cycles in the tax schedules;
  - short bonds are necessary for the government to smooth the tax schedule.
  - The assumption of no landing constraints helps to match the empirical facts.

- Introducing small **transaction costs** makes r/r too costly and **no buyback arises endogenously**.

- The results are robust to the assumption of different bonds (s.a. coupon bonds and callable bonds).

Contribution

- *Empirical contribution*: analysis of the buy back data for callable and non callable bonds;
- *Theoretical contribution*: effects of the "no buyback" assumption for optimal fiscal policy models. With this assumption the Ramsey policy becomes a positive theory of debt management;
- *Methodological contribution*: new solution methods for portfolio and large state space problems with stochastic projection methods;

Model with Buyback

The Ramsey planner:

$$\max_{\{c_t, x_t, b_{1,t}, b_{N,t}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \left[u\left(c_t\right) + v\left(x_t\right) \right]$$

subject to

$$g_t + b_{1,t-1} + \mathbf{p}_{N-1,t} \mathbf{b}_{N,t-1} = \tau_t \left(T - x_t \right) + p_{1,t} b_{1,t} + p_{N,t} b_{N,t}$$

$$c_t + g_t \leq T - x_t$$

$$\underline{M} \leq \beta^i b_{i,t} \leq \overline{M} \quad \text{for } i = 1, N$$

$$b_{1,-1}, b_{N,-1}, ... b_{N,-N} \text{ given}$$

- an exogenous and stochastic government spending process

- $p_{1,t} = \frac{\beta E_t \{u_{c,t+1}\}}{u_{c,t}}$, $p_{N,t} = \frac{\beta^N E_t \{u_{c,t+N}\}}{u_{c,t}}$ and $\tau_t = 1 - \frac{v_{x,t}}{u_{c,y}}$.

Model with Buyback

Off corners when $\xi^i_{L,t} = \xi^i_{H,t} = 0$ we get:

$$\lambda_t = \frac{E_t \left\{ \lambda_{t+1} u_{c,t+i} \right\}}{E_t \left\{ u_{c,t+i} \right\}}$$

that means that λ_t is a **risk adjusted random walk**.

Following Marcet and Marimon (2014) and Aiyagari et al. (2002) the optimal solution has a recursive formulation where:

$$\begin{bmatrix} b_{N,t} \\ b_{1,t} \\ \lambda_t \\ c_t \end{bmatrix} = F\left(g_t, \lambda_{t-1}, ..., \lambda_{t-N}, b^N_{t-1}, ..., b^N_{t-N} \right)$$

In FMOS (2016) we show that the Lagrange multipliers are needed because they enforce in the appropriate continuation problem the promises of future taxes that affect interest rates.

Parametrisation

- We follow Marcet and Scott (2009):
  - Annual horizon: $\beta = 0.95$;
  - $u(c_t) + v(x_t) = \log(c_t) - \eta \frac{1}{x_t}$
  - The process of government spending: $g_t = \rho g_{t-1} + (1-\rho)\overline{g} + \varepsilon_t$
  - $\rho = 0.95$, $\overline{g} = 0.25\overline{y}$ and $\sigma_\varepsilon = 1.44$

- Debt constraints: $\underline{M} \leq \beta^i b_{i,t} \leq \overline{M}$
  - Lending model: $+/-100\%$ of GDP for each i (Faraglia et al. 2012)
  - No lending model: $\underline{M} = 0$ (Chari and Kehoe (1999), Lustig et al. (2008), Faraglia et al (2013))

Buyback Model: Moments

Moments: Data and Model

	US DATA	**BuyBack**	
		Lending	No Lending
S_{ST}	43%	$4{\cdot}10^3$%	12%
$\sigma_{S_{ST}}$	7.8	$3{\cdot}10^5$	13.0
$corr(S_{ST,t}, S_{ST,t-1})$	0.94	0.47	0.86
$corr\left(\frac{B_{ST,t}}{GDP_t}, \frac{B_{LT,t}}{GDP_t}\right)$	0.86	-0.01	0.25
$\%_{S_t} = 0$	0	-	13.1%
$\%_{S_t} \leq 0.1$	0	-	56.6%

Model: Average of 1000 samples of 60 periods

The No Buyback Assumption: Pros

We modify the budget constraint such that:

$$g_t + b_{1,t-1} + \mathbf{b}_{N,t-N} = \tau_t \left(T - x_t \right) + p_{1,t} b_{1,t} + p_{N,t} b_{N,t}$$

after some algebra The intertemporal budget constraint is:

$$E_t \sum_{j=0}^{\infty} \beta^j \frac{u_{c,t+j}}{u_{c,t}} s_{t+j} = p_{N-1,t} b_{N,t-1} + p_{N-2,t} b_{N,t-2} + ... + b_{N,t-N} + b_{1,t-1}$$

where s_t is the primary surplus.

$\Longrightarrow$ **Fiscal insurance motive is still present! However....**

The No Buyback Assumption: Cons

Assume only an N period bond:

We modify the budget constraint such that:

$$g_t + b_{N,t-N} = \tau_t \left(T - x_t\right) + p_{N,t} b_{N,t}$$

Now the FOC shows that the **random walk property no longer holds**:

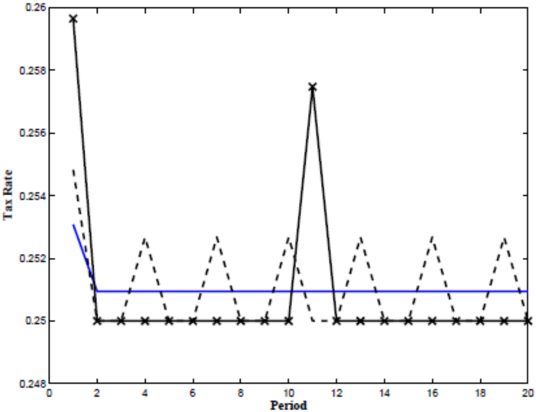
$$\lambda_t = \frac{E_t \left\{u_{c,t+N} \boldsymbol{\lambda}_{t+N}\right\}}{E_t \left\{u_{c,t+N}\right\}}$$

Intuitively...

- If $g_t > g_{t+1}$ and $g_{t+1} = \overline{g}$ for $t+1$ onwards then τ_t and $b_{N,t}$ will increase. I have to redeem the bond in $t+N$ by rising taxes and more debt...and so on
- There is an optimal N **period cycle in fiscal policy** which violates tax smoothing.

Taxes and No Buyback

Figure 7: **Response of the Tax Schedule - No Buyback Model**



Notes: The Figure plots the tax rate in a single bond economy without buyback. The solid line is a maturity of one year. The dashed line sets the maturity to three years and the crossed line to 10 years.

Model with Buyback and two Bonds

The government budget constraint

$$g_t + b_{1,t-1} + b_{N,t-N} = \tau_t \left(T - x_t \right) + p_{1,t} b_{1,t} + p_{N,t} b_{N,t}$$

Now the FOC become:

$$\lambda_t = \frac{E_t \left\{ u_{c,t+N} \boldsymbol{\lambda}_{t+N} \right\}}{E_t \left\{ u_{c,t+N} \right\}}$$

$$\lambda_t = \frac{E_t \left\{ u_{c,t+1} \boldsymbol{\lambda}_{t+1} \right\}}{E_t \left\{ u_{c,t+1} \right\}}$$

- Implications for debt management:
  - Long bonds have a hedging value
  - Short bonds are beneficial to smooth taxation

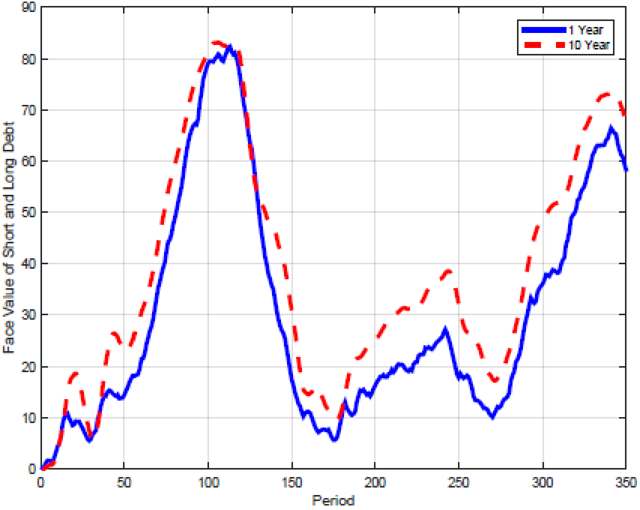
No Buyback Model: Moments

Moments: Data and Model

	US DATA	**BuyBack**		**No BuyBack**	
		Lend.	No Lend.	Lend.	No Lend.
S_{ST}	43%	$4{\cdot}10^3$%	12%	76%	48%
$\sigma_{S_{ST}}$	7.8	$3{\cdot}10^5$	13.0	$3{\cdot}10^3$	8.1
$corr(S_{ST,t}, S_{ST,t-1})$	0.94	0.47	0.86	0.42	0.92
$corr\left(\frac{B_{ST,t}}{GDP_t}, \frac{B_{LT,t}}{GDP_t}\right)$	0.86	-0.01	0.25	0.86	0.92
$\%_{S_t} = 0$	0	-	13.1%	-	0.01%
$\%_{S_t} \leq 0.1$	0	-	56.6%	-	0.02%

Model: Average of 1000 samples of 60 periods

No Buyback and No Lending



Optimal Buy Back and Transaction costs

$$g_t + b_{1,t-1} + b_{N,t-N} - \mathbf{R}_{t-N+1} + \mathbf{p}_{N-1,t}\mathbf{R}_t(\mathbf{1} + \mathbf{T}^R(R_t))$$
$$= \tau_t(T - x_t) + \sum_{i\in\{S,N\}} p_{i,t} b_{i,t}\left(\mathbf{1} - \mathbf{T}^i(b_{i,t})\right)$$

- Transaction costs are calibrated from the empirical evidence:
  - bid ask spreads and brokerage fees of bonds (0.038%) and treasury bills (0.0099) (Amihud and Mendelson (1991))
  - auction effects on yields (3bp on the yield) (Lou, Yan and Zhang (2013))
- Result: **The government does not want to buy back the debt:** similar results of NBB model.

No Buyback Model: Moments

Moments: Data and Model

	US DATA	**No BuyBack**		**Repurchases**
		Lend.	No Lend.	No Lend
S_{ST}	43%	76%	48%	45%
$\sigma_{S_{ST}}$	7.8	$3{\cdot}10^3$	8.1	9.0
$corr(S_{ST,t}, S_{ST,t-1})$	0.94	0.42	0.92	0.92
$corr\left(\frac{B_{ST,t}}{GDP_t}, \frac{B_{LT,t}}{GDP_t}\right)$	0.86	0.86	0.92	0.93
$\%_{S_t} = 0$	0	-	0.01%	0.01%
$\%_{S_t} \leq 0.1$	0	-	0.02%	0.01%

Model: Average of 1000 samples of 60 periods

Implications for Debt Management and Fiscal Policy

Assuming Buyback does not match the empirical data.

Assuming No Buyback delivers very sharp predictions:

- Government debt is no longer (only) long term;
- The government finances deficits with both bonds;
- Introducing small transaction costs makes no buyback arise endogenously;
- Results are robust to different model specifications

The Ramsey policy becomes a positive theory of debt management.