Procyclical Debt as Automatic Stabilizer

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Motivation

A Semantic Point of View

- *Procyclical Debt*
  - Empirical Evidence for the United States
  - SVAR: A-B model restrictions
  - Estimate parameters for fiscal rules
  - Debt moves procyclical with output
- *as Automatic Stabilizer*
  - Real Business Cycle model for the U.S.
  - Blanchard-Yaari type consumers (debt is wealth)
  - Fiscal rules (debt is a function of output)
  - New channel for business cycle stabilization
  - Procyclical debt generates *smaller* fluctuations as countercyclical debt
  - Implications for fiscal policy provocative

- Non-Ricardian
  - Empirically: Bernheim (1987), Leiderman and Blejer (1988)
  - Continuous-time: Yaari (1965), Blanchard (1985), Weil (1988, 1989)
  - Discrete-time: Frenkel and Razin (1986, 1987)
  - Ghironi (2000), Cavallo and Ghironi (2002), Smets and Wouters (2002)
  - Leith and Wren-Lewis (2000), Annicchiarico et al. (2004, 2009), Leith and von Thadden (2008)
- Fiscal rules
  - Leeper and Yang (2004), Chung and Leeper (2007)
  - Leeper, Plante, and Traum (2010)
  - Blanchard and Perotti (2002), Perotti (2004)
- Contribution: *New* channel that emerges from *combining* streams

- Bivariate SVAR in output and government debt
- Time series for the U.S. obtained from NIPA: 1960:Q1 to 2008:Q3
- Identification: A-B restrictions

$$\mathbf{A} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \mathbf{B} = \begin{bmatrix} * & 0 \\ 0 & * \end{bmatrix},$$

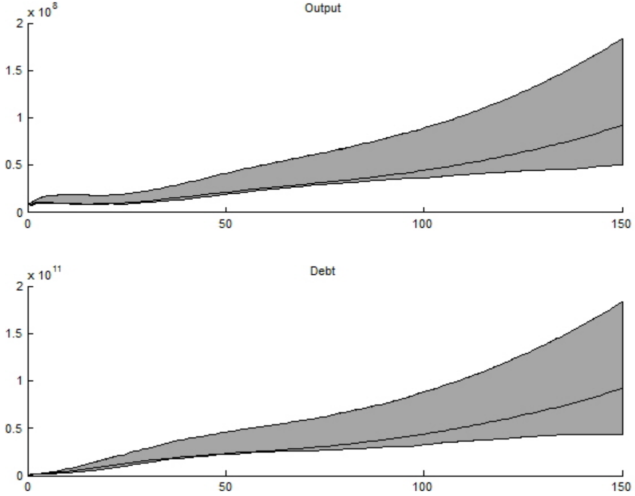
on

$$\mathbf{A} y_t = \sum_{i=0}^{p} A_i^* y_{t-i} + \mathbf{B}\varepsilon_t, \left[\mathbf{A} u_t = \mathbf{B}\varepsilon_t\right].$$

- Debt innovations have *no* effect on output

Empirical Evidence (cont'd)

Results



- Correlation: Data (0.17) vs. model (0.30)

Empirical Evidence (cont'd)

Robustness and Literature

- Output and debt are cointegrated
  - Johansen test on deterministic and stochastic cointegration ▸ Results
  - Reveals one cointegrating relationship
- Estimate SVAR with BQ, VECM, and SVECM
  - Confirm procyclicality of debt ▸ Graphs
  - Correlation: 0.57/ 0.16 / 0.15
- Alesina and Marinescu (2008): countercyclical debt in output gap by OLS

The Model

- Canonical RBC in discrete time
- Blanchard-Yaari perpetual-youth model
- Fiscal policy described by rules
- Mean-reverting, aggregate technology shock
- Prescott's narrative approach
    - Preferences and Technology
    - Market Structure
    - Optimization and Equilibrium

Preferences and Technology

Blanchard-Yaari Perpetual-Youth Structure

- Probability of surviving: $\vartheta > 0$ and expected lifetime $(1-\vartheta)^{-1}$
- Fraction of $(1-\vartheta)$ is born every period t
- Constant population (set to one) with identical preferences
- Different ages and wealth levels but face same life horizon
- $\Rightarrow$ Homogeneous w.r.t. marginal propensity to consume (Aggregation)

Preferences and Technology (cont'd)

Life Insurance Agency - Closing Wealth Dynamics

- Perfectly competitive insurance market
- No bequest and negative bequests are ruled out
- Agents contract all of their wealth returned to agency contingent on death
- Agency equally distribute the wealth of the deceased to survivers (pay fair premium)

Preferences and Technology (cont'd)

Households

- Expected von Neumann-Morgenstern utility function

$$\Gamma_t = \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} (\vartheta\beta)^j \left[\ln\left(C_{t+j}^s\right) - \frac{\left(N_{t+j}^s\right)^{1+\varphi}}{1+\varphi} \right] \right\},$$

- Single-period utility function, $\Gamma_0 : \mathbb{R}^2 \rightarrow \mathbb{R}$, satisfies the Inada conditions and is compatible with balanced growth
- Note: iso-elastic preferences $\Rightarrow$ consumption is non-linear in wealth, prohibit aggregation

- Cobb-Douglas production function

$$Y_t = Z_t K_t^{\alpha} N_t^{1-\alpha}.$$

- Aggregate, Hicks-neutral technology shock by Z_t

$$\ln Z_t = \rho_Z \ln Z_{t-1} + e_{Z,t},$$

  where $e_{Z,t} \sim N(0, \sigma_Z)$.
- The capital accumulation technology is given by

$$K_t = (1-\delta) K_{t-1} + \left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] I_t,$$

- $S(\cdot) = 0$, $S'(\cdot) = 0$, and $S''(\cdot) > 0$.

Preferences and Technology (cont'd)

Fiscal Policy

- Fiscal policy is a sequence $\{B_t, G_t, \tau_t\}$.
- The equilibrium restriction on government actions is

$$\frac{B_{t+1}}{R_t} = B_t + G_t - \tau_t.$$

- Tax rule

$$\hat{\tau}_t = \tau_Y \hat{Y}_{t-1} + \tau_B \hat{B}_{t-1},$$

- Government spending rule

$$\hat{G}_t = \gamma_Y \hat{Y}_{t-1} + \gamma_B \hat{B}_{t-1}.$$

Market Structure

- Four spot markets (bond, capital, goods, labor), three of them perfectly competitive
- Mehra and Prescott (1980)
  - Only households own capital
  - Sell to firms at the beginning of each quarter
  - At quarter's end: firms sell all capital back to the households
- Finiteness of agents life: Firms are long-lived $\Rightarrow$ stock market
  - Firm is a legal entity issuing equity shares
  - Ownership is perfectly divisible across unbounded sequence of agents

- Assumptions
  - Economy begins with all households having identical financial wealth/consumption histories
  - Optimal use of contingent claims markets ⇒ homogeneity will continue
  - Agents have access to a full set of state-contingent Arrow-Debreu securities *after* birth
- Two restrictions

$$
\begin{aligned}
(IBC) \quad &: \quad \frac{B^s_{t+1}}{R_t} + Q_t K^s_{t+1} \leq A^s_t + W_t N^s_t + Z^s_t - T^s_t - C^s_t, \\
(TC) \quad &: \quad \lim_{t\to\infty} \left\{ (\vartheta\beta)^t A^s_t \right\} \geq 0.
\end{aligned}
$$

- Financial wealth is defined by

$$
A^s_t = \frac{1}{\vartheta}\left[B^s_t + \left((1-\delta) Q_t + R^k_t \right) K^s_t \right],
$$

Optimization and Equilibrium (cont'd)

Households (cont'd)

- Solution to concave optimization problem is system of FONCs

$$
\begin{aligned}
\partial C_t^s &: \frac{1}{C_t^s} = \zeta_t, \\
\partial I_t^s &: 1 = q_t \left[1 - S\left(\frac{I_t^s}{I_{t-1}^s}\right) - S'\left(\frac{I_t^s}{I_{t-1}^s}\right)\frac{I_t^s}{I_{t-1}^s} \right] \\
&\quad + \mathbb{E}_t \left[\beta \frac{\zeta_{t+1}}{\zeta_t} q_{t+1} S'\left(\frac{I_t^s}{I_{t-1}^s}\right)\left(\frac{I_{t+1}^s}{I_t^s}\right)^2 \right], \\
\partial K_t^s &: q_t = \mathbb{E}_t \left\{ \beta \frac{\zeta_{t+1}}{\zeta_t} \left[R_{t+1}^K + q_{t+1}(1-\delta) \right] \right\}, \\
\partial N_t^s &: \zeta_t W_t = \left(N_t^s\right)^{\varphi}.
\end{aligned}
$$

- Define human wealth

$$H_t^s = h_t^s + \mathbb{E}_t \left\{ \sum_{j=1}^{\infty} \vartheta^j \left[\prod_{k=0}^{j-1} \frac{1}{R_{t+k}} \right] h_{t+j}^s \right\},$$

where $h_t^s = W_t N_t^s + Z_t^s - T_t^s$.

- Some algebra,

$$\begin{aligned} A_{t+1}^s &= R_t \left[A_t^s - C_t^s + h_t^s \right], \\ C_t^s &= (1 - \beta\vartheta) \left[A_t^s + H_t^s \right]. \end{aligned}$$

Optimization and Equilibrium (cont'd)

Firms

- The firm solves

$$\max_{\{N_t, K_t\}_{t=0}^{\infty}} \left\{ Y_t - W_t N_t - R_t^k K_t \right\},$$

s.t. production frontier.

- Solution to this sorting problem is an optimal capital-to-labor ratio

$$\frac{K_t}{N_t} = \frac{\alpha}{1-\alpha} \frac{W_t}{R_t^k},$$

- Factor prices given by

$$W_t = \frac{(1-\alpha)\, Y_t}{N_t}, R_t^k = \frac{\alpha Y_t}{K_t}.$$

- The aggregate value, X_t, of any individual variable, X_t^s, is

$$X_t = (1-\vartheta) \sum_{s=0}^{\infty} \vartheta^s X_t^s.$$

- Aggregation gives

$$\begin{aligned} A_{t+1} &= R_t \left[A_t - C_t + h_t \right], \\ C_t &= (1-\beta\vartheta) \left[A_t + H_t \right]. \end{aligned}$$

- Expression for aggregate consumption (where $\psi = (1-\beta\vartheta)$)

$$C_t = \mathbb{E}_t \left\{ \frac{1}{R_t} \left[\frac{\psi}{1-\psi}(1-\vartheta)A_{t+1} + \frac{\vartheta}{1-\psi} C_{t+1} \right] \right\},$$

- Assume $\vartheta < 1 \Rightarrow$ dynamics of financial wealth (Barro (1974)) matter

Optimization and Equilibrium (cont'd)

Equilibrium

A competitive equilibrium for given initial conditions, the stochastic process $\{Z_t\}$ and a set of prices $\{R_t, q_t, R_t^k, W_t\}$, is a tuple of processes for $\{C_t, A_t, I_t, K_t, N_t, Y_t, B_t, G_t, \tau_t\}$ such that

- *Household optimality*
    - Given $\left\{W_t, R_t, R_t^k\right\}$, the processes for $\{C_t^s, A_t^s, I_t^s, N_t^s, K_t^s\}$ solve the optimization problem for any individual agent out of generation s.
- *Aggregation*
    - Individual variables are transformed into aggregate variables.
- *Profit maximization*
    - The process for $\{K_t, N_t\}$ solve the optimization problem. Processes for W_t and R_t^k follow FONCs.

- *Fiscal policy*
  - The processes for $\{B_t, G_t, \tau_t\}$ are determined by fiscal rules, while the government equilibrium restriction holds with equality.
- *Market clearing*
  - In equilibrium, factor and goods market clear and any feasible allocations are those satisfying

$$Y_t \geq C_t + I_t + G_t.$$

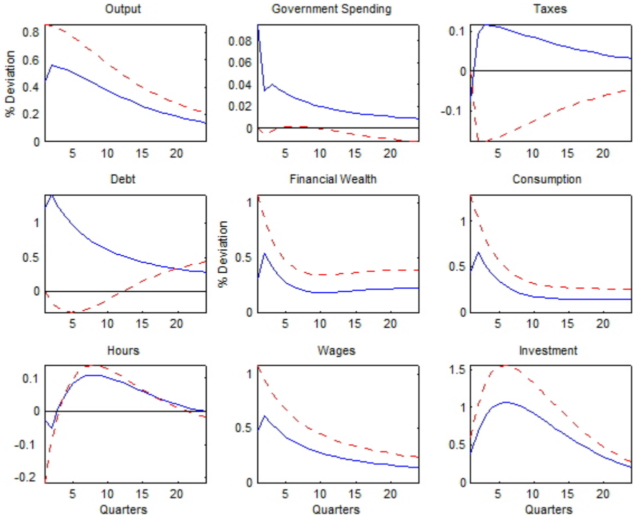
- Set of equations forming the rational expectation equilibrium is log-linearized around the non-stochastic steady state and solved by applying the Sims (2002) algorithm.

Table: Calibrated Parameters to match the U.S. taken from Leeper et al. (2010).

	Values		Values
β	0.998	G	0.2
$1-\vartheta$	0.015	B	0.3396
φ	2	ρ_Z	0.9
α	0.3	σ_Z	0.0049
δ	0.025	Q	1

Table: Estimated Parameters

	τ_B	τ_Y	γ_B	γ_Y
Estimate	0.0014	0.2077	0.0255	0.0077
S.E.	0.0182	0.0572	0.0060	0.0189
Counter	-0.0014	-0.2077	-0.0255	-0.0077



Output
Government Spending
Taxes
Debt
Financial Wealth
Consumption
Hours
Wages
Investment
% Deviation
% Deviation
Quarters
Quarters
Quarters

Table: Second Moments

	Data	Procyclical	Countercyclical	Δ
$std(Y)$	1.81	0.75	1.17	-0.36
$Rstd(C)$	0.74	0.77	0.94	-0.18
$Rstd(N)$	0.99	0.21	0.21	0
$Rstd(I)$	2.93	2.05	1.91	0.07
$Rstd(G)$	0.07	0.08	0.03	2.67
$Rstd(T)$	0.12	0.21	0.21	0
$Rstd(B)$	2.80	2.01	1.06	1.90

Robustness

Robustness to changes in survival probability

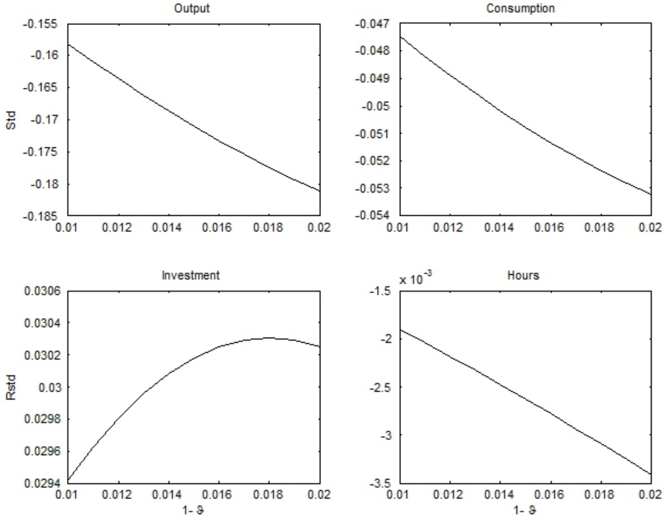
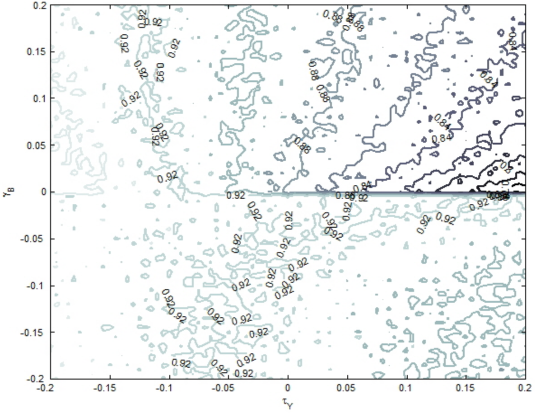


Figure: Second Moments as function of ϑ

Robustness (cont'd)

Fiscal Rules

- Fiscal Rules: *Every* policy generating countercyclical debt will create larger second moments compared to the procyclical case.
- How does the volatility depend on τ_Y-γ_B?



Conclusion

- Debt is procyclical in the United States
- New channel (different to *Fiscal Theory of the Price Level*)
  - Non-Ricardian: Debt is wealth
  - Fiscal rules: Debt responds to output changes
- An *additional* automatic stabilizer of economic activity
- Holds for almost *all* type of shocks

Conclusion (cont'd)

Implications

- Consequences for fiscal policy are provocative
- Here: Classical (countercyclical) Keynesian fiscal policy **destabilizes** the business cycle
- Government
  - can affect the size of the additional wealth effect $\Rightarrow$ fiscal rules
  - influence cyclical fluctuations
  - contribute to macroeconomic stability
- Limiting Factors
  - Monetary policy (rules)
  - Government structure
  - Borrowing constraints (Structure of government debt)
  - Involuntary unemployment

Conclusion (cont'd)

A Cyclical Fiscal Theory of the Price Level

- FTPL claims that fiscal disturbances drive the price level
- They change the real value of debt $\Rightarrow$ wealth effect
- Affect private sector budget constraints $\Rightarrow$ aggregate demand
- Iff "Non-Ricardian" regime: no adjustments of fiscal instruments
- Must debt explode in a Non-Ricardian regime?
  - No!
  - If there is *no* doubt about the government *not* adjusting instruments $\Rightarrow$ prices adjust accordingly
- New channel allows for *cyclical* implications of FTPL to *all* shocks
- Cointegration $\Rightarrow$ equilibrium

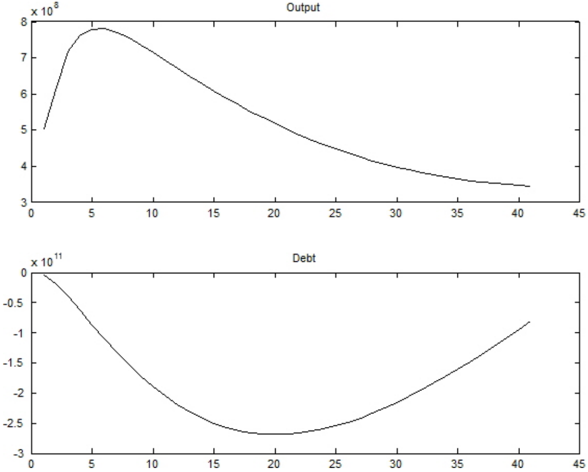
Johansen Test

Table: Johansen test results at 5% significance level.

	r	pValue	Result
DCI	0	0.001	true
	1	0.6393	false
SCI	0	0.001	true
	1	0.999	false

Back

SVECM


Output
x 10^8
8
7
6
5
4
3
0
5
10
15
20
25
30
35
40
45
Debt
x 10^11
0
-0.5
-1
-1.5
-2
-2.5
-3
0
5
10
15
20
25
30
35
40
45

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