Government Policy Response to War-Expenditure Shocks

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Wartime policy in the U.S.

Episodes of interest:

- Civil War
- World War I
- World War II

Qualitative stylized facts:

1. mix of *contemporaneous* financing instruments: debt, inflation and taxes
2. large and persistent debt response
3. significant increase in GDP
4. large wartime deficits followed by peacetime surpluses
5. WWII: inflation is also used to finance accumulated debt

Model predictions

Barro (JPE 1979) or Ramsey w/incomplete markets:

- explains (some aspects of) debt-behavior
- cannot explain wartime increase in taxation
- no predictions for inflation

Ramsey + money (Chari-Christiano-Kehoe, JMCB 2001):

- no persistence in debt (and response is in wrong direction)
- very volatile inflation (with zero or negative autocorrelation)

Limited commitment (Martin, RED 2009):

- matches some facts qualitatively
- predicts too much inflation
- counterfactual post-war tax behavior
- not a systematic study

This paper

Match qualitative and quantitative facts of U.S. wartime policy, using a model of government policy with limited commitment.

- Complements empirical studies on wartime policy, by providing a theoretical explanation
- Improves confidence in limited commitment as a key friction in explaining government policy

Related Literature

- **U.S. policy:** Goldin (1980); Ohanian (AER, 1997; 1998); Bohn (QJE, 1998); McGrattan and Ohanian (2008).
- **Limited commitment as mechanism for debt:** Martin (RED, 2009; 2010; JME, 2011); Díaz-Gimenez et al. (RED, 2008); Niemann et al. (2011), Krusell, et al. (2008).
- **Ramsey approach:** Lucas & Stokey (JME, 1983); Lucas (JME, 1986); Chari, Christiano & Kehoe (JMCB, 1991); Aiyagari et al. (JPE, 2002); Marcet & Scott (JET, 2009); Aruoba & Chugh (JET, 2010).
- **Other motives for debt:** Diamond (1965), Aiyagari & McGrattan (JME, 1998), Shin (2006), Battaglini & Coate (AER, 2008).
- **Micro founded approach to monetary economics:** Wallace (IER, 2001), Lagos & Wright (JPE, 2005), . . .

A monetary economy

Variant of Lagos-Wright (2005).

Continuum of agents.

Two competitive markets open in sequence: DAY and NIGHT.

Day-Market:

- equal chance of becoming a consumer or producer
- banks as in Berentsen-Camera-Waller (2007)
- double coincidence of wants problem, anonymity and limited commitment $\Rightarrow$ medium of exchange is essential

Night-Market: linear disutility from labor.

Government

Government is benevolent and produces a public good.

Instruments: money, one-period nominal bonds and labor taxes.

Policy is announced at the beginning of each period before the day market opens, but after aggregate shocks are realized.

Government only operates in the night market.

Limited commitment: government cannot commit to policy choices beyond the current period.

Wars: agent's marginal utility from public good is stochastic.

Bonds are "book entries": records are not accessible during the day $\Rightarrow$ bonds are not exchanged in day-market.

Government Budget Constraint (GBC)

Normalize nominal variables by the aggregate money stock.

Government budget constraint:

$$\frac{1+B}{p} + g = \tau n + \frac{[1+\mu][1+qB']}{p}$$

- B: bond-money ratio
- p: (normalized) price of night-output
- τ: night-labor income tax rate
- μ: money growth rate
- q: price of a government bond that pays \$1 next period
- n: night-labor

Markets

Day Market:

- producers deposit and consumers borrow fiat money; financial intermediation is conducted by banks
- consumers and producers exchange day-good x for fiat money
- flow utility: $u(x)$ for consumers and $-x$ for producers

Night Market:

- all agents can produce and want to consume the night good c
- government supplies public good g, financed with labor taxes, money and bonds
- agents exchange goods, money and bonds
- flow utility: $U(c) + \psi v(g) - \alpha n$

Problem of the agent

Day Market:

$$\begin{aligned} V^c(m,b,B,\psi) &= \max_{x,\ell\geq\tilde{p}x-m} u(x)+W(m+b-\tilde{p}x-i\ell,B,\psi) \\ V^p(m,b,B,\psi) &= \max_{x,d\leq m} -x+W(m+b+\tilde{p}x+id,B,\psi) \end{aligned}$$

Night Market:

$$W(m+b,B,\psi)=\max_{c,n,m',b'} U(c)-\alpha n+\psi v(g)+\beta E[V(m',b',B',\psi')|\psi]$$

subject to: $pc+[1+\mu][m'+qb']=p[1-\tau]n+[m+b]$

GBC IN MONETARY EQUILIBRIUM

Primal approach: use equilibrium conditions to replace prices and policies with allocations.

In a monetary equilibrium, GBC can be written in terms of $\{B, B', x, x', c, g\}$. equations

NOTE: $x' = \mathcal{X}(B', \psi')$ is implemented by tomorrow's government.

From equilibrium conditions:

- $\uparrow \mu \;\Leftrightarrow\; \downarrow x$
- $\uparrow \tau \;\Leftrightarrow\; \downarrow c$

GBC in a monetary equilibrium:

$$\varepsilon(B, x, c, g) + \beta E[\vartheta(B', \mathcal{X}(B', \psi'), \psi')|\psi] = 0$$

Problem of the government

Given (B, ψ) and anticipating that future governments will implement $\mathcal{X}(B, \psi)$, the problem of the current government is

$$\mathcal{V}(B, s) = \max_{B', x, c, g} \underbrace{0.5[u(x) - x]}_{day} + \underbrace{U(c) + \psi v(g) - \alpha[c + g]}_{night}$$
$$+ \beta \underbrace{E[\mathcal{V}(B', \psi')|\psi]}_{tomorrow}$$

subject to

$$\varepsilon(B, x, c, g) + \beta E[\vartheta(B', \mathcal{X}(B', \psi'), \psi')|\psi] = 0$$

Markov-Perfect Monetary Equilibrium:
fixed point in $\{\mathcal{V}(B, \psi), \mathcal{X}(B, \psi)\}$

Inspecting the mechanism

Generalized Euler Equation: all

$$E\Big[x' \underbrace{(\lambda-\lambda')}_{\text{tax smoothing}} + \lambda \underbrace{\mathcal{X}'_B}_{dx'/dB'} \big(\underbrace{u'_x + u'_{xx}x'}_{dV'_m/dx'} + \underbrace{1}_{dV'_b/dx'} B'\big) \mid \psi\Big] = 0$$

Government weights:

1. objective of smoothing distortions intertemporally
2. time consistency-problem from interaction between debt and monetary policy

Debt $\Rightarrow$ Monetary policy: higher inherited debt, larger incentive to inflate $\Rightarrow \mathcal{X}'_B < 0$.

Monetary policy $\Rightarrow$ Debt: anticipated changes in future monetary policy affect current policy trade-offs.

Monetary policy $\Rightarrow$ Debt

Consider the effects of increasing debt: $\uparrow B'$.

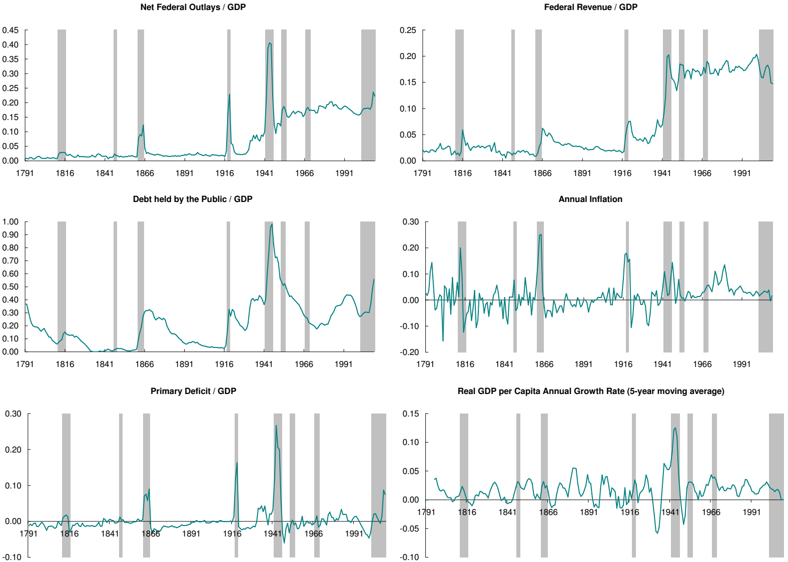
- government tomorrow increases money growth rate: $\uparrow \mu' \Leftrightarrow \downarrow x'$.
- under standard assumptions on preferences, agents would prefer to have arrived with more money, $\uparrow V'_m$: current demand for money increases. Relaxes GBC.
- future value of bonds decreases, $\downarrow {V_b}'$: current demand for bonds decreases and thus, $\uparrow q$. Tightens GBC.

Debt increases (decreases) if the overall effect on the current demand for money and bonds relaxes (tightens) the GBC.

The cost is lower intertemporal distortion smoothing.

U.S. GOVERNMENT POLICY 1791—2010

Defense Goldin (1980)



Ex.1: Calibration to post-war U.S.

Calibration needs to be consistent with: details

- primary deficit decreasing in debt (Bohn, QJE 1998)
- expenditure/GDP roughly constant at different debt levels

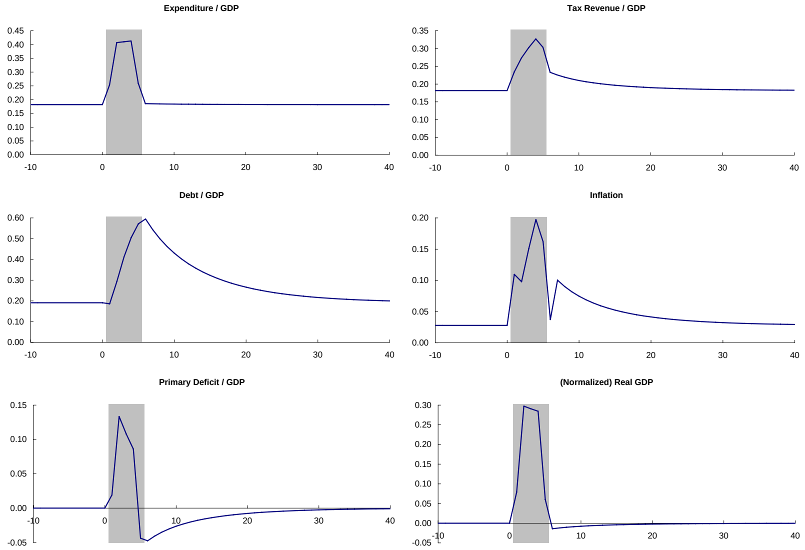
Table: Target statistics, U.S. 1962 – 2006

Debt/GDP	Inflation	Interest rate	Revenue/GDP	Outlays/GDP
0.308	0.044	0.073	0.182	0.182

Marginal utility of public good: ψ_L targets 1962 – 2006 expenditure levels; ψ_M and ψ_H target WWII expenditure levels.

Transition probabilities target 9% unconditional probability of wartime and average war duration of 4.5 years (Martin, RED 2009).

Simulated response to a WWII-like shock



War peak vs 5-year pre-war average

Table: Averages over 1,000,000 simulated periods

	U.S. Wars *	Model
Outlays/GDP	[0.108 – 0.322]	0.223
		(0.033)
Revenue/GDP	[0.050 – 0.135]	0.132
		(0.034)
Deficit/GDP	[0.087 – 0.252]	0.129
		(0.024)
Debt/GDP	[0.292 – 0.579]	0.360
		(0.148)
Inflation	[0.243 – 0.132]	0.156
		(0.052)
GDP	[0.058 – 0.500]	0.288
		(0.046)

Includes wars that last at least 3 years and were preceded by at least 10 years of peace.

Ex.2: World War II calibration

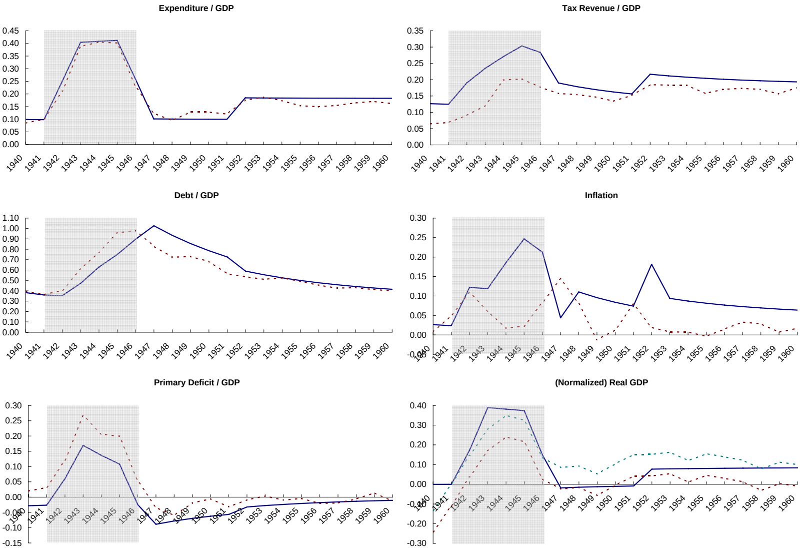
Idea: calibrate model to pre-WWII and simulate WWII shock.

Not a straightforward exercise: economy transitions out of depression pre-war and long-run policy looks very different post-war.

Option 1: recalibrate to pre-WWII economy; problematic!

Option 2: keep post-war calibration; only add an extra expenditure state for pre-WWII economy and select corresponding initial debt; simulate path of outlays from 1940-1960.

World War II: data vs LW model μ



Concluding remarks

A theory of long-run government policy based on limited commitment helps explain wartime policy.

An empirically plausible post-WWII calibration matches qualitative and quantitative facts of wartime financing.

Problematic to model inflation response: price controls, velocity.

Perception of a permanent increase in size of government may be an explanation for distinct policy during Korean War.

Concerns for high inflation in the future:
increased debt $+$ limited commitment $=$ higher inflation.

Goldin (1980)

Return

Wars are financed with a mix of policy instruments:

	Civil War	World War I	World War II
Direct taxes	0.093	0.240	0.410
Debt and seigniorage	0.907	0.760	0.590

Return

In a monetary equilibrium:

$$\begin{aligned}
\mu &= \frac{\beta E[u'_x x' \mid \psi]}{x} - 1 \\
\tau &= 1 - \frac{\alpha}{U_c} \\
\tilde{p} &= \frac{2}{x} \\
p &= \frac{2U_c}{x} \\
q &= \frac{1}{E[u'_x \mid \psi]} \\
i &= u_x - 1
\end{aligned}$$

GBC:

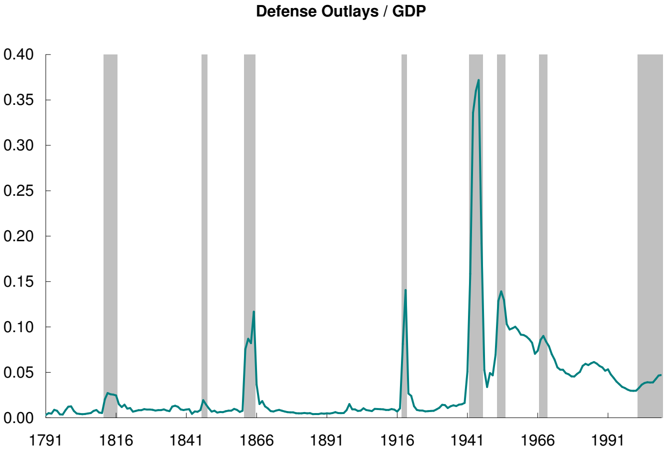
$$U_c c - \alpha(c+g) - \frac{x(1+B)}{2} + \frac{\beta E[x'(u'_x - 1) + x'(1+B') \mid \psi]}{2} = 0$$

Return

FOCs of government's problem:

$$\begin{aligned}
E\left[x'(\lambda-\lambda')+\lambda(u'_x+u'_{xx}x'+B')\mathcal{X}'_B \mid \psi\right] &= 0 \\
u_x-1-\lambda(1+B) &= 0 \\
U_c-\alpha+\lambda(U_c+U_{cc}c-\alpha) &= 0 \\
-\alpha+\psi v_g-\lambda\alpha &= 0
\end{aligned}$$

Return



Defense Outlays / GDP
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1791
1816
1841
1866
1891
1916
1941
1966
1991

Functional forms:

$$
\begin{aligned}
u(x) &= \varphi \frac{x^{1-\sigma} - 1}{1 - \sigma} \\
U(c) &= \frac{c^{1-\rho} - 1}{1 - \rho} \\
v(g) &= \ln g .
\end{aligned}
$$

TABLE: Parameters

α	β	ρ	σ	φ
4.172	0.973	8.188	2.508	10.753

Marginal utility of public good: $\{\psi_L, \psi_M, \psi_H\} = \{1.0, 1.5, 3.0\}$.

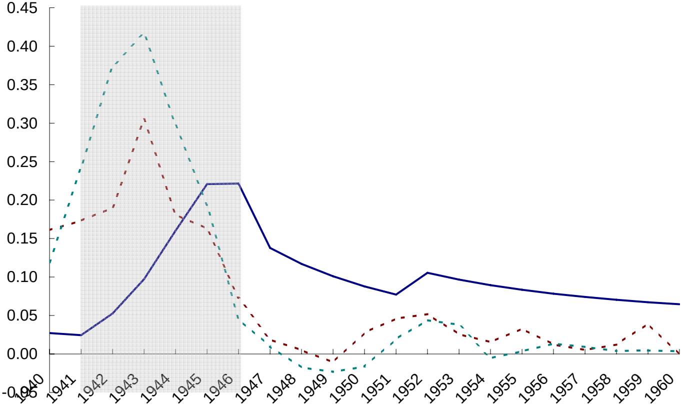
Return

War peak vs 5-year pre-war average

	Civil War	World War I	World War II
Policy variable			
Outlays / GDP	0.108	0.208	0.322
Revenue / GDP	0.050	0.057	0.135
Deficit / GDP	0.087	0.160	0.252
Debt / GDP	0.293	0.292	0.579
Inflation	0.243	0.122	0.132
Detrended GDP per capita			
Linear	0.075	0.060	0.500
HP-filter	0.096	0.071	0.279
HP-filter (Ravn-Uhlig)	0.063	0.058	0.137

Return

Money growth rate



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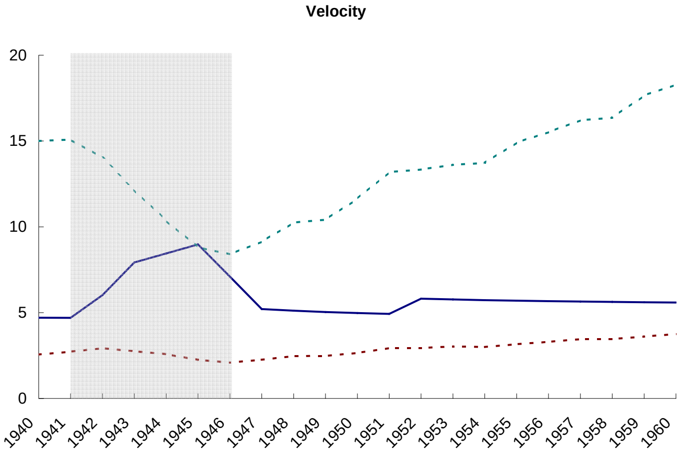
Velocity
20
15
10
5
0
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960