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).


- **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 ⇒ 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:

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

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 \( \{B, B', x, x', c, g\} \).

**Note:** \( x' = x'(B', \psi') \) is implemented by tomorrow’s government.

From equilibrium conditions:

- \( \uparrow \mu \iff \downarrow x \)
- \( \uparrow \tau \iff \downarrow c \)

GBC in a monetary equilibrium:

\[
\varepsilon(B, x, c, g) + \beta E[\vartheta(B', x'(B', \psi'), \psi')|\psi] = 0
\]
Problem of the government

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

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

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: \[ E \left[ x' \left( \lambda - \lambda' \right) + \lambda \frac{\lambda'}{B'} \left( u'_x + u'_{xx} x' + \frac{1}{dV'_m/dx'} + \frac{1}{dV'_b/dx'} B' \right) \right] = 0 \]

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

DEBT ⇒ MONETARY POLICY: higher inherited debt, larger incentive to inflate ⇒ \( \lambda'_B < 0 \).

MONETARY POLICY ⇒ DEBT: anticipated changes in future monetary policy affect current policy trade-offs.
Monetary policy ⇒ Debt

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

- government tomorrow increases money growth rate: $\uparrow \mu' \iff \downarrow x'$.

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

Calibration needs to be consistent with:

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

**Table:** Target statistics, U.S. 1962 — 2006

<table>
<thead>
<tr>
<th>Debt/GDP</th>
<th>Inflation</th>
<th>Interest rate</th>
<th>Revenue/GDP</th>
<th>Outlays/GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.308</td>
<td>0.044</td>
<td>0.073</td>
<td>0.182</td>
<td>0.182</td>
</tr>
</tbody>
</table>

Marginal utility of public good: $\psi_L$ targets 1962 — 2006 expenditure levels; $\psi_M$ and $\psi_H$ 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

Expenditure / GDP

Tax Revenue / GDP

Debt / GDP

Inflation

Primary Deficit / GDP

(Normalized) Real GDP
# War peak vs 5-year pre-war average

**Table:** Averages over 1,000,000 simulated periods

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

*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

- Expenditure / GDP
- Tax Revenue / GDP
- Debt / GDP
- Inflation
- Primary Deficit / GDP
- (Normalized) Real GDP
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.
**WARS ARE FINANCED WITH A MIX OF POLICY INSTRUMENTS:**

<table>
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<tr>
<th></th>
<th>Civil War</th>
<th>World War I</th>
<th>World War II</th>
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<tbody>
<tr>
<td>Direct taxes</td>
<td>0.093</td>
<td>0.240</td>
<td>0.410</td>
</tr>
<tr>
<td>Debt and seigniorage</td>
<td>0.907</td>
<td>0.760</td>
<td>0.590</td>
</tr>
</tbody>
</table>
In a monetary equilibrium:

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

GBC:

\[
U_c c - \alpha(c + g) - \frac{x(1 + B)}{2} + \frac{\beta E[x'(u'_x - 1) + x'(1 + B') | \psi]}{2} = 0
\]
FOCs of government’s problem:

\[ E \left[ x' (\lambda - \lambda') + \lambda (u'_x + u'_{xx} x' + B') x'_B \mid \psi \right] = 0 \]
\[ u_x - 1 - \lambda (1 + B) = 0 \]
\[ U_c - \alpha + \lambda (U_c + U_{cc} c - \alpha) = 0 \]
\[ -\alpha + \psi v_g - \lambda \alpha = 0 \]
Functional forms:

\[ u(x) = \varphi \frac{x^{1-\sigma} - 1}{1 - \sigma} \]

\[ U(c) = \frac{c^{1-\rho} - 1}{1 - \rho} \]

\[ v(g) = \ln g. \]

**Table:** Parameters

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta$</th>
<th>$\rho$</th>
<th>$\sigma$</th>
<th>$\varphi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.172</td>
<td>0.973</td>
<td>8.188</td>
<td>2.508</td>
<td>10.753</td>
</tr>
</tbody>
</table>

Marginal utility of public good: \( \{\psi_L, \psi_M, \psi_H\} = \{1.0, 1.5, 3.0\} \).
### War peak vs 5-year pre-war average

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<th>Civil War</th>
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<th>Detrended GDP per capita</th>
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<tbody>
<tr>
<td>Linear</td>
</tr>
<tr>
<td>HP-filter</td>
</tr>
<tr>
<td>HP-filter (Ravn-Uhlig)</td>
</tr>
</tbody>
</table>