AGGREGATE SHOCKS AND DEBT MANAGEMENT II

Fiscal and Monetary Policy 2024

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PLAN

- We look at how the U.S. financed its wars over the last 200 years.
- We confront these patterns with the predictions of two theories: Barro (1979) and Lucas and Stokey (1983).
- We follow the chapter of the Handbook of Historical Economics by Hall and Sargent (2021) – but we omit many interesting institutional details.

TWO THEORIES

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- Recall the two theories we discussed earlier:
  - Barro (1979): incomplete markets
  - Lucas and Stokey (1983): complete markets
- These two theories have different recommendations regarding the optimal mix of taxes and debt to finance wars.
- We will focus on a simplified version of Lucas and Stokey (1983): assume the same reduced form objective function as in the previous lecture.

TWO THEORIES

- The only difference is the budget constraint.
- In the Barro (1979) case the government can only use one-period debt:

$$\tau_t + a_t = \frac{1}{1+r} a_{t+1} + g_t,$$

  where a_t is a risk free claim on time t goods that the government purchased at time $t-1$; debt is $-a_t$.

- In the simplified version of Lucas and Stokey (1983) case the government can use state-contingent debt:

$$\tau_t + a_{t-1}(s_t) = \int q_t(s_{t+1} \mid s_t)\, a_t(s_{t+1})\, ds_{t+1} + g_t,$$

  where $a_{t-1}(s_t)$ is Arrow security that pays in state s_t and $q_t(\cdot)$ are prices.

TWO THEORIES

- Let PVG_t be the expected present value of future government expenditures:

$$PVG_t = \mathbb{E}\left[\sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^j g_{t+j} \mid s_t\right] = H(s_t).$$

- H satisfies the functional equation

$$\begin{aligned} H(s_t) &= G(s_t) + \frac{1}{1+r}\int H(s_{t+1})\,\phi(s_{t+1} \mid s_t)\,ds_{t+1} \\ &= G(s_t) + \frac{1}{1+r}\mathbb{E}\left[H(s_{t+1}) \mid s_t\right]. \end{aligned}$$

TWO THEORIES

- In Barro (1979) the optimal plan is

$$\tau_t = \frac{r}{1+r}\left[H\left(s_t\right) + a_t\right]$$

  and has the implication that taxes are a random walk

$$\mathbb{E}_t\left[\tau_{t+1}\right] = \tau_t.$$

- Government assets are also a random walk.

TWO THEORIES

- This simplified version of Lucas and Stokey (1983) has the optimal plan that

$$\tau_t = \tau_0.$$

- The state-contingent asset-purchasing strategy supports this tax collection policy:

$$a_{t-1}(s_t) = H(s_t) - \frac{1+r}{r}\tau_0.$$

TWO THEORIES

- To facilitate comparison we assume

$$q\left(s_{t+1} \mid s_t\right) = \frac{1}{1+r}\phi\left(s_{t+1} \mid s_t\right).$$

- This results in the budget constraint for the Lucas and Stokey (1983) case:

$$\tau_t + a_{t-1}\left(s_t\right) = \frac{1}{1+r}\mathbb{E}\left[a_{t+1} \mid s_t\right] + g_t,$$

where we define $\mathbb{E}\left[a_{t+1} \mid s_t\right] = \int a_t\left(s_{t+1}\right)\phi\left(s_{t+1} \mid s_t\right) ds_{t+1}$.

EX-POST RETURNS

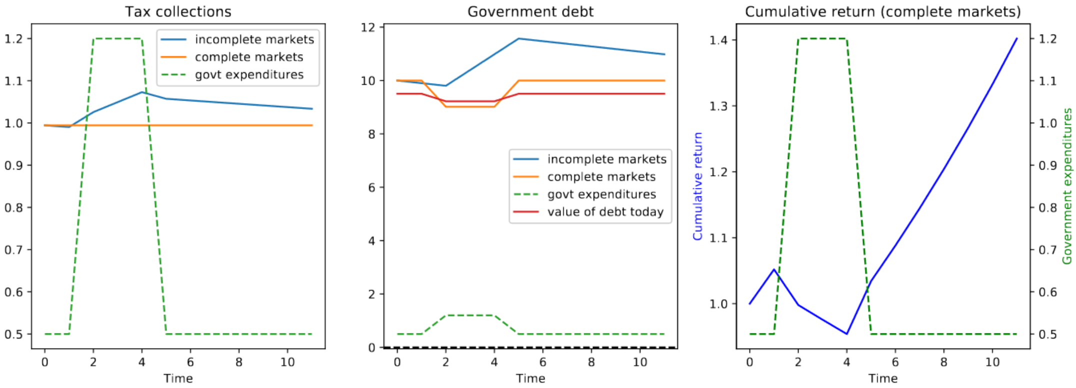
- Useful to distinguish between ex-ante and ex-post returns.
- Ex-post return on a portfolio of Arrow securities is

$$R_t\left(s_{t+1} \mid s_t\right) = \frac{a_t\left(s_{t+1}\right)}{\mathbb{E}\left[a_{t+1} \mid s_t\right]}$$

- The conditional expectation of the return on the government portfolio (ex-ante) is then

$$\mathbb{E}\left[R_t\left(s_{t+1} \mid s_t\right) \mid s_t\right] = 1 + r$$

TWO THEORIES



Tax and debt policy in complete and incomplete markets.

GOVERNMENT BUDGET CONSTRAINT

GOVERNMENT BUDGET CONSTRAINT

- We need to map the model into the data.
- Let $B_{t-1} = \sum_{j=1}^{n} B_{t-1}^{j}$ be the total nominal value of interest bearing government debt at $t-1$, where B_{t-1}^{j} is the nominal value of zero coupon bonds of maturity j at $t-1$.
- The government budget constraint at time t is

$$B_t = B_{t-1} + r_{t-1,t}B_{t-1} + G_t - T_t - \left(M_t - M_{t-1}\right),$$

where M_t is the nominal money supply and $r_{t-1,t}$ is implicitly defined by

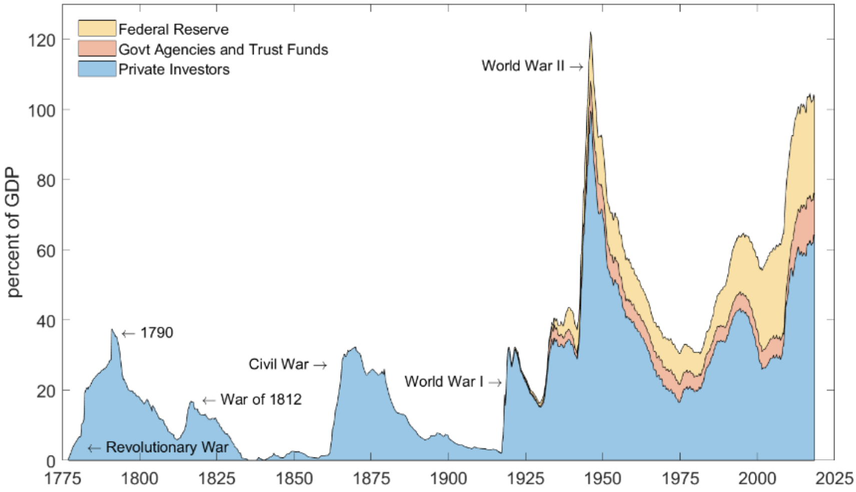
$$r_{t,t-1}B_{t-1} = \sum_{j=1}^{n} r_{t-1,t}^{j} B_{t-1}^{j}.$$

- All variables above are nominal.

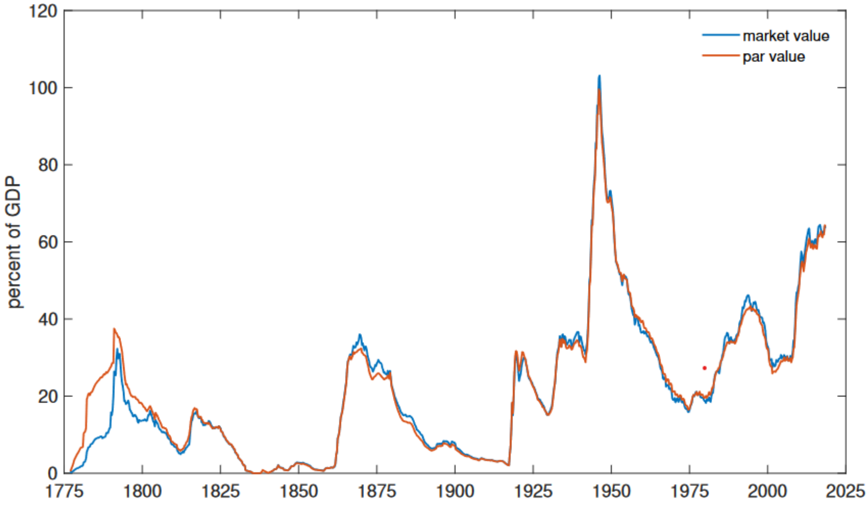
GOVERNMENT BUDGET CONSTRAINT

- Hall and Sargent make two adjustments to the U.S. Treasury's record of total public debt outstanding:
    1. net out holdings by the Federal Reserve and Government Agencies and Trust Funds;
    2. measure Treasury debt by its market value rather than its par value.

DEBT OWNERSHIP



DEBT VALUE



market value
par value
percent of GDP
120
100
80
60
40
20
0
1775
1800
1825
1850
1875
1900
1925
1950
1975
2000
2025

GOVERNMENT BUDGET CONSTRAINT

- We can rewrite the budget constraint as

$$
\begin{aligned}
\frac{G_t}{Y_t} + r_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} = \frac{T_t}{Y_t} &+ \left(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}}\right) + \frac{M_t - M_{t-1}}{Y_t} \\
&+ g_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} + \pi_{t-1,t}\frac{B_{t-1}}{Y_{t-1}} \\
&+ r_{t-1,t}\left(g_{t-1,t} + \pi_{t-1,t}\right)\frac{B_{t-1}}{Y_{t-1}}
\end{aligned}
$$

  where $g_{t-1,t}$ denotes the growth rate of real GDP, and $\pi_{t-1,t}$ denotes the inflation rate.
- The first three terms on the right side record sources of government revenue as shares of GDP: taxes, new borrowing and money creation.
- The next two terms record the diminution of the debt/GDP ratio due to real GDP growth and inflation.

GOVERNMENT BUDGET CONSTRAINT

- A "peacetime baseline" version of the constraint

$$
\begin{aligned}
\left(\frac{G}{Y}\right)^{\text{base}} + \left(r_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{\text{base}} &= \left(\frac{T}{Y}\right)^{\text{base}} + \left(\frac{B}{Y} - \frac{B_{-1}}{Y_{-1}}\right)^{\text{base}} \\
&+ \left(\frac{M - M_{-1}}{Y}\right)^{\text{base}} \\
&+ \left(g_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{\text{base}} + \left(\pi_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{\text{base}} \\
&+ \left(r_{-1,t}\left(g_{-1,0} + \pi_{-1,0}\right)\frac{B_{-1}}{Y_{-1}}\right)^{\text{base}}
\end{aligned}
$$

GOVERNMENT BUDGET CONSTRAINT

- In each period we can calculate deviation of "wartime" budget constraint from the "peacetime baseline".
- Hall and Sargent sum from the beginning of the war to the end of the war to get the total wartime deviation.

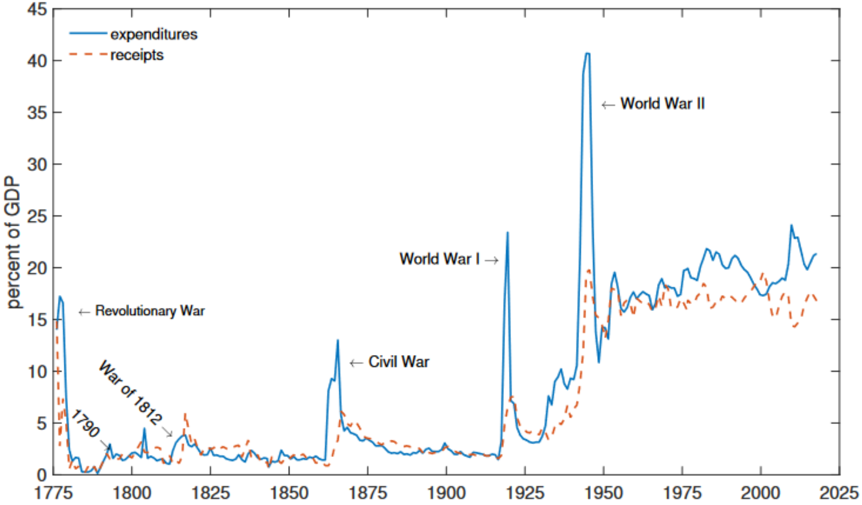
$$
\begin{aligned}
&\sum_{t=T_1}^{T_2}\left[\frac{G_t}{Y_t}-\left(\frac{G}{Y}\right)^{\text{base}}\right]+\sum_{t=T_1}^{T_2}\left[r_{t-1,t}\frac{B_{t-1}}{Y_{t-1}}-\left(r_{-1,0}\frac{B_{-1}}{Y_{-1}}\right)^{\text{base}}\right]\\
&=\sum_{t=T_1}^{T_2}\left[\frac{T_t}{Y_t}-\left(\frac{T}{Y}\right)^{\text{base}}\right]+\sum_{t=T_1}^{T_2}\left[\left(\frac{B_t}{Y_t}-\frac{B_{t-1}}{Y_{t-1}}\right)-\left(\frac{B}{Y}-\frac{B_{-1}}{Y_{-1}}\right)^{\text{base}}\right]\\
&\qquad+\sum_{t=T_1}^{T_2}\left[\frac{M_t-M_{t-1}}{Y_t}-\left(\frac{M-M_{-1}}{Y}\right)^{\text{base}}\right]+\cdots
\end{aligned}
$$

War Start - End (U.S. entry -)	(1) government spending	(2) return on debt	(3) (1)+(2)	(4) tax revenue	(5) debt growth	(6) money growth	(7) GDP growth	(8) inflation	(9) cross term	(10) residual
War of 1812										
1812:6 - 1815:2	7.34	-0.20	7.14	-2.35	10.60	0.00	-0.16	0.06	-0.39	-0.62
				-32.9	148.5	0.0	-2.2	0.8	-5.5	-8.7
Mexican War										
1846:5 - 1848:2	2.26	0.20	2.47	-0.06	2.72	0.00	-0.06	-0.01	-0.00	-0.12
				-2.4	110.4	0.0	-2.5	-0.5	-0.1	-4.8
Civil War (Union)										
1861:4 - 1865:4	31.04	2.10	33.14	2.26	19.74	6.49	1.08	3.95	0.40	-0.77
				6.8	59.6	19.6	3.2	11.9	1.2	-2.3
Spanish-American War										
1898:4 - 1898:8	0.78	0.11	0.90	0.45	-0.26	0.07	0.67	0.13	0.03	-0.18
				50.0	-28.9	7.3	74.3	14.6	3.2	-20.4
World War I										
1914:7 - 1918:11	36.11	0.43	36.54	6.83	26.76	3.41	0.52	1.22	0.03	-2.24
				18.7	73.2	9.3	1.4	3.4	0.1	-6.1
(1917:4 -)	36.93	0.30	37.23	7.76	27.79	2.59	0.05	0.76	0.00	-1.73
				20.8	74.6	7.0	0.1	2.1	0.0	-4.6
World War II										
1939:9 - 1945:8	129.50	0.10	129.60	49.91	54.78	11.32	15.42	9.62	0.26	-11.71
				38.5	42.3	8.7	11.9	7.4	0.2	-9.0
(1941:12 -)	116.48	2.00	118.48	35.80	54.53	11.96	8.99	6.05	0.43	0.71
				30.2	46.0	10.1	7.6	5.1	0.4	0.6
Korean War										
1950:6 - 1953:6	15.43	-0.71	14.73	5.42	4.17	2.53	10.99	-10.12	0.05	1.70
				36.8	28.3	17.2	74.6	-68.7	0.3	11.5
Vietnam War										
1964:8 - 1973:6	5.53	-2.13	3.41	1.39	0.44	-0.60	-5.55	3.91	0.19	3.63
				40.8	12.9	-17.8	-163.0	114.9	5.7	106.5

OPTIMAL RESPONSE

- Suppose $r = 0.06$, the net real interest rate in our model is 6%.
- Barro (1979) implies that a purely transitory increse in g_t should be financed in 6% by taxes and in 94% by debt.
- We see it for the Civil War only.
- Caveat: were these increases in government purchases really transitory?

RECEIPTS AND EXPENDITURES

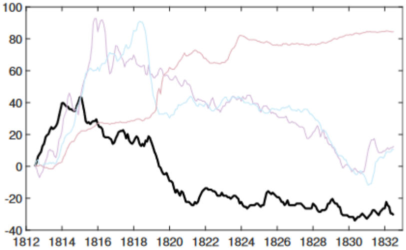


OPTIMAL RESPONSE

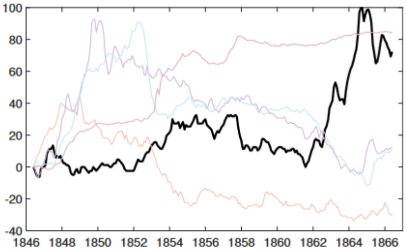
- Lucas and Stokey (1983) implies that unexpected increases in government spending should be absorbed by wartime decreases in returns to government creditors.
- With the exception of the Mexican War and the Korean War, the contribution of inflation is greater than the contribution of the nominal return on the debt.
- Negative wartime real returns.

War postwar period	100 × Debt/GDP (1) end of war	 (2) 15 years postwar	 (3) change	Contributions (4) nominal returns	 (5) real gdp growth	 (6) inflation	 (7) primary deficit	 (8) cross term	 (9) seignorage	 (10) residual
War for Independence 1791-1806	33.3	9.6	-23.8	11.3 47	-15.4 -65	-7.6 -32	-17.3 -73	-1.0 -4	– –	6.3 26
War of 1812 1815-1830	11.6	3.4	-8.2	10.5 128	-5.6 -68	4.9 60	-19.4 -237	0.1 1	– –	1.3 16
Mexican War 1848-1860†	2.7	1.2	-1.5	0.8 53	-0.9 -60	-0.1 -7	-1.5 -100	-0.1 -7	– –	0.3 20
Civil War (Union) 1865-1880	22.1	15.6	-6.5	21.4 329	-14.5 -223	13.5 208	-29.5 -454	0.1 2	1.2 18	1.3 20
Spanish-American War 1898-1913	4.6	2.2	-2.4	0.9 38	-1.2 -50	-1.1 -46	-1.9 -79	-0.1 -4	0.8 33	0.1 4
World War I 1919-1929‡	28.6	20.2	-8.4	12.5 149	-6.4 -76	2.4 29	-20.3 -242	0.3 4	2.0 24	1.0 12
World War II 1945-1960	90.1	35.7	-54.4	14.3 26	-15.8 -29	-38.9 -71	-13.0 -24	-0.6 - 1	-0.3 -1	-0.2 0
Korean War 1953-1968	49.9	21.8	-28.1	14.0 50	-20.3 -72	-10.8 -38	4.0 14	-0.8 -3	-5.8 -21	-8.5 -30
Vietnam War 1973-1988	16.4	34.7	+18.3	32.3 177	-12.2 -67	-19.2 -105	19.7 108	-2.7 -15	-6.0 -33	6.3 35

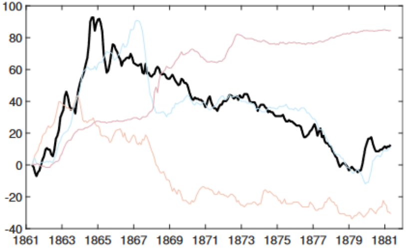
PRICES



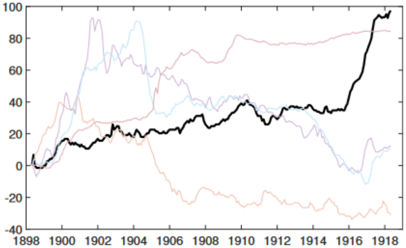
(a) War of 1812



(b) Mexican War

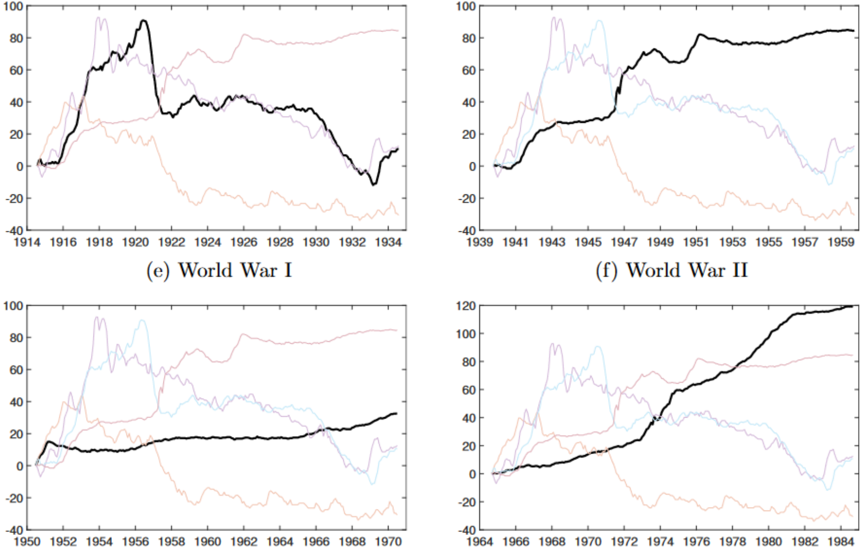


(c) Civil War



(d) Spanish-American War

PRICES



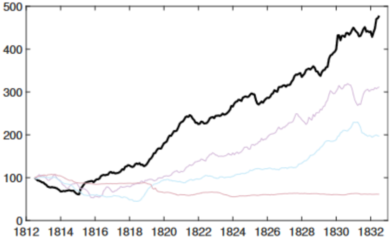
(e) World War I

(f) World War II

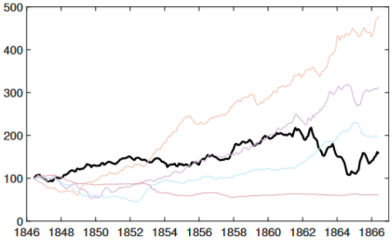
(g) Korean War

(h) Vietnam War

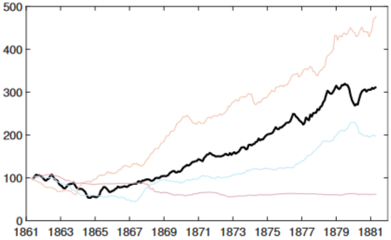
RETURNS



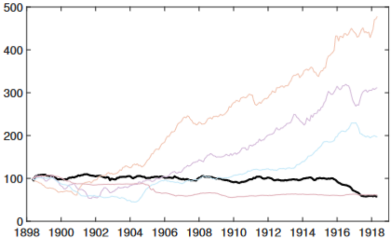
(a) War of 1812



(b) Mexican War

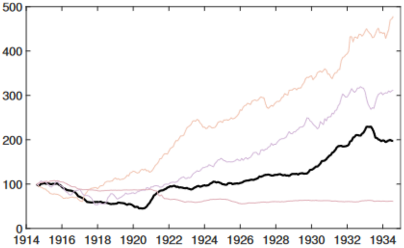


(c) Civil War

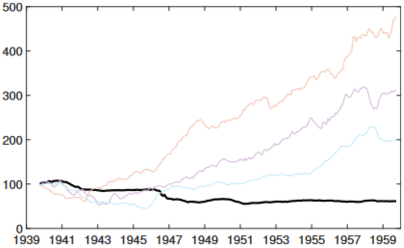


(d) Spanish-American War

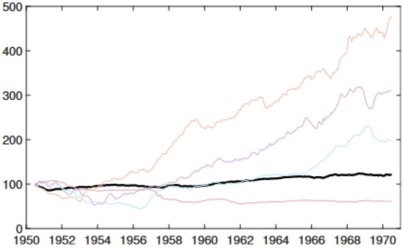
RETURNS



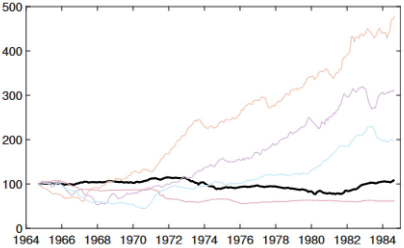
(e) World War I



(f) World War II



(g) Korean War



(h) Vietnam War

CONCLUSIONS

- Evidence of Barro tax smoothing in most wars, but only during the Civil War the split between taxes and debt that the model recommends for a purely temporary expenditure surge.
- Negative wartime bond returns followed by positive postwar returns in the War of 1812, the Civil War, World War I and the Korean War as prescribed by the Lucas-Stokey model
- However, this model directs that bondholders should receive an immediate capital loss at the outbreak of a war. This happens only in the Korean War.
- The U.S. had little debt at the outbreak of most wars, the Lucas-Stokey action would not help the government’s financial situation.