Appendices for Recovery of 1933*

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Appendices

A Model Details, Derivations and Results

This section provides additional model details and states the results of the main text more generally. Most results can easily be extended to include nominal rigidities and long-term government debt.

A.1 A model of the gold standard

Necessary and sufficient conditions for optimality are that the first-order conditions

$$\frac{U_m(m_t)}{U_c(C_t)} = \frac{i_t}{1+i_t} \tag{A.1}$$

$$\frac{U_g(G_t^m)}{U_c(C_t)} = \frac{P_t^g}{P_t}\left(1 - Q_{t,t+1}\frac{P_{t+1}^g}{P_t^g}\right) \tag{A.2}$$

$$\frac{U_c(C_t)}{U_c(C_{t+1})} = \frac{\beta}{Q_{t,t+1}}\frac{P_t}{P_{t+1}} \tag{A.3}$$

$$\frac{V_h(H_t)}{U_c(C_t)} = \frac{w_t}{P_t} \tag{A.4}$$

*April 1, 2023. We thank Jeff Borland, Mike Bordo, John Cochrane, Tom Coleman, Bob Gregory, Greg Kaplan, Tom Sargent, Chris Sims, Gregor Smith, and Ellis Tallman. We especially thank Tao Zha for both code and VAR counsel and George Hall and Tom Sargent for providing their government debt data. Any opinions, findings, and conclusions or recommendations in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. Jacobson acknowledges support from the National Science Foundation Graduate Research Fellowship Program under Grant No. 2015174787. Preston acknowledges research support from the Australian Research Council, under the grant FT130101599. This material reflects the views of the authors and not those of the Federal Reserve Board of Governors.

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must hold at all times and states, along with the transversality condition

$$\lim_{T\to\infty} E_t[Q_{t,T}W_T] = 0.$$

The above conditions assume that utility from gold is additively separable to that obtained from consumption and real money balances. The period interest rate must satisfy

$$\frac{1}{1+i_t} = \beta E_t\left[\frac{U_c(C_{t+1})}{U_c(C_t)}\frac{P_t}{P_{t+1}}\right]. \tag{A.5}$$

For simplicity, we assume that the supply of gold, G_t, is exogenously given. Household and government holdings of gold satisfy

$$G_t = G_t^m + G_t^p.$$

The government's holdings of gold back the money supply according to $P_t^g G_t^m = \alpha M_t$ where the policy parameter satisfies $0 < \alpha < 1$. Under a gold standard the government fixes the dollar price of gold at $P_t^g = \bar{P}^g$. Given exogeneity of the gold supply, gold sector profits are

$$\Pi_t = P_t^g(G_t - G_{t-1}).$$

A rational expectations equilibrium is then a set of state-contingent paths for endogenous variables that satisfy the conditions for household optimality together with market-clearing conditions

$$Y_t = C_t + F_t \tag{A.6}$$

$$M_t = M_t^s \tag{A.7}$$

$$A_{t+1} = A_{t+1}^s \tag{A.8}$$

at all dates and states, with F_t government purchases which are exogenously determined.

Combining (A.2) and (A.3), taking expectations and solving forward gives

$$\frac{P_t^g}{P_t} = E_t\sum_{T=t}^{\infty}\beta^{T-t}\frac{U_g(G_T^g)}{U_c(C_t)}$$

as reported in the main text. Substituting (A.6) – (A.7) into (A.1) and (A.2) gives

$$\frac{U_m(M_t^s/P_t)}{U_c(Y_t - F_t)} = \frac{i_t}{1+i_t} \tag{A.9}$$

$$\frac{U_g(G_t - \alpha M_t^s/\bar{P}^g)}{U_c(Y_t - F_t)} = \frac{\bar{P}^g}{P_t}\frac{i_t}{1+i_t} \tag{A.10}$$

where (A.10) makes use of the constant dollar price of gold under the gold standard. Under standard assumptions on preferences we can solve for real money balances and the relative

price of gold as

$$\frac{M_t^s}{P_t} = L^m(Y_t - F_t, i_t) \tag{A.11}$$

$$\frac{\bar{P}^g}{P_t} = L^g(Y_t - F_t, i_t, G_t) \tag{A.12}$$

where the liquidity preference function L^m is increasing in the first argument and decreasing in the second argument. The function L^g is increase in the first and final argument, decreasing in the second and third.

The transversality condition and flow budget constraint provide the restriction

$$\begin{aligned}
\frac{W_t^s}{P_t} &= E_t \sum_{T=t}^{\infty} \beta^{T-t} \frac{U_c(Y_T - F_T)}{U_c(Y_t - F_t)} \left[S_T + \frac{i_T}{1+i_T} \frac{M_T^s}{P_T} + \frac{\bar{P}^g}{P_T}(G_t^p - G_{t-1}^p) - \Pi_T^g \right] \\
&= E_t \sum_{T=t}^{\infty} \beta^{T-t} \frac{U_c(Y_T - F_T)}{U_c(Y_t - F_t)} \left[S_T + \frac{i_T}{1+i_T} \frac{M_T^s}{P_T} - \frac{\bar{P}^g}{P_T}(G_t^m - G_{t-1}^m) \right] \\
&= E_t \sum_{T=t}^{\infty} \beta^{T-t} \frac{U_c(Y_T - F_T)}{U_c(Y_t - F_t)} \left[S_T + \frac{i_T}{1+i_T} \frac{M_T^s}{P_T} - \alpha(\frac{M_T^s}{P_T} - \frac{M_{T-1}^s}{P_{T-1}}) \right]
\end{aligned}$$

and

$$W_t^s = M_{t-1}^s + (1 + i_{t-1}) B_{t-1}^s$$

in the special case of risk free debt and where the surplus is defined as $S_t = T_t - F_t$.

Now consider the implications of a purely exogenous, possibly time-varying, interest rate peg, $i_t = \bar{i}_t$ and an exogenous surplus rule, $S_t = \bar{S}_t$ for all t. Using (A.11) and (A.12) gives

$$m_t = L^m(Y_t - F_t, \bar{i}_t)$$

which is determined by the exogenous processes for output and government spending. This permits solving for the price level as

$$P_t = \bar{P}^g / L^g(Y_t - F_t, \bar{i}_t, G_t). \tag{A.13}$$

The price level is a stationary random variable determined by the exogenous processes for income, government spending, and gold supply. Using liquidity preference function, goods market clearing and the gold backing policy

$$\frac{M_{t-1}^s + (1 + i_{t-1}) B_{t-1}^s}{P_t} = E_t \sum_{T=t}^{\infty} \beta^{T-t} \frac{U_c(Y_T - F_T)}{U_c(Y_t - F_t)} \left[\bar{S}_T + (\Delta_T - \alpha) \frac{M_T^s}{P_T} + \alpha \frac{M_{T-1}^s}{P_{T-1}} \right] \tag{A.14}$$

where

$$\Delta_T = \frac{\bar{i}_T}{1 + \bar{i}_T}$$

so that the right hand side is uniquely determined and exogenous. For the intertemporal budget constraint to be satisfied requires variations in P_t with variations in structural surpluses, S, to ensure appropriate revaluation of government liabilities. But the resulting price

level will not satisfy (A.13), being independent of the structural surplus. An unbacked fiscal expansion is not feasible under a gold standard.

When the dollar price of gold is allowed to vary the household's intertemporal budget constraint uniquely determines the price level. Then (A.13) determines the equilibrium relative price of gold. Permanent changes in the price level result in permanent changes in the dollar price of gold. Unbacked fiscal expansion requires leaving the gold standard. In this case, the liabilities of the government satisfy

$$\begin{aligned} W^s_{t+1} &= M^s_t + (1+\bar{i}_t)B^s_t \\ &= M^s_t + (1+\bar{i}_t)[W^s_t + P_t\bar{S}_t - M^s_t - P^g(G^m_t - G^m_{t-1})] \\ &= (1+i_t)[W^s_t + P_t\bar{S}_t - \Delta_t M^s_t - P^g(G^m_t - G^m_{t-1})] \end{aligned} \tag{A.15}$$

Finally, we can verify that (A.5) is satisfied under an unbacked fiscal expansion

$$\begin{aligned} \beta E_t[U_c(C_{t+1})P^{-1}_{t+1}] &= \frac{1}{W^s_{t+1}} E_t \sum_{T=t+1}^{\infty} \beta^{T-t} U_c(C_T)[P_T\bar{S}_T + \Delta M^s_T - P^g_T(G^m_T - G^m_{T-1})] \\ &= \frac{U_c(C_t)}{(1+\bar{i}_t)P_t}\left[\frac{(1+\bar{i}_t)W^s_t}{W^s_{t+1}} - \frac{(1+\bar{i}_t)P_t}{W^s_{t+1}}[P_t\bar{S}_t + \Delta M^s_t - P^g_t(G^m_t - G^m_{t-1})]\right] \\ &= \frac{U_c(C_t)}{(1+\bar{i}_t)P_t} \end{aligned}$$

where the final equality follows from (A.15).

A.2 Firm Decisions

We assume a simple theory of production to give microfoundations to movements in the natural rate of interest. This matters for later results on the effects of government spending. A continuum of competitive firms solve a standard profit maximization problem. Each firm j produces according to the production function

$$Y_t(j) = A_t f(H_t(j))$$

where $A_t > 0$ is an exogenous technology factor and f increasing and concave with labor the only input to production. Nominal variable cost of supplying $Y_t(j)$ is

$$w_t H_t(j) = w_t f^{-1}(Y_t(j)/A_t).$$

Real marginal costs are given by

$$mc_t(j) = \frac{MC_t(j)}{P_t} = \frac{v_h(f^{-1}(Y_t/A_t))}{u_c(Y_t - F_t)A_t}\Psi(Y_t(j)/A_t) = mc(Y_t(j), Y_t; A_t, F_t).$$

Firms maximise profits

$$\Pi^f_t(j) = p_t(j)Y_t(j) - w_t H_t(j)$$

subject to the production technology giving the first order condition

$$1 = mc(Y_t(j), Y_t; A_t, F_t) \tag{A.16}$$

for all j. In equilibrium there is a unique solution in which all firms supply the identical amount $Y_t(j) = Y_t = Y^n(A_t, F_t)$

A.3 Log-linear Approximation

Because the empirical analysis emphasizes the evolution of debt in response to variations in the structural surplus, we rewrite the evolution of government liabilities as

$$\begin{aligned} B_t^s &= (1+i_{t-1})B_{t-1}^s - M_t^s + M_{t-1}^s + P_t^g G_t^m - P_t^g G_{t-1}^m - P_t T_t + P_t F_t \\ &= (1+i_{t-1})B_{t-1}^s - \left(M_t^s - M_{t-1}^s - P_t^g G_t^m + P_t^g G_{t-1}^m + P_t T_t\right) + P_t F_t \\ &= (1+i_{t-1})B_{t-1}^s - P_t \bar{T}_t + P_t F_t \end{aligned}$$

where

$$P_t \bar{T}_t = P_t T_t + M_t^s - M_{t-1}^s - P_t^g G_t^m + P_t^g G_{t-1}^m$$

so that $\bar{T}_t$, in addition to representing taxes net of transfers to effects the required adjustments in money balances and the purchase and sale of gold for monetary purposes. This expression satisfies

$$b_t^s = (1+i_{t-1})\frac{P_{t-1}}{P_t} b_{t-1}^s - S_t$$

where we redefine the primary surplus as

$$S_t = \bar{T}_t - F_t.$$

Finally, redefine the state variable for debt such that $B_t = (1+i_t)B_t^s$ gives

$$\frac{b_t}{1+i_t} = \frac{P_{t-1}}{P_t} b_{t-1} - S_t$$

where $b_t = B_t/P_t$.

We look for an approximation in the neighborhood of steady state in which the relative prices P_t/P_{t-1} and $\bar{P}_t^g/P_t$ are in the neighborhood of unity, $1+i = \beta^{-1}$, and real variables are constant. Defining

$$\tilde{b}_t = \frac{b_t - b}{Y}; \quad \tilde{T}_t = \frac{\bar{T}_t - \bar{T}}{Y}; \text{ and } \quad \tilde{F}_t = \frac{F_t - F}{Y}$$

and

$$\pi_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \text{ and } \quad \hat{i}_t = \ln\left(\frac{1+i_t}{1+i}\right).$$

For all other variables Z_t, we have

$$\hat{z}_t = \log\left(\frac{Z_t}{Z}\right)$$

for steady state value Z.

This permits the first-order approximation

$$\tilde{b}_t = \beta^{-1}\tilde{b}_{t-1} + \beta^{-1}\delta(\hat{i}_t - \pi_t) - (\tilde{T}_t - \tilde{F}_t). \tag{A.17}$$

The real marginal cost function satisfies

$$\begin{aligned} \hat{mc}_t &= (\omega_p + \omega_w)(\hat{Y}_t^n - \hat{A}_t) - \hat{A}_t + \sigma_c^{-1}\hat{C}_t \\ &= \omega\hat{Y}_t^n - (1+\omega)\hat{A}_t + \sigma^{-1}(\hat{Y}_t^n - \tilde{F}_t) \\ &= 0 \end{aligned}$$

where $\sigma = s_c\sigma_c$, $s_c = \frac{C}{Y}$ and

$$\begin{aligned} \sigma_c &= \frac{U_c}{U_{cc}C} \\ \omega_p &= -\frac{f''f}{(f')^2} \\ \omega_w &= \frac{V_{hh}H}{V_h}\frac{f}{f'H}. \end{aligned}$$

It follows that

$$\hat{Y}_t^n = \frac{(1+\omega)\hat{A}_t + \sigma^{-1}\tilde{F}_t}{\omega + \sigma^{-1}}.$$

The log-linear approximation to the Euler equation provides

$$\hat{Y}_t^n = E_t\hat{Y}_{t+1}^n - \sigma(\hat{i}_t - \pi_{t+1}) + E_t(\tilde{F}_t - \tilde{F}_{t+1}) \tag{A.18}$$

which can be re-written as

$$\hat{i}_t = E_t\pi_{t+1} + r_t^n$$

where

$$r_t^n = \sigma^{-1}E_t[(\tilde{F}_t - \tilde{F}_{t+1}) - (\hat{Y}_t^n - \hat{Y}_{t+1}^n)].$$

In the absence of technology shocks and other shocks being *i.i.d.* we have

$$r_t^n = \frac{1}{\sigma + \omega^{-1}}\tilde{F}_t.$$

The model is then closed with assumptions on monetary and fiscal policy.

A log-linear approximation to the Euler equations for money and gold holdings provide

$$\beta E_t\pi_{t+1} + \varphi(1-\beta)\hat{m}_t = \sigma^{-1}\left(\hat{Y}_t^n - \tilde{F}_t\right) - \sigma^{-1}\beta E_t\left(\hat{Y}_{t+1}^n - \tilde{F}_{t+1}\right) \tag{A.19}$$

$$\hat{p}_t^g + \nu(1-\beta)\hat{G}_t^p = \beta E_t\hat{p}_{t+1}^g + \sigma^{-1}E_t\left(\left(\hat{Y}_t^n - \tilde{F}_t\right) - \beta\left(\hat{Y}_{t+1}^n - \tilde{F}_{t+1}\right)\right) \tag{A.20}$$

where

$$\hat{p}_t^g = \log\left(\frac{\bar{P}^g}{P_t}\right)$$

and

$$\varphi \equiv -\frac{U_{mm}}{U_m}m > 0 \text{ and } \nu \equiv -\frac{U_{gg}}{U_g}\bar{G}_m > 0$$

give the curvature of the utility function with respect to real money balances and gold holdings. A log-linear approximation to the market clearing condition for gold, the gold backing policy and the definition of inflation (given the fixed dollar price of gold) is

$$\hat{G}_t^p = (1+\theta_m)\,\hat{G}_t - \theta_m \hat{G}_t^m \tag{A.21}$$

$$\hat{p}_t^g + \hat{G}_t^m = \hat{m}_t \tag{A.22}$$

$$\pi_t = -\hat{p}_t^g + \hat{p}_{t-1}^g \tag{A.23}$$

where $\theta_m = G^m/G^p$, the steady state ratio of monetary to private gold. To close the model, an assumption must be made about tax policy, discussed further below.

The model of the gold standard is therefore given by equations (A.17)-(A.23) and the tax rule. These eight equations describe the evolution of

$$\left\{\pi_t, \hat{i}_t, \hat{m}_t, \hat{p}_t^g, \hat{G}_t^p, \hat{G}_t^m, \tilde{b}_t, \tilde{T}_t\right\}$$

as a function of exogenous disturbances

$$\left\{\hat{Y}_t^n, \tilde{F}_t, \hat{G}_t\right\}.$$

A.4 Proof of Result 1

Solving the model provides insight into the mechanics of monetary and fiscal policy under a gold standard. We show that both monetary and fiscal policy must be passive, accommodating required equilibrium adjustments in money balances and government debt.

For simplicity assume that government spending and gold supply are constant. Combining (A.21) and (A.22) gives

$$\hat{G}_t^p = -\theta_m(\hat{m}_t - \hat{p}_t^g).$$

Using this expression with (A.19) and (A.20) provides

$$(1+\nu\theta_m)\,\hat{p}_t^g = (\nu\theta_m + \varphi)\,\hat{m}_t$$

or

$$\hat{m}_t = \frac{(1+\nu\theta_m)}{(\varphi+\nu\theta_m)}\hat{p}_t^g. \tag{A.24}$$

Substituting this expression to eliminate money balances in (A.19) gives

$$\sigma\beta E_t\hat{Y}_{t+1}^n - \beta E_t\hat{p}_{t+1}^g = \sigma\hat{Y}_t^n - \beta\hat{p}_t^g - \varphi\,(1-\beta)\,\frac{(1+\nu\theta_m)}{(\varphi+\nu\theta_m)}\hat{p}_t^g. \tag{A.25}$$

a linear rational expectations model of $\hat{p}_t^g$. This equation can be solved using standard methods. Given a solution for $\hat{p}_t^g$, the variables $\left\{\pi_t, \hat{m}_t, \hat{G}_t^p, \hat{G}^m, \hat{i}_t, \tilde{b}_t\right\}$ follow directly.

Solving the difference equation forward, assuming the natural rate of output is an *i.i.d.* process, we have

$$\beta E_t \hat{p}^g_{t+1} + \sigma \hat{Y}^n_t = \left(\beta + \varphi\,(1-\beta)\,\frac{(1+\nu\theta_m)}{(\varphi+\nu\theta_m)}\right)\hat{p}^g_t$$

or

$$\hat{p}^g_t = \left(\beta + \varphi\,(1-\beta)\,\frac{(1+\nu\theta_m)}{(\varphi+\nu\theta_m)}\right)^{-1}\left(\beta E_t \hat{p}^g_{t+1} + \sigma \hat{Y}^n_t\right).$$

Because the eigenvalue must be less than unity we have a unique bounded rational expectations equilibrium of the form

$$\hat{p}^g_t = \sigma\left(\beta + \varphi\,(1-\beta)\,\frac{(1+\nu\theta_m)}{(\varphi+\nu\theta_m)}\right)^{-1}\hat{Y}^n_t.$$

Which means that $\log P_t$ is stationary with mean $\log \bar{P}^g$. This condition holds for all maintained parameter values.

The remaining variables can be solved immediately. Note that together the consumption and money Euler equations, (A.18) and (A.19), connect the evolution of interest rates to money balances. Interest rate policy must passively adjust to ensure the correct level of nominal and real money holdings. Finally note that for a bounded solution for government debt, we must restrict the evolution of taxes. In particular, for a tax rule

$$\tilde{T}_t = \gamma \tilde{b}_{t-1}$$

debt evolves according to

$$\tilde{b}_t = \left(\beta^{-1} - \gamma\right)\tilde{b}_{t-1} + \beta^{-1}\delta(\hat{i}_t - \pi_t).$$

For stability we must have the eigenvalue $\beta^{-1} - \gamma$ inside the unit circle. That is, taxes must be adjusted passively to stabilize the public debt. This result extends directly to a model with endogenous supply of output, nominal rigidities and long-term debt. Monetary and fiscal policy cannot achieve any desired price level under a gold standard. If taxes do not stabilize the public debt, there is no equilibrium. Debt grows without bound violating the household's transversality condition.

A.5 Impulse Response Functions

To approximate FDR's budgetary arrangements, let

$$\begin{aligned}\tilde{T}_t &= \tilde{T}^o_t + \tilde{T}^e_t \\ \tilde{F}_t &= \tilde{F}^o_t + \tilde{F}^e_t\end{aligned}$$

for ordinary and emergency taxes and spending. The flow budget constraint of the government is then

$$\tilde{b}_{t-1} = \beta\tilde{b}_t + (\tilde{T}^o_t + \tilde{T}^e_t - \tilde{F}^o_t - \tilde{F}^e_t) - \beta\delta\hat{i}_t + \delta\pi_t. \tag{A.26}$$

We assume that the "ordinary budget" is balanced each period, so that $T^o_t = F^o_t$ in both levels and deviations from steady state. This permits the budget identity to be expressed as

$$\tilde{b}_{t-1} = \beta\tilde{b}_t + (\tilde{T}^e_t - \tilde{F}^e_t) - \beta\delta\hat{i}_t + \delta\pi_t. \tag{A.27}$$

only the emergency primary surplus appears in the budget identity.

We posit an interest rate rule in log-linear form

$$\hat{i}_t = \phi \pi_t \tag{A.28}$$

Emergency fiscal variables, (T_t^e, F_t^e), are exogenous and taken to be *i.i.d.* for these derivations.

The model includes a Fisher equation

$$\hat{i}_t = r_t^n + E_t \pi_{t+1} \tag{A.29}$$

where

$$r_t^n \equiv \frac{1}{\sigma + \omega^{-1}} \tilde{F}_t = \frac{1}{\sigma + \omega^{-1}} (\tilde{F}_t^o + \tilde{F}_t^e) \tag{A.30}$$

is the exogenously given natural real rate of interest. Given the restrictions on preference parameters, higher government purchases always raise the natural rate of interest. Ordinary and emergency purchases have identical impacts on r^n.

With emergency taxes and spending exogenous, identity (A.27) is a stable difference equation in real debt when solved forward. Use (A.28) to replace the nominal interest rate, iterate forward, and impose the transversality condition to yield

$$\tilde{b}_{t-1} = \sum_{j=0}^{\infty} \beta^j E_t \left[\tilde{T}_{t+j}^e - \tilde{F}_{t+j}^e + \delta(1 - \beta\phi) \pi_{t+j} \right] \tag{A.31}$$

i.i.d. emergency fiscal variables reduce the expected present value of primary surpluses to only the current surplus, $T_t^e - F_t^e$. To solve for expected inflation rates, combine (A.28) with (A.29) to yield an expression for the one-step-ahead inflation rate

$$E_t \pi_{t+1} = \phi \pi_t - r_t^n$$

which generalizes to

$$E_t \pi_{t+j} = \phi^j \pi_t - \phi^{j-1} r_t^n$$

We now can express

$$\delta(1 - \beta\phi) \sum_{j=0}^{\infty} \beta^j E_t \pi_{t+j} = \delta(\pi_t - \beta r_t^n) \tag{A.32}$$

Use this solution in (A.31) to solve for equilibrium inflation

$$\begin{aligned} \pi_t &= \frac{1}{\delta} \tilde{b}_{t-1} - \frac{1}{\delta} (\tilde{T}_t^e - \tilde{F}_t^e) + \frac{\beta}{\sigma + \omega^{-1}} (\tilde{F}_t^o + \tilde{F}_t^e) \\ &= \underbrace{\frac{\beta}{\sigma + \omega^{-1}} (\tilde{F}_t^o + \tilde{F}_t^e)}_{\text{Keynesian hydraulics}} + \underbrace{\frac{\beta}{\delta} (\tilde{F}_t^e - \tilde{T}_t^e) + \frac{1}{\delta} \tilde{b}_{t-1}}_{\text{wealth effects}} \end{aligned} \tag{A.33}$$

where we used (A.30) to replace the natural rate of interest with the sum of ordinary and emergency purchases.

Turning to debt dynamics, use (A.28) in (A.27) to obtain this form of the budget identity

$$\tilde{b}_t = \beta^{-1} \tilde{b}_{t-1} - \beta^{-1} (\tilde{T}_t^e - \tilde{F}_t^e) - \delta(\beta^{-1} - \phi) \pi_t$$

and substitute for equilibrium inflation from (A.33) to yield

$$\begin{aligned}\tilde{b}_t &= \phi\tilde{b}_{t-1} - \phi(\tilde{T}_t^e - \tilde{F}_t^e) - \left(\frac{1-\beta\phi}{\delta(\sigma+\omega^{-1})}\right)(\tilde{F}_t^o + \tilde{F}_t^e) \\ &= \underbrace{-\frac{\delta(1-\beta\phi)}{\sigma+\omega^{-1}}(\tilde{F}_t^o + \tilde{F}_t^e)}_{\text{Keynesian hydraulics}} + \underbrace{\beta\phi(\tilde{F}_t^e - \tilde{T}_t^e) + \phi\tilde{b}_{t-1}}_{\text{wealth effects}} \end{aligned} \tag{A.34}$$

establishing Result 5. The multiplier effects for different fiscal variables follow immediately.

To establish Result 6 note that

$$\begin{aligned}\frac{\partial\pi_t}{\partial F_t^o} &= \frac{\beta}{\sigma+\omega^{-1}} \\ \frac{\partial\pi_{t+j}}{\partial F_t^o} &= -\frac{1-\beta\phi}{\sigma+\omega^{-1}}\phi^{j-1}\end{aligned}$$

where the second condition holds for $j > 0$. The price effect of emergency spending is then given by summing the inflation changes

$$\begin{aligned}\sum_{j=0}^{\infty}\frac{\partial\pi_{t+j}}{\partial F_t^e} &= \sum_{j=0}^{\infty}\left(\frac{\partial\pi_{t+j}}{\partial F_t^o} - \frac{\partial\pi_{t+j}}{\partial T_t^e}\right) \\ &= \frac{\beta}{\sigma+\omega^{-1}} - \frac{1-\beta\phi}{\sigma+\omega^{-1}}\sum_{j=1}^{\infty}\phi^{j-1} + \frac{\beta}{\delta}\sum_{j=0}^{\infty}\phi^j \\ &= \frac{\beta}{\sigma+\omega^{-1}} - \frac{1-\beta\phi}{\sigma+\omega^{-1}}\frac{1}{1-\phi} + \frac{\beta}{\delta}\frac{1}{1-\phi}.\end{aligned}$$

It is straightforward to show that for the final expression to be positive requires satisfaction of the stated condition in Result 6.

B Data Details

B.1 Emergency Expenditures

Table B.1 shows the three main categories of emergency expenditures: public works, relief, and other spending.

The first category, public works, doubled under Roosevelt from record highs under Hoover. These expenditures consisted of public highways, Hoover dam, reclamation projects, improvements of rivers and harbors, flood control, and the Tennessee Valley Authority.

Relief spending—the second category of emergency expenditures—comprised the largest category in most years and was a mixture of direct relief and works projects. The Federal Emergency Relief Administration (FERA) was established in May 1933 and totaled $3.1 billion from 1934 to 1936, replacing many of the relief efforts of Hoover's January 1932

Reconstruction Finance Corporation (RFC).[1,2,3,4]

"Other emergency spending"—the third category—includes grants to the Agricultural Adjustment Administration for farm subsidies aimed at raising agricultural prices, RFC loans, and other farm and housing assistance including the Home Owners' Loan Corporation created in June 1933 to assume mortgage debt of distressed homeowners amounting to $3.1 billion [Studenski and Krooss (1952, p. 417)].

Finally, table B.1 shows that regular operating expenditures were lower under Roosevelt than Hoover in all years except 1936 when the veterans' bonus was paid out [Hausman (2016)]. Although there were cuts to regular operating expenditures, the shifting of existing RFC and public works expenditures to the emergency category starting in 1934 largely account for the lower level [Annual Report of the Secretary of the Treasury (1934, p. 5)].[5]

	Hoover				Roosevelt			
	1930	**1931**	**1932**	**1933**	**1934**	**1935**	**1936**	**1937**
Regular Operating	2927.5	3028.4	3231.3	2879.4	2348.7	2676.9	4743.2	3746.0
Social Security	0	0	0	0	0	0	28.4	447.7
Total Emergency	414.4	642.5	1509.7	1801.9	4396.5	4125.4	3704.6	3802
Public Works	256.5	404.1	478.7	458.7	613.1	762.7	912.5	1079.4
Relief	0	0	0	359.5	1852.8	2360.9	2342.4	2466.8
Other	157.9	238.4	1031.0	983.7	1930.6	1001.8	449.7	255.8
Total Expenditures	3341.9	3670.9	4741.0	4681.3	6745.2	6802.3	8476.3	7995.7

Table B.1: Federal expenditures by category, millions of dollars. Total expenditures exclude debt and railroad retirements. Emergency expenditures in this table contain some regular expenditures resulting in totals that are 10 to 30 percent higher than the official emergency expenditures listed in table 1. The "other emergency expenditures" category includes net loans, subscriptions to stock and surplus, and the agricultural adjustment program. Source: Annual Report of the Secretary of the Treasury (p. 354, 1937).

[1]While the RFC lent primarily to states, public entities, and distressed financial institutions, the FERA made direct grants to states who used the proceeds for relief programs including sanitation improvements, repair or construction of public buildings, national park improvements, and financial assistance to troubled farmers [Studenski and Krooss (1952, pp. 374, 411) and Fishback, Kantor, and Wallis (2003)].

[2]In contrast to FERA, the Civil Works Administration (CWA) operated directly under the federal government and focused on works projects such as sewer pipes, roads, schools, playgrounds, and airports as well providing work to teachers, writers, and artists [https://slate.com]. From 1934 to 1935, the CWA had $1 billion in federal relief expenditures and employed 4 million workers.

[3]The Works Progress Administration (WPA) also focused on work relief by spending $8.1 billion between 1936 and 1940 and employing 2.2 million workers per year on average for projects that included highways, reforestation, and rural rehabilitation [Studenski and Krooss (1952, p. 412)].

[4]The Civilian Conservation Corps (CCC) spent $2.5 billion to employ 3 million from 1933 to 1942 on natural resources conservation [Annual Report of the Secretary of the Treasury (1940, p. 27)].

[5]Even though the Economy Act of 1933 cut $243 million of regular operating expenditures by reducing the pay of federal workers by 15 percent and decreasing veterans' benefits by 10 percent, Congress eventually restored most of the pay cuts which unwound the budgetary savings [Studenski and Krooss (1952, p. 404)].

B.2 Net Interest

B.2.1 Interest Receipts This section details our sources and calculation of monthly net interest. Interest receipts are only available on a yearly basis in the *Annual Report of the Secretary of the Treasury on the State of the Finances*. From 1928 to 1940, we use the total of series called "Interest, exchange, and dividends on capital stock" or "Total interest, exchange, dividends" computed from the unrevised daily Treasury statements.[6] Disaggregated components of this series are available in tables based on warrants issued or revised daily Treasury statements.[7]

In 1927, interest receipts are only available based on warrants issued. Although the aggregate total of "Interest, premium, and discount" is no longer provided, the disaggregated elements of this total are included. We continue to included dividends, premiums, discounts, and exchanges to be consistent with the years when only the aggregate series is available.

[6] From 1928 to 1933, we use total interest receipts which is the sum of general and special funds categories.

[7] On Page 389 of the 1928 Annual Report, daily Treasury statements (unrevised) are defined as figures compiled "from the latest daily reports received by the Treasurer of the United States, from Treasury officers, and public depositaries holding Government funds. The daily Treasury statement, therefore, is a current report compiled from latest available information, and, by reason of the promptness with which the information is obtained and made public, it has come into general use as reflecting the financial operations of the Government covering a given period, and gives an accurate idea of the actual condition of the Treasury as far as it is ascertainable from day to day. This is known as 'current cash basis,' according to daily Treasury statements (unrevised)." Revised Treasury statements reflect actual transactions during the period under review. Page 373 of the 1929 annual report explains that receipts and expenditures are revised "on account of the distance of some of the Treasury offices and depositaries from the Treasury, it is obvious that the report from all officers covering a particular day's transactions can not be received and assembled in the Treasury at one time without delaying for several days the publication of the Treasury statement." Warrants issued (receipts) are defined based on Section 305 of the Revised Statues as, "receipts for all moneys received by the Treasurer of the United States shall be indorsed upon warrants signed by the Secretary of the Treasury, without which warrants, so signed, no acknowledgment for money received into the Public Treasury shall be valid. The issuance of warrants by the Secretary of the Treasury, as provided by law, represents the formal covering of receipts into the Treasury." Warrants issued (expenditures) are defined by the fact that, "The Constitution of the United States provides that no money shall be drawn from the Treasury but in consequence of appropriations made by law. Section 305 of the Revised Statutes requires that the Treasurer of the United States shall disburse the moneys of the United States upon warrants drawn by the Secretary of the Treasury. As the warrants are issued by the Secretary they are charged against the appropriate appropriations provided by law. Some of these warrants do not represent actual payments to claimants, but are merely advances of funds to be placed to the credit of disbursing officers of the Government with the Treasurer of the United States for the payment of Government obligations. The disbursing officer then issues his check on the Treasurer in payment of such obligations. As far as the appropriation accounts are concerned, the warrants issued and charged thereto constitute expenditures, but it will be observed that such expenditures necessarily include unexpended balances to the credit of the disbursing officers. Under normal conditions these balances over a period of several years fluctuate very little in the aggregate, and the difference between the total expenditures on a warrant basis and a cash basis (revised) is immaterial.

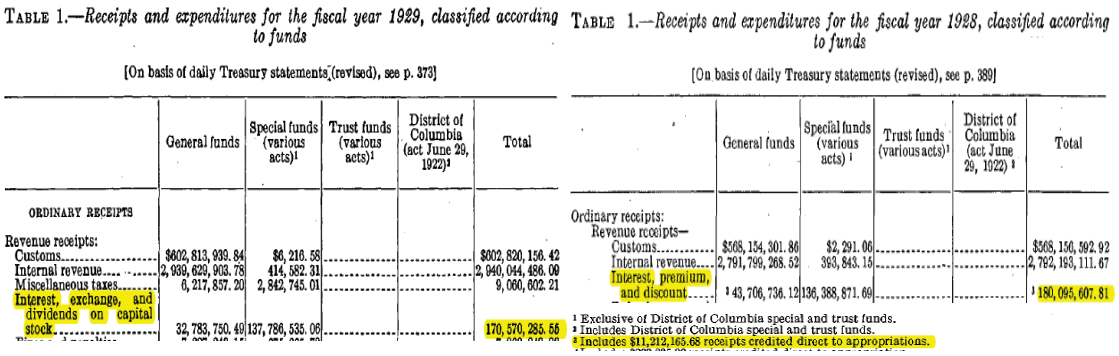


TABLE 1.—*Receipts and expenditures for the fiscal year 1929, classified according to funds*

[On basis of daily Treasury statements (revised), see p. 373]

	General funds	Special funds (various acts)[1]	Trust funds (various acts)[1]	District of Columbia (act June 29, 1922)[2]	Total
ORDINARY RECEIPTS					
Revenue receipts:					
Customs	$602,813,939.84	$6,216.58			$602,820,156.42
Internal revenue	2,939,629,903.78	414,582.31			2,940,044,486.09
Miscellaneous taxes	6,217,857.20	2,842,745.01			9,060,602.21
Interest, exchange, and dividends on capital stock	32,783,750.49	137,786,535.06			170,570,285.55

TABLE 1.—*Receipts and expenditures for the fiscal year 1928, classified according to funds*

[On basis of daily Treasury statements (revised), see p. 389]

	General funds	Special funds (various acts)[1]	Trust funds (various acts)[1]	District of Columbia (act June 29, 1922)[2]	Total
Ordinary receipts:					
Revenue receipts—					
Customs	$568,154,301.86	$2,291.06			$568,156,592.92
Internal revenue	2,791,799,268.52	393,843.15			2,792,193,111.67
Interest, premium, and discount	[3] 43,706,736.12	136,388,871.69			[3] 180,095,607.81

[1] Exclusive of District of Columbia special and trust funds.
[2] Includes District of Columbia special and trust funds.
[3] Includes $11,212,165.68 receipts credited direct to appropriations.

(a) 1929, page 374 (b) 1928, page 391

Figure B.1: Annual Reports

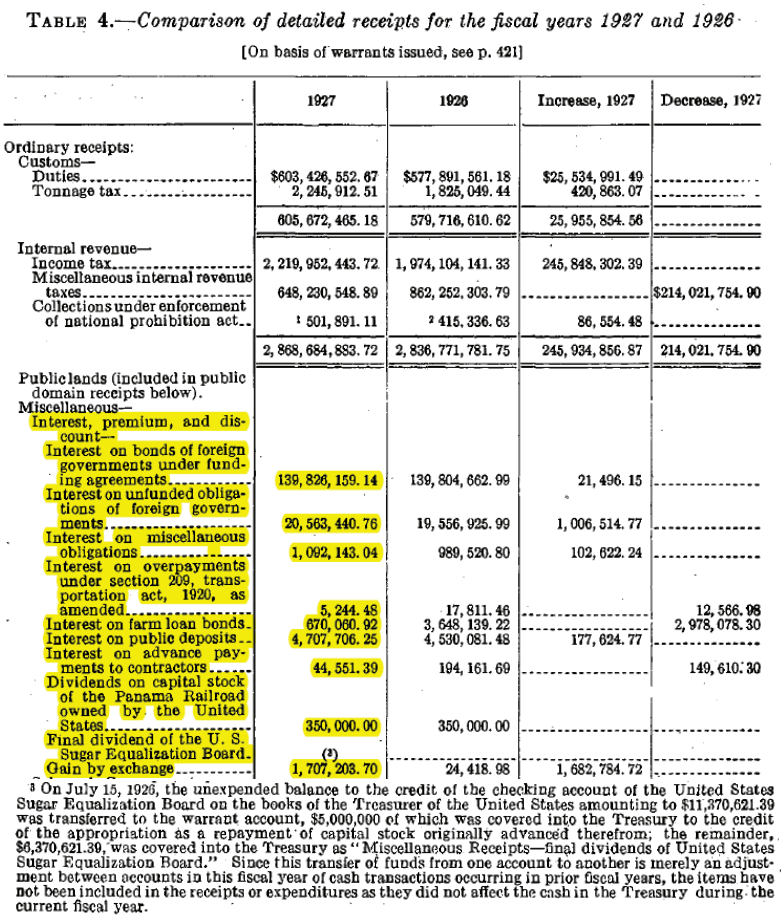


TABLE 4.—*Comparison of detailed receipts for the fiscal years 1927 and 1926*

[On basis of warrants issued, see p. 421]

	1927	1926	Increase, 1927	Decrease, 1927
Ordinary receipts:				
Customs—				
Duties	$603,426,552.67	$577,891,561.18	$25,534,991.49	
Tonnage tax	2,245,912.51	1,825,049.44	420,863.07	
	605,672,465.18	579,716,610.62	25,955,854.56	
Internal revenue—				
Income tax	2,219,952,443.72	1,974,104,141.33	245,848,302.39	
Miscellaneous internal revenue taxes	648,230,548.89	862,252,303.79		$214,021,754.90
Collections under enforcement of national prohibition act	[1] 501,891.11	[2] 415,336.63	86,554.48	
	2,868,684,883.72	2,836,771,781.75	245,934,856.87	214,021,754.90
Public lands (included in public domain receipts below).				
Miscellaneous—				
Interest, premium, and discount—				
Interest on bonds of foreign governments under funding agreements	139,826,159.14	139,804,662.99	21,496.15	
Interest on unfunded obligations of foreign governments	20,563,440.76	19,556,925.99	1,006,514.77	
Interest on miscellaneous obligations	1,092,143.04	989,520.80	102,622.24	
Interest on overpayments under section 209, transportation act, 1920, as amended	5,244.48	17,811.46		12,566.98
Interest on farm loan bonds	670,060.92	3,648,139.22		2,978,078.30
Interest on public deposits	4,707,706.25	4,530,081.48	177,624.77	
Interest on advance payments to contractors	44,551.39	194,161.69		149,610.30
Dividends on capital stock of the Panama Railroad owned by the United States	350,000.00	350,000.00		
Final dividend of the U. S. Sugar Equalization Board	[3]			
Gain by exchange	1,707,203.70	24,418.98	1,682,784.72	

[1] On July 15, 1926, the unexpended balance to the credit of the checking account of the United States Sugar Equalization Board on the books of the Treasurer of the United States amounting to $11,370,621.39 was transferred to the warrant account, $5,000,000 of which was covered into the Treasury to the credit of the appropriation as a repayment of capital stock originally advanced therefrom; the remainder, $6,370,621.39, was covered into the Treasury as "Miscellaneous Receipts—final dividends of United States Sugar Equalization Board." Since this transfer of funds from one account to another is merely an adjustment between accounts in this fiscal year of cash transactions occurring in prior fiscal years, the items have not been included in the receipts or expenditures as they did not affect the cash in the Treasury during the current fiscal year.

Figure B.2: 1927 Annual Report, page 431

Starting in 1922, interest receipts, premiums, discounts, and exchanges are no longer given as separate categories. The components of federal receipts are listed alphabetically.[8]

Comparison of receipts, fiscal years 1922 and 1921, on the basis of warrants issued (net).

	1922	1921	Increase, 1922.	Decrease, 1922.
Customs	$357,544,712.40	$308,025,102.17	$49,519,610.23	
Internal revenue:				
Income and profits taxes	2,086,918,464.85	3,228,137,673.75		$1,141,219,208.90
Miscellaneous	1,121,239,843.45	1,351,835,935.31		230,596,091.86
Sales of public lands	895,391.22	1,530,439.42		635,048.20
Alaska fund	136,053.10	174,329.90		38,276.80
Assessments on Federal reserve banks for salaries, etc.	3,067,169.36	4,819,339.72		1,752,170.36
Assessments on national banks for expenses of examiners	2,012,600.00	1,583,037.11	429,562.89	
Consular fees	6,707,058.72	5,676,850.61	1,030,208.11	
Customs fees, fines, penalties, services of officers, etc.	1,032,589.34	1,173,285.63		140,696.29
Commerce collections	239,432.57	305,904.84		66,472.27
Donation of royalty on machine guns		520,266.12		520,266.12
Depredations on public lands	60,140.90	68,646.25		8,496.35
Deposits for surveying public lands	68,461.03	62,324.51	6,136.52	
District of Columbia general receipts	14,777,218.19	14,439,983.93	337,232.26	
District of Columbia sources	457,798.25	561,106.29		103,308.04
Discount on bonds, notes, and certificates purchased	3,436,145.91	10,675,194.55		7,239,048.64
Earnings on radio service	369,735.67	666,371.84		296,636.17
Federal land banks, liquidation of capital stock	1,057,830.00	954,835.00	102,995.00	
Food Administration		37,078,988.55		37,078,988.55
Forest Service, cooperative fund	1,394,826.71	1,946,041.18		551,214.47
Fees on letters patent	2,875,013.15	2,606,502.46	175,510.69	
Forest reserve fund	5,125,668.20	2,591,297.93	2,534,370.27	
Franchise tax (surplus earnings of Federal reserve banks)	59,974,465.64	60,724,742.27		750,276.63
Funds contributed for river and harbor improvements	2,930,051.68	3,774,947.68		844,896.00
Gain by exchange	7,245,624.49	19,008.08	7,226,616.41	
Grain Corporation, decrease of capital stock	25,000,000.00	100,000,000.00		75,000,000.00
Housing Corporation, operations and disposal of properties	4,523,207.53	4,240,055.17	283,152.36	
Farm loan bonds:				
Principal	44,400,000.00		44,400,000.00	
Interest	8,611,170.08	8,306,075.00	305,095.08	
Foreign loans:				
Principal	49,114,107.46	83,678,223.38		34,564,115.92
Interest	6,607,723.54	18,327,306.91		11,719,583.37
Interest on foreign obligations, sale of surplus property, War Department	21,107,317.25	12,701,508.93	8,405,808.32	
Interest on public deposits	7,388,278.07	5,668,852.42	1,719,425.65	
Interest on loans to railroad companies	[1] 3,000.00	[2] 84,000.00		81,000.00
Interest on advance payments to contractors	14,300.29	667,383.05		653,082.76
Immigrant fund	2,517,823.19	5,767,893.69		3,250,070.50
Judicial fees, fines, penalties, etc.	5,132,937.71	4,382,676.51	750,261.20	
Land fees	1,139,880.25	1,753,759.83		613,879.58

[1] Exclusive of $12,906,960.89 interest received on account of loans to railroads under section 210 of the transportation act of 1920, and $27,324,181.14 interest collected under the provisions of the Federal control act of Mar. 21, 1918, which amounts were credited, respectively, to the revolving funds, "Loans to railroads" and "Federal control of transportation systems."

[2] Exclusive of $4,369,607.49 interest received on account of loans to railroads under sec. 210 of the transportation act of 1920, and $26,415,163.88 interest collected under the provisions of the Federal control act of Mar. 21, 1918, which amounts were credited, respectively, to the revolving funds, "Loans to railroads" and "Federal control of transportation systems."

Figure B.3: 1922 Annual Report, page 107

Interest receipts on foreign obligations—a subset of total interest receipts—are available on an unrevised cash basis. This data is also available at a monthly frequency for fiscal years 1929 to 1931 and 1936 to 1940. The location of these data is included in Table B.2.

[8]Net warrants issued includes unexpended balances to the credit of disbursing officers at the end of the year, but not expenditures under such unexpended balances at the beginning of the year.

Table name	Year	Basis	Page no.
Comparison of receipts, fiscal years 1920 and 1919	1920	warrant	262/263
Comparison of receipts, fiscal years 1921 and 1920	1921	warrant	140
Receipts and exp. for fiscal years 1920 and 1921 (int. on foreign obl.)		unrevised	152
Comparison of receipts, fiscal years 1922 and 1921	1922	warrant	107
Receipts and exp. for fiscal years 1921 and 1922 (int. on foreign obl.)		unrevised	100
Comparison of receipts, fiscal years 1923 and 1922	1923	warrant	114
Receipts and exp. for fiscal years 1922 and 1923 (int. on foreign obl.)		unrevised	107
Comparison of receipts, fiscal years 1924 and 1923	1924	warrant	131
Receipts and exp. for fiscal years 1923 and 1924 (int. on foreign obl.)		unrevised	123
Comparison of receipts, fiscal years 1925 and 1924	1925	warrant	150
Receipts and exp. for fiscal years 1924 and 1925 (int. on foreign obl.)		unrevised	141
Comparison of receipts, fiscal years 1926 and 1925	1926	warrant	429
Receipts and exp. for fiscal years 1925 and 1926 (int. on foreign obl.)		unrevised	176
Comparison of receipts, fiscal years 1927 and 1926	1927	warrant	431
Receipts and exp. for fiscal years 1926 and 1927 (int. on foreign obl.)		unrevised	30
Receipts and expenditures for the fiscal year 1928	1928	revised	391
Receipts and exp. for the fiscal year 1928 (int. on foreign obligations)		unrevised	19
Receipts and expenditures for the fiscal year 1929	1929	revised	375
Receipts and exp. for the fiscal year 1929 (int. on foreign obligations)		unrevised	20
Ordinary Receipts (monthly) (foreign obligations)		unrevised	535
Receipts and exp. for the fiscal year 1930	1930	revised	469
Receipts and exp. for the fiscal year 1930 (int. on foreign obligations)		unrevised	35
Ordinary Receipts (monthly) (foreign obligations)		unrevised	631
Receipts and exp. for the fiscal year 1931	1931	warrant	426
Receipts and exp. for the fiscal year 1931 (int. on foreign obligations)		unrevised	25
Receipts and exp., by months (foreign obligations)		unrevised	575
Receipts and expenditures for the fiscal year 1932	1932	warrant	341
Receipts and exp. for the fiscal year 1932 (int. on foreign obligations)		unrevised	27
Details of receipts by sources and funds, for the fiscal year 1933	1933	warrant	310
Receipts and exp. for the fiscal year 1933 (int. on foreign obligations)		unrevised	19
Details of receipts by sources and funds, for the fiscal year 1934	1934	warrant	276
Receipts and exp. for the fiscal year 1934 (int. on foreign obligations)		unrevised	20
Details of receipts by sources and funds, for the fiscal year 1935	1935	warrant	296
Receipts and exp. for the fiscal year 1935 (int. on foreign obligations)		unrevised	32
Details of receipts by sources and funds, for the fiscal year 1936	1936	warrant	314
Receipts and exp. for the fiscal year 1935 (int. on foreign obligations)		unrevised	35
Classified receipts and expenditures, monthly		unrevised	339/344
Actual receipts for the fiscal year 1937	1937	warrant	380
Classified receipts and expenditures for the fiscal years 1932 to 1937		unrevised	338
Classified receipts and exp., monthly (int. on foreign obligations)		unrevised	320/326
Actual receipts for the fiscal year 1937	1938	warrant	457
Classified receipts and expenditures for the fiscal years 1932 to 1938		unrevised	401
Classified receipts and exp., monthly (int. on foreign obligations)		unrevised	379/387
Details of receipts, by sources and accounts	1939	warrant	314
Classified receipts and exp., monthly (int. foreign obligations)		unrevised	337/345
Details of receipts, by sources and accounts.	1940	warrant	587
Classified receipts and exp., monthly (int. foreign obligations)		unrevised	612/619

Table B.2: Table names and page numbers from the *Annual Reports of the Secretary of the Treasury* for interest receipts

B.2.2 Interest Expenditures Interest expenditures are available on a monthly basis starting in January 1922. For July 1919 to December 1921, interest expenditures are available on a quarterly frequency. We divide the quarterly data by three to interpolate monthly data for this time period.

Table name	Year	Page number
Preliminary Statement Showing Classified Expenditures (quarterly)...	1920	see 1921 357
Receipts and expenditures of the Government for fiscal (yearly)...		see 1926 448
Preliminary Statement Showing Classified Expenditures (quarterly)...	1921	357
Receipts and expenditures of the Government for fiscal (yearly)...		see 1926 448
Preliminary Statement Showing Classified Expenditures (monthly)...	1922	103
Receipts and expenditures of the Government for fiscal (yearly)...		see 1926 448
Preliminary Statement Showing Classified Expenditures (monthly)...	1923	110
Receipts and expenditures for fiscal years 1922 and 1923 (yearly)		107
Preliminary Statement Showing Classified Expenditures (monthly)...	1924	127
Receipts and expenditures for fiscal years 1923 and 1924 (yearly)		123
Preliminary Statement Showing Classified Expenditures (monthly)...	1925	145
Receipts and expenditures for fiscal years 1924 and 1925 (yearly)		142
Expenditures of the Government, by months for the fiscal year 1926	1926	452
Receipts and expenditures of the Government for fiscal years (yearly)		450
Expenditures by months, classified according to...	1927	463
Ordinary receipts, expenditures chargeable against... (yearly)		448
Expenditures by months, classified according to...	1928	425
Receipts and expenditures for the fiscal year 1928		19
Expenditures by months, classified according to...	1929	414
Receipts and expenditures for the fiscal year 1929 (yearly)		20
Expenditures by months, classified according to...	1930	510
Receipts and expenditures for the fiscal year 1930 (yearly)		35
Expenditures by months, classified according to...	1931	464
Ordinary receipts, expenditures chargeable against... (yearly)		446
Expenditures by months, classified according to...	1932	371
Receipts and expenditures for the fiscal year 1932 (yearly)		27
Expenditures by months, classified according to...	1933	313
Receipts and expenditures for the fiscal year 1933 (yearly)		280
Expenditures by months, classified according to...	1934	308
Receipts and expenditures for the fiscal year... (yearly)		305
Expenditures by months, classified according to...	1935	330
Expenditures by months, classified according to (yearly)...		334
Classified receipts and expenditures, monthly	1936	337
Classified receipts and expenditures, monthly (yearly)		339
Classified receipts and expenditures, monthly	1937	322/328
Classified receipts and expenditures, monthly (yearly)		328
Classified receipts and expenditures, monthly	1938	381/389
Classified receipts and expenditures, monthly (yearly)		389
Classified receipts and expenditures, monthly	1939	339/347
Classified receipts and expenditures, monthly (yearly)		347
Classified receipts and expenditures, monthly	1940	614/621
Classified receipts and expenditures, monthly (yearly)		621

Table B.3: Table names and page numbers from the *Annual Reports of the Secretary of the Treasury* for interest expenditures on an unrevised basis.

B.2.3 Calculating Monthly Net Interest

Because interest receipts are only available at a yearly frequency, our monthly series of net interest is imputed. We first calculate the ratio of yearly interest receipts to yearly interest expenditures and then multiply this ratio by monthly interest expenditures to impute monthly interest receipts for month t,

$$\text{Imputed Monthly Interest Receipts}_t = \frac{\text{Yearly Interest Receipts}}{\text{Yearly Interest Expenditures}} \times \text{Monthly Interest Expenditures}_t$$

Monthly net interest is then calculated as

$$\text{Imputed Monthly Net Interest}_t = \text{Monthly Interest Expenditures}_t - \text{Imputed Monthly Interest Receipts}_t$$

B.3 Federal Receipts and Expenditures

This section documents the differences between monthly federal receipts and expenditures used in other sources and those we construct from the *Annual Reports of the Secretary of the Treasury on the State of Finances*. The other sources are the chapter 15 of the NBER Macro History Database (NBER), Firestone's (1960) book, and Romer (1992) who uses the 1979 *Statistical Appendix to the Annual Report*, table 2, pp. 4-11. Additionally, aggregating our monthly series to a yearly frequency does not always match corresponding yearly series given elsewhere in the annual reports and we document these differences.

Figure B.4 shows our series of receipts and expenditures from July 1919 to June 1940 aggregated by fiscal year—July 1 of the previous year through June 30 of the current year.[9] Although these series are given on an unrevised cash basis, the expenditure series are revised in the 1933 annual report to "cover all expenditures of the Reconstruction Finance Corporation, including payments against credits established for the corporation through the purchase of its notes under section 9 of the Reconstruction Finance Corporation Act."[10]

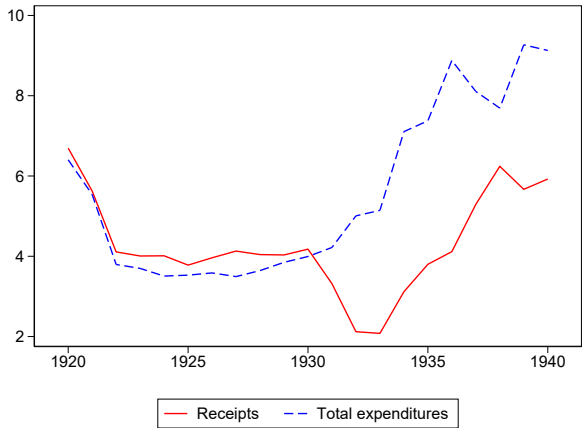


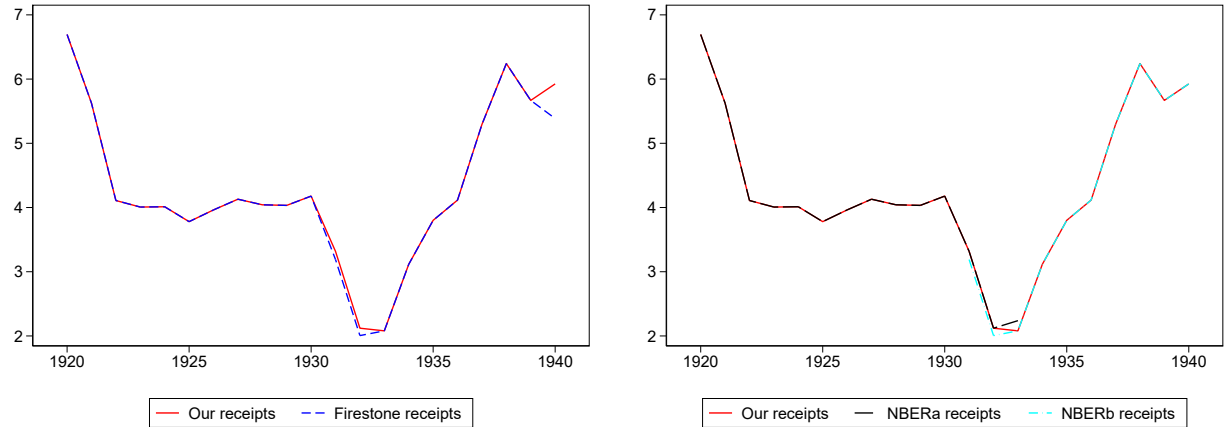
Figure B.4: Federal receipts and total expenditures aggregated by fiscal year, billions of dollars. Source: Department of the Treasury (various). See table B.4 for details.

[9] For example, the 1933 fiscal year is July 1, 1932 to June 30, 1933.

[10] See footnote 7 of this appendix for an explanation of accounting conventions. See footnote 1, Table 6, page 312 of *Annual Report of the Secretary of the Treasury on the State of the Finances for Fiscal year ended June 30, 1933* for the Reconstruction Finance Corporation revisions.

B.3.1 Federal Receipts Differences across and within sources of federal receipts are generally quite small.

Figure B.5 shows the receipts series across sources. Panel B.5a shows that receipts from Firestone (1960) match our series except for fiscal years 1931, 1932, and 1940.[11] Receipts from the NBER is split into three series a, b, and c. Panel B.5b shows that the NBERa series matches our series up to fiscal year 1932. The NBERb series matches that of Firestone (1960) for fiscal years 1931 and 1932 and then tracks our series through fiscal year 1940.[12]



(a) Comparing receipts to Firestone (1960) (b) Comparing receipts to the NBER

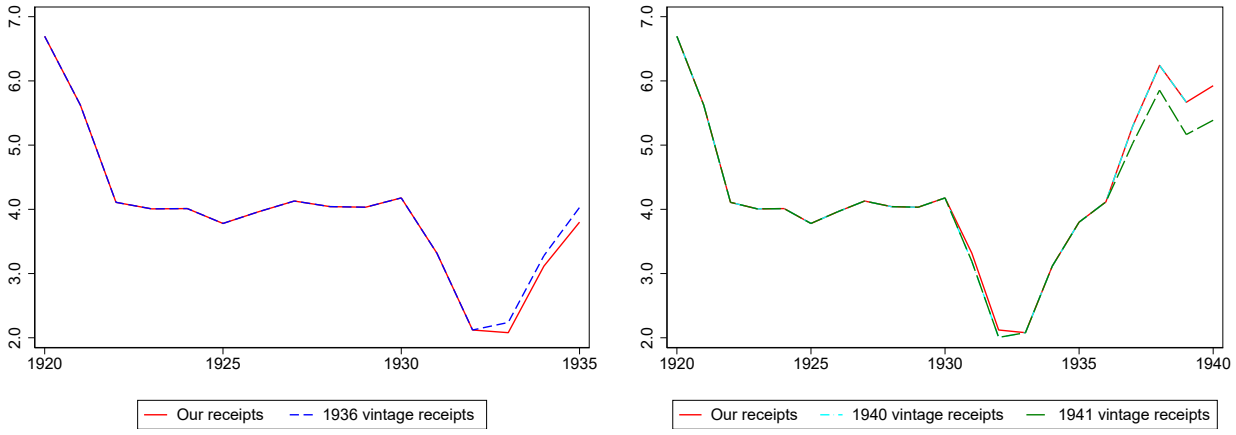
Figure B.5: Federal receipts aggregated by fiscal year, billions of dollars. Source: Department of the Treasury (various). See table B.4 for details; Firestone (1960); NBER Macrohistory database (m15004a, m15004b).

Within the annual reports, yearly totals of monthly receipts do not always match the yearly totals given in other tables, as shown in figure B.6. Although the yearly data is often revised, the monthly is not. Panel B.5a shows that yearly receipts are revised in the 1936 annual report which results in our series of aggregated monthly receipts being slightly lower from 1933 onward. Yearly receipts are revised in the 1940 and 1941 annual reports as shown in panel B.6b. The 1940 vintage of receipts was mostly revised downwards for fiscal years 1931 through 1935 and then matches our series from fiscal years 1933 through 1939. In the 1941 vintage, annual receipts were revised downwards for fiscal years 1937 through 1940.[13]

[11] Firestone (1960, p. 80) explains that trust fund receipts were eliminated from internal revenue after June 1932 and his series take into a account this revision back to July 1930. Firestone (1960, p. 82) also deducts net transfers from the Federal Old-Age and Survivors Insurance Trust Fund resulting in lower monthly receipts for fiscal year 1940.

[12] Like the series from Firestone (1960), the NBERb series also takes into account the elimination of trust fund receipts. The NBERc series (not shown) also deducts net transfers from the Federal Old-Age and Survivors Insurance Fund and thus tracks Firestone (1960) for fiscal year 1940.

[13] Footnote 14 on Page 649 of the 1940 Annual Report explains that: "In the fiscal year 1941 amounts representing appropriations equal to 'Social Security-Unemployment taxes' collected and deposited as provided under sec. 201 (a) of the Social Security Act Amendments of 1939, less reimbursements to the General Fund for administrative expenses, are deducted on the daily Treasury statement from total receipts. Such net amounts are reflected under trust account receipts as net appropriations to the Federal old-age and survivors insurance trust fund. The fiscal years 1937, 1938, and 1939, have been revised in this statement to reflect similar treatment. Fiscal year 1940 figures are also on this revised basis."



(a) Receipts, 1936 vintage

(b) Receipts, 1940 and 1941 vintages

Figure B.6: Federal receipts aggregated by fiscal year, billions of dollars. Source: Department of the Treasury (various). See table B.4 for details.

B.3.2 Federal Expenditures Relative to federal receipts, federal expenditures are much more likely to vary across and within sources and are subject to larger revisions.

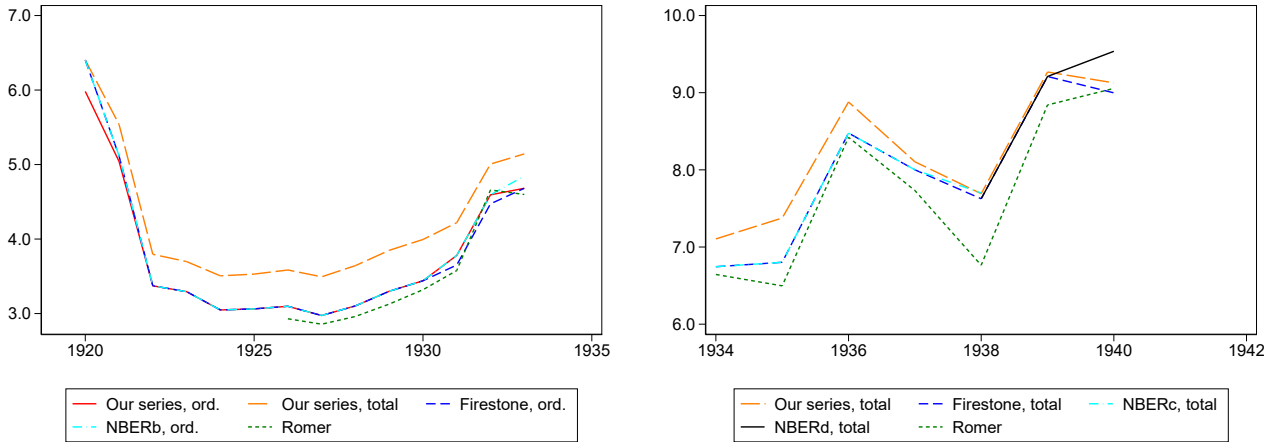
Figure B.7 shows a comparison of federal expenditures across sources. We use total expenditures in all analysis while other sources instead use ordinary expenditures until 1934 and total expenditures thereafter. Ordinary expenditures are a subset of total expenditures and exclude both public debt retirements for the period shown and purchase obligations of foreign governments for fiscal years 1920 to 1926. Panel B.7a shows that ordinary expenditures are, on average, roughly 13 percent lower than total expenditures until fiscal year 1934. Furthermore, panel B.7a shows that our series of ordinary expenditures closely tracks those of Firestone (1960) and the NBER.[14] Romer's (1992) series is actually ordinary outlays which are slightly different from expenditures and accounts for the series being almost always lower than our series and the others.[15]

Starting in fiscal year 1934, total expenditures are divided into general and emergency categories in the *Annual Report of the Secretary of the Treasury* so that Roosevelt could point to a balanced ordinary budget.[16] The sum of general and emergency expenditures

[14]The expenditure series from Firestone (1960) matches our series of ordinary expenditures from fiscal year 1922 through 1930. Firestone (1960, p. 82) explains that starting in fiscal year 1931, trust fund transactions were eliminated from ordinary expenditures chargeable against ordinary receipts. Trust fund expenditures were, however, still included in ordinary receipts through 1933. Firestone's (1960) data for January 1932 to June 1933 matches that of NBERc (not shown in panel B.7a) and our series of ordinary expenditures matches NBERb up to fiscal year 1933.

[15]Starting in the 1968 annual report (p. 8), the Treasury introduced the new unified budget concepts of outlays which is both expenditures and loans.

[16]The *Annual Report of the Secretary of the Treasury on the State of the Finances for Fiscal year ended June 30, 1934* (P. 316, Table 6, footnote 6) explains that "Emergency expenditures prior to the fiscal year 1934 (except Reconstruction Finance Corporation) are included in general expenditures, the classification of which emergency expenditures is not available for comparison with emergency expenditures for the fiscal year 1934. Therefore, neither the totals of general expenditures nor the totals of emergency fiscal expenditures for the fiscal year 1934 are comparable with the total of prior fiscal years."



(a) Total and ordinary expenditures, 1920-1933

(b) Total expenditures, 1934-1940

Figure B.7: Federal expenditures aggregated by fiscal year, billions of dollars. Source: Department of the Treasury (various). See table B.4 for details; Firestone (1960); NBER Macrohistory database (m15004b, m15004c, m15004d); Romer (1992).

is total expenditures. Our series of total expenditures is larger than the series from either Firestone (1960) or NBERc from 1934 through 1938. Although the gap shrinks from 1938 through 1940, our series is slightly higher than all of the others shown in panel B.7b. Romer's (1992) series of total outlays is below all series for most years.[17]

As with the receipts series, our series of total and ordinary expenditures aggregated by fiscal year do not always match yearly data given elsewhere in the annual reports. Our expenditures series shown in figure B.8 match the yearly series from fiscal years 1922 to 1931, but are revised upwards in the 1934 annual report for 1932-1933.[18]

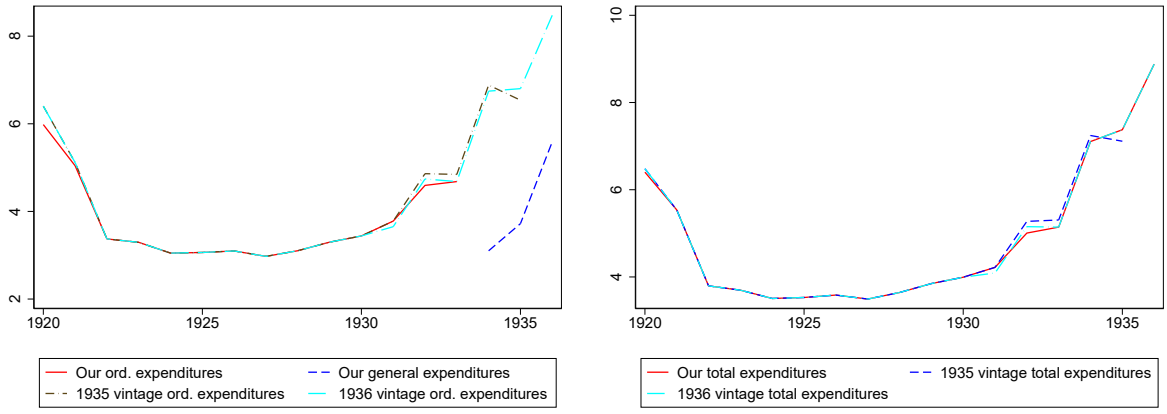
From 1934 to 1939, yearly tables continue to categorize expenditures into ordinary and total even though the monthly series do not maintain this distinction and are instead split into general and emergency categories. As a result, ordinary expenditures stop in 1934 where we switch to general expenditures for the remainder of the period shown in figure B.9. Panels B.9a-B.9b show that the 1936 and 1937 vintages are both revised up relative to our series. Panels B.9c-B.9d show that expenditures are also revised in the 1938, 1939, and 1941 vintages.

[17] The total expenditure series from Firestone (1960) matches that of NBERc from fiscal year 1934 through fiscal year 1937. From fiscal year 1937 through 1939, Firestone's (1960) series matches that of NBERd. Firestone (1960, p. 84) explains that under an act of February 1938, the Secretary of the Treasury canceled $2.7 billion of obligations purchased from the Reconstruction Finance Corporation which they could not repay. As a consequence, expenditures show only amounts spent from funds allocated by the Reconstruction Finance Corporation for purposes for which no provisions for repayment to the Treasury were made. The series from Firestone (1960) matches that of NBERe (not shown in panel B.7b) for fiscal year 1940.

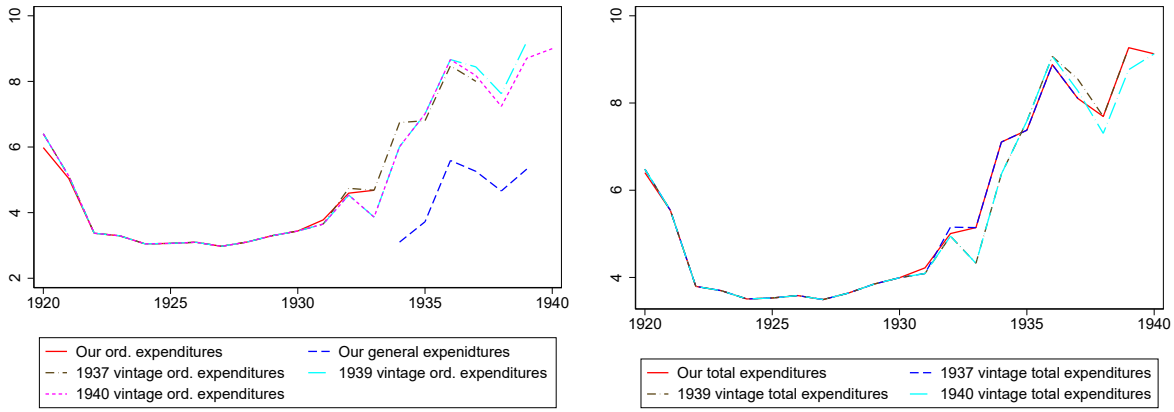
[18] These revisions differ from those of the 1933 expenditures of the Reconstruction Finance Corporation.

(a) Ordinary expenditures, 1920-1933 (b) Total expenditures, 1920-1933

Figure B.8: Federal expenditures aggregated by fiscal year, billions of dollars. Source: Department of the Treasury (various). See table B.4 for details.



(a) Ordinary expenditures, 1920-1936 (b) Total expenditures, 1920-1936



(c) Ordinary expenditures, 1920-1940 (d) Total expenditures, 1920-1940

Figure B.9: Federal expenditures aggregated by fiscal year, billions of dollars. Source: Department of the Treasury (various). See table B.4 for details.

Table name	Year	Page number Receipts	Expenditures
Ordinary receipts, and expenditures chargeable against (monthly)	1920	see 1921	
Ordinary receipts, and expenditures chargeable against (yearly)		see 1922	
STATEMENT SHOWING CLASSIFIED RECEIPTS...	1921	240	241
Ordinary receipts, and expenditures chargeable against (yearly)		see 1922	
Ordinary receipts, and expenditures chargeable against (monthly)	1922	270	271
Ordinary receipts, and expenditures chargeable against (yearly)		270	271
Ordinary receipts, and expenditures chargeable against (monthly)	1923	512	513
Receipts and expenditures of the United States Government...		512	513
Ordinary receipts, and expenditures chargeable against (monthly)	1924	378	379
Receipts and expenditures of the United States Government...		378	379
Ordinary receipts, and expenditures chargeable against (monthly)	1925	472	474
Receipts and expenditures of the United States Government...		472	474
Ordinary receipts, and expenditures chargeable against (monthly)	1926	445	447
Ordinary receipts, and expenditures chargeable against (yearly)		443	443
Ordinary receipts, and expenditures chargeable against (monthly)	1927	462	462
Ordinary receipts, and expenditures chargeable against (yearly)		445	445
Summary of ordinary receipts, expenditures chargeable (monthly)...	1928	424	424
Summary of ordinary receipts, expenditures chargeable (yearly)...		407	407
Summary of ordinary receipts, expenditures chargeable (monthly)...	1929	412	412
Summary of ordinary receipts, expenditures chargeable (yearly)...		394	394
Summary of ordinary receipts, expenditures chargeable (monthly)...	1930	506	506
Summary of ordinary receipts, expenditures chargeable (yearly)....		488	488
Summary of ordinary receipts, expenditures chargeable (monthly)...	1931	462	462
Ordinary receipts, expenditures chargeable against (yearly)...		448	448
Summary of ordinary receipts, expenditures chargeable (monthly)...	1932	370	370
Receipts and expenditures for the fiscal years 1789 to...		365	369
Summary of ordinary receipts, expenditures chargeable (monthly)...	1933	312	312
Receipts and expenditures for the fiscal years 1789 to...		306	310
Summary of ordinary receipts, expenditures chargeable (monthly)...	1934	306	306
Receipts and expenditures for the fiscal years 1789 to...		301	305
Summary of ordinary receipts, expenditures chargeable (monthly)...	1935	328	328
Receipts and expenditures for the fiscal years 1789 to...		323	327
Classified receipts and expenditures, monthly...	1936	337	339/342
Receipts and expenditures for the fiscal years 1789 to...		359	363
Classified receipts and expenditures, monthly...	1937	320	322/324
Receipts and expenditures for the fiscal years 1789 to...		349	353
Expenditures by major functions for the fiscal years 1930-1937			354
Classified receipts and expenditures, monthly...	1938	379	381/384
Receipts and expenditures for the fiscal years 1789 to...		413	417
Expenditures by major functions for the fiscal years 1931-1938			418
Classified receipts and expenditures, monthly...	1939	337	339/342
Receipts and expenditures for the fiscal years 1789 to...		361	365
Expenditures by major functions for the fiscal years 1931-1939			367
Classified receipts and expenditures, monthly...	1940	612	615/616
Receipts and expenditures for the fiscal years 1789 to...		645	649
Expenditures by major functions for the fiscal years 1933-1940			653
Receipts in general and special accounts, by major sources...		651	

Table B.4: Table names and page numbers from the *Annual Reports of the Secretary of the Treasury* for federal receipts and expenditures

C Additional VAR Results

	Percent of P Due to Shocks in				
Months	$\boldsymbol{F^o}$	$\boldsymbol{F^e}$	**T**	**P**	**Y**
6	5.1	8.9	0.5	85.3	0.2
36	5.5	27.7	6.0	60.7	0.1
	Percent of Y Due to Shocks in				
Months	$\boldsymbol{F^o}$	$\boldsymbol{F^e}$	**T**	**P**	**Y**
6	0.5	7.2	0.6	5.5	86.2
36	0.4	29.1	3.5	3.9	63.1
	Percent of $\boldsymbol{F^o}$ Due to Shocks in				
Months	$\boldsymbol{F^o}$	$\boldsymbol{F^e}$	**T**	**P**	**Y**
6	98.2	0.3	0.3	0.2	1.2
36	97.1	1.1	0.3	0.2	1.4
	Percent of $\boldsymbol{F^e}$ Due to Shocks in				
Months	$\boldsymbol{F^o}$	$\boldsymbol{F^e}$	**T**	**P**	**Y**
6	2.7	92.5	0.6	0.3	3.9
36	2.7	90.3	1.4	1.0	4.5
	Percent of T Due to Shocks in				
Months	$\boldsymbol{F^o}$	$\boldsymbol{F^e}$	**T**	**P**	**Y**
6	0.8	0.4	96.8	1.9	0.2
36	1.6	0.5	94.0	3.1	0.6

Table C.1: Percentage of forecast error variance in GNP deflator (P), real GNP (Y), ordinary expenditures surplus (F^o), emergency expenditures (F^e), and tax receipts (T) attributable to shocks to each equation. Columns may not sum to 100 due to rounding.

$$
\begin{aligned}
\underset{(1.133,2.101)}{1.989i} &= \underset{(-.014,.037)}{.022M^s} + \underset{(-.006,.010)}{.004G^m} + \varepsilon^{MP} \\
\underset{(.061,.080)}{.073M^d} &= \underset{(-1.155,.318)}{-.688i} + \underset{(.004,.044)}{.028P} + \underset{(.001,.016)}{.009Y} + \varepsilon^{MD} \\
\underset{(.0045,.0054)}{.0050S} &= \underset{(-.039,-.006)}{-.023B} - \underset{(-.040,.001)}{.020P} - \underset{(-.009,.006)}{.001Y} + \varepsilon^{FP} \\
\underset{(.013,.019)}{.018G^m} &= \underset{(-1.262,.602)}{-.457i} + \underset{(-.010,.030)}{.013P} + \underset{(.001,.017)}{.010Y} + \varepsilon^{GS} \\
\underset{(.077,.094)}{.087B} &= \underset{(-1.061,-.563)}{-.826i} - \underset{(-.035,-.018)}{.027M} - \underset{(-.0019,.0004)}{.0008S} + \underset{(.003,.007)}{.005G^m} \\
&\quad - \underset{(-.048,-.008)}{.028P} + \underset{(-.001,.014)}{.007Y} + \varepsilon^{B} \\
\underset{(.159,.186)}{.172P} &= \underset{(.007,.022)}{.015Y} + \varepsilon^{P} \\
\underset{(.060,.070)}{.065Y} &= \varepsilon^{Y}
\end{aligned}
$$

Table C.2: Posterior mode estimates of parameters in the A_0 matrix. 68-percent probability intervals appear in parentheses base on 500,000 draws from the posterior distribution. Coefficients and probability intervals in the table are divided by 1000.

Correlations Among Exogenous Shocks							
Shock	ε^{MP}	ε^{MD}	ε^{PS}	ε^{B}	ε^{GS}	ε^{P}	ε^{Y}
ε^{MP}	1.0	$(-.09, .13)$	$(-.07, .10)$	$(-.11, .11)$	$(-.10, .12)$	$(-.02, 13)$	$(-.09, .11)$
ε^{MD}		1.0	$(-.05, .15)$	$(-.14, .08)$	$(-.14, .06)$	$(-.10, .12)$	$(-.13, .08)$
ε^{PS}			1.0	$(-.16, .06)$	$(-.04, .12)$	$(-.16, .08)$	$(-.15, .08)$
ε^{B}				1.0	$(-.12, .10)$	$(-.13, .09)$	$(-.14, .08)$
ε^{GS}					1.0	$(-.13, .09)$	$(-.14, .09)$
ε^{P}						1.0	$(-.10, .10)$
ε^{Y}							1.0

Table C.3: Correlations computed from 500,000 draws from the posterior distribution of the model that table C.2 reports.

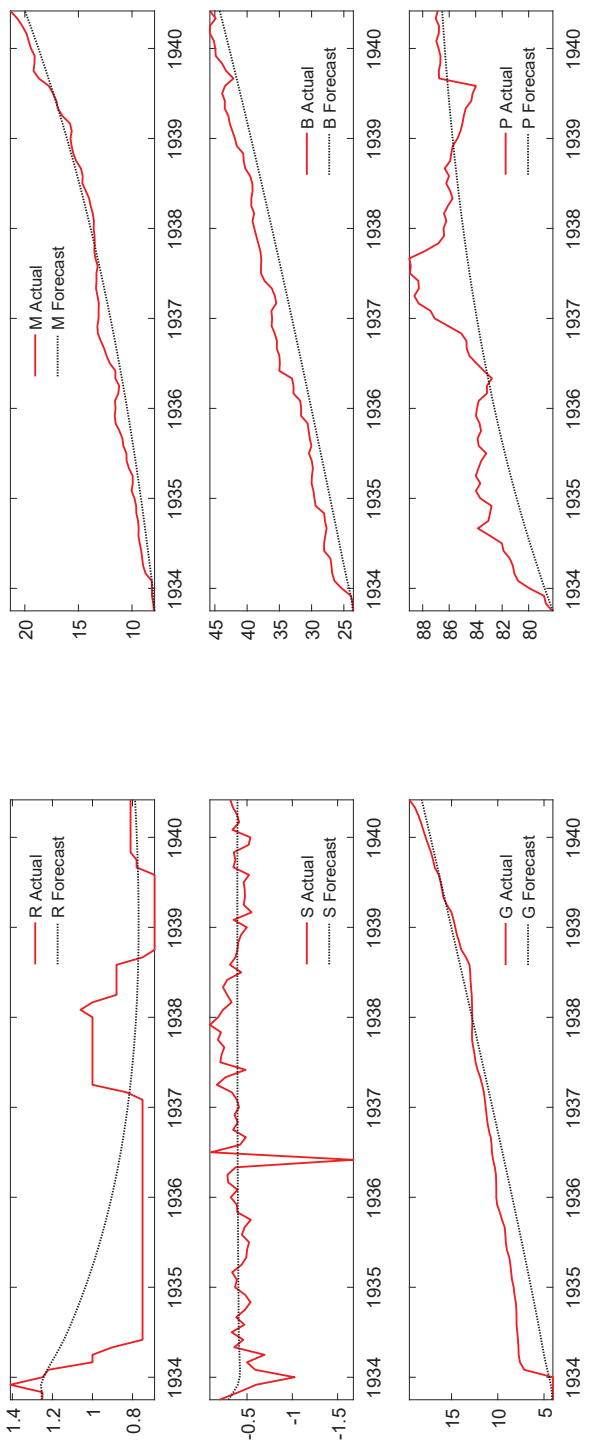


Figure C.1: Actual and unconditional forecasts of variables in VAR using the hyperparameters $\lambda_0 = 0.6, \lambda_1 = 0.3, \lambda_3 = 1.0, \lambda_4 = 1.75, \mu_5 = \mu_6 = 2.0$, in the notation of Sims and Zha (1998).

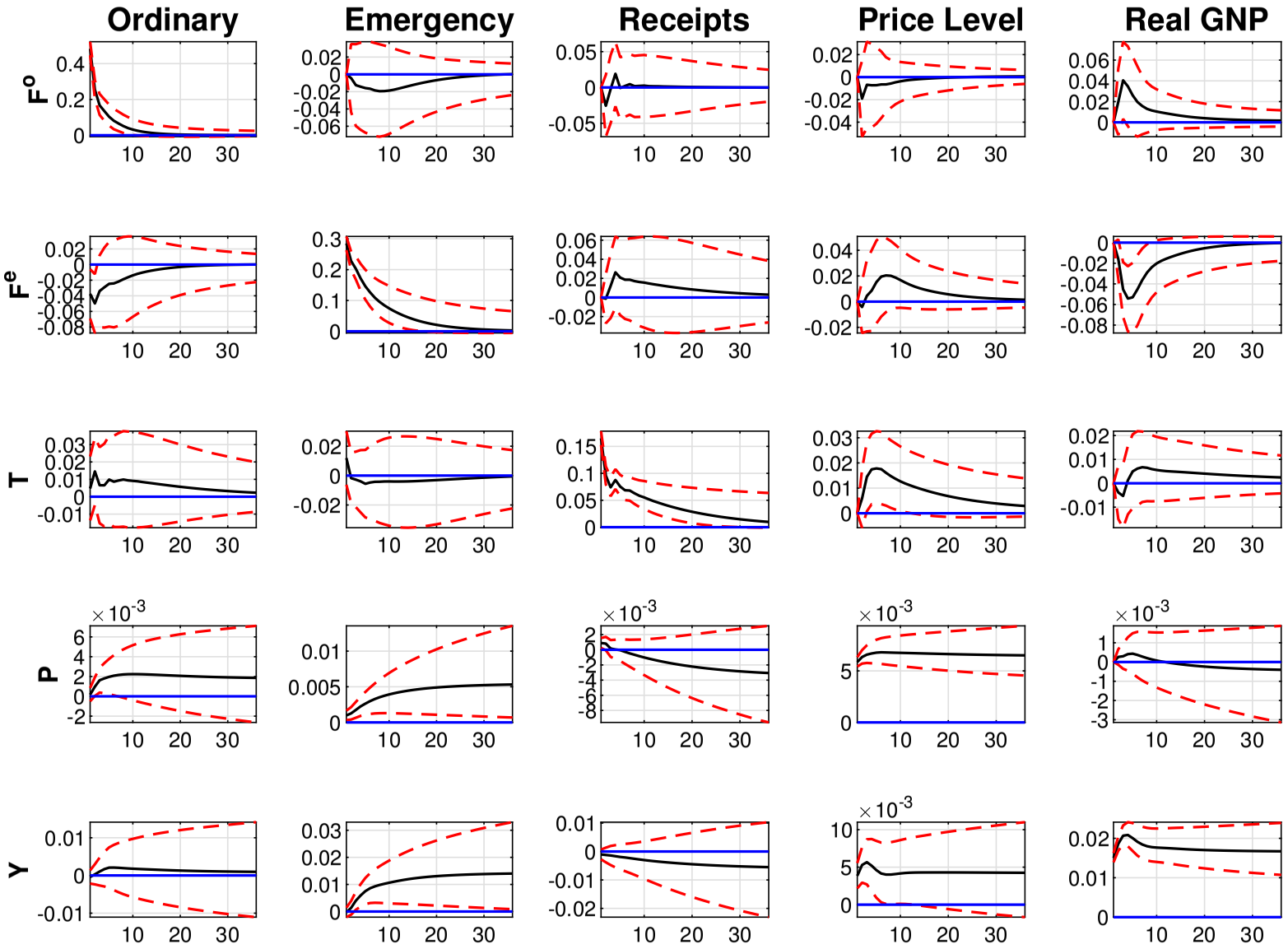


Figure C.2: Full moving average representation of the five-variable identified VAR estimated over the period April 1933 to June 1940. Identification is recursive with variables ordered $F^o/B, F^e/B, T/B, P, Y$. Solid lines are maximum likelihood estimates; dashed lines are 68 percentile probability bands based on 500,000 draws from the posterior distribution of all the VAR parameters.

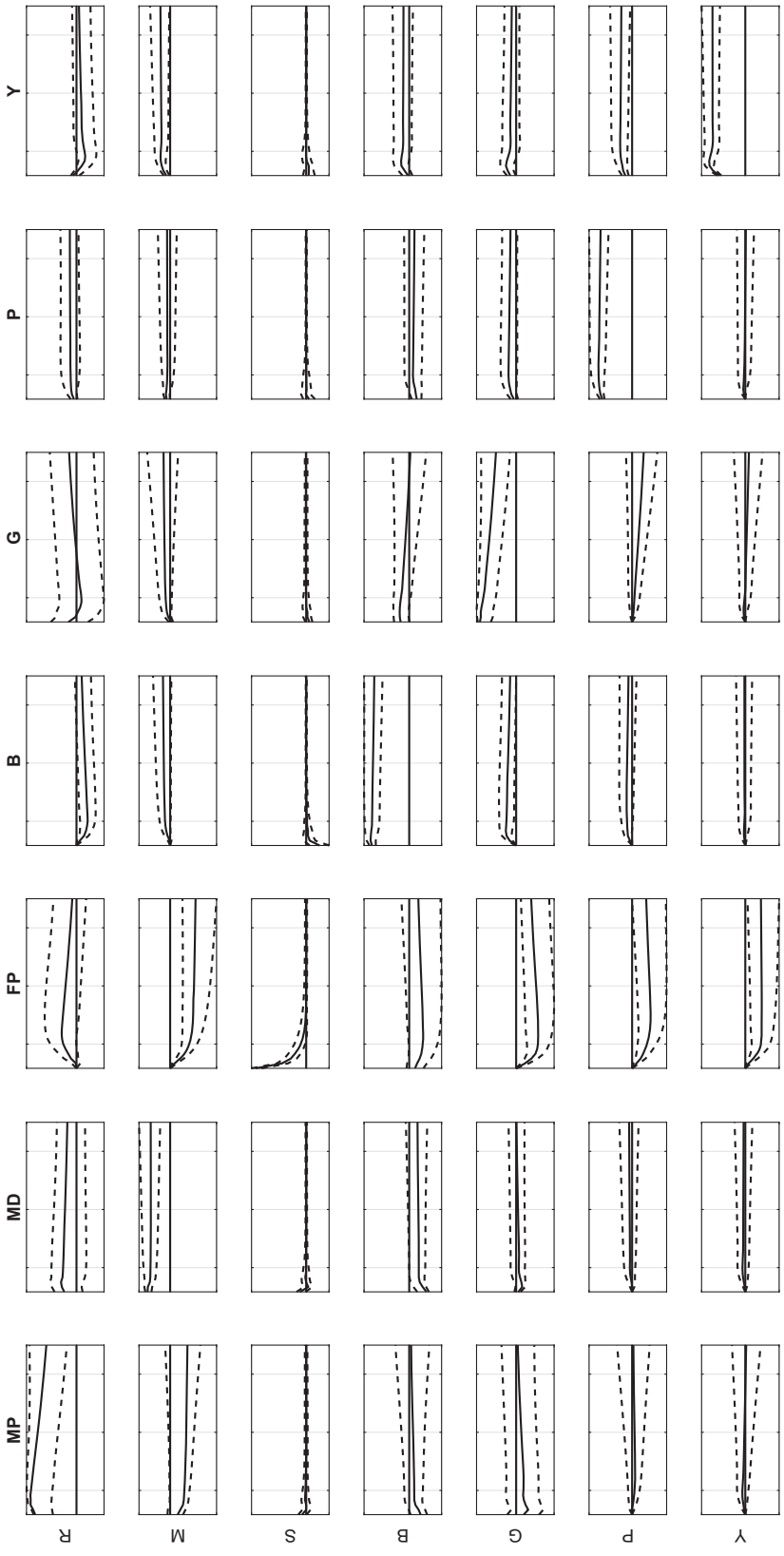


Figure C.3: Full moving average representation of the identified VAR estimated over the period April 1933 to June 1940. Identification from table C.2. Solid lines are maximum likelihood estimates; dashed lines are 68 percentile probability bands based on 500,000 draws from the posterior distribution of all the VAR parameters.

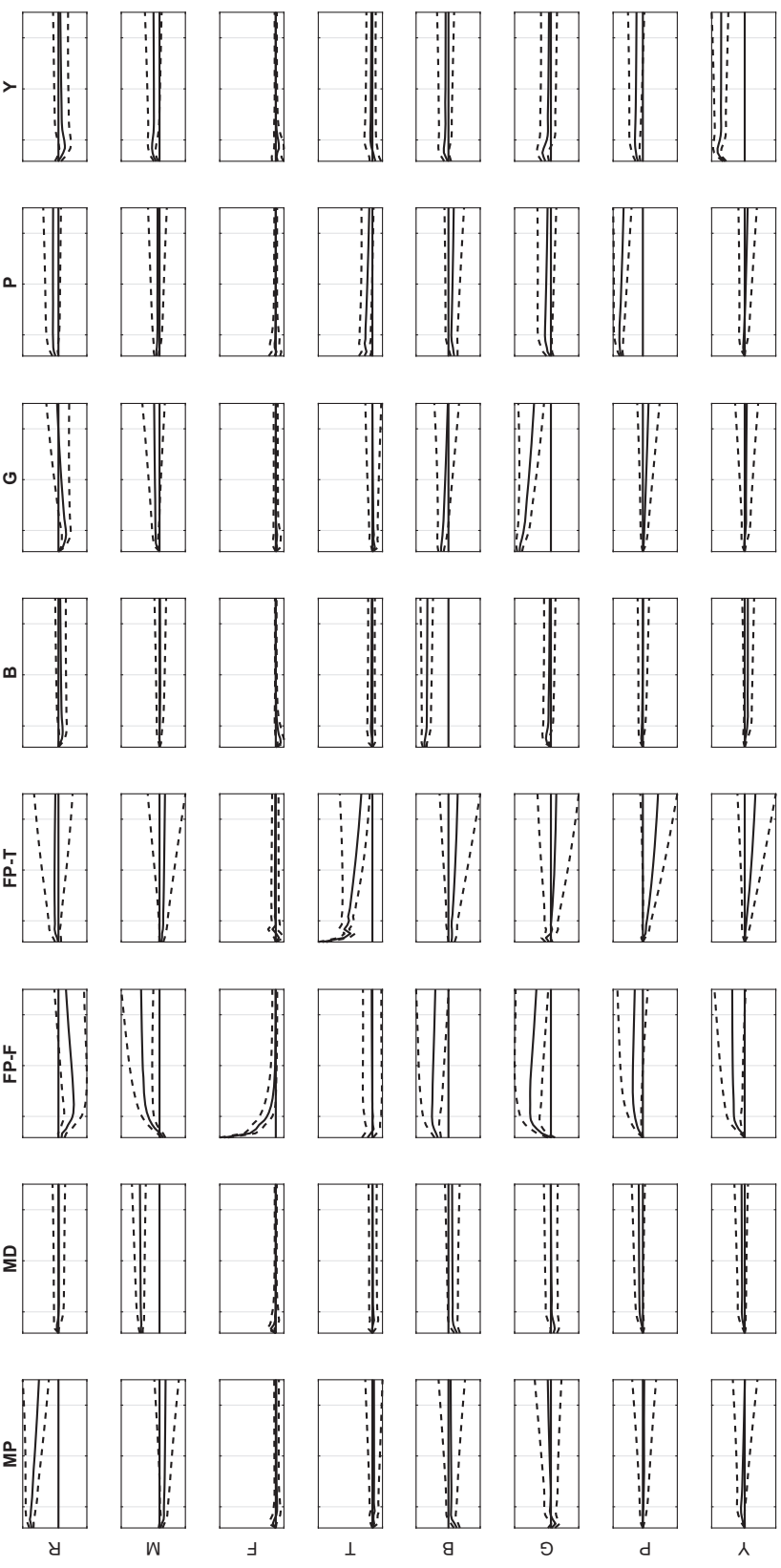


Figure C.4: Full moving average representation of 8-variable VAR ordered recursively—P, Y, F, T, R, M, G, B—estimated over the period (April 1933 to June 1940). F is government expenditures net of interest payments and T is tax receipts. Solid lines are maximum likelihood estimates; dashed lines are 68 percentile probability bands based on 500,000 draws from the posterior distribution of all the VAR parameters.

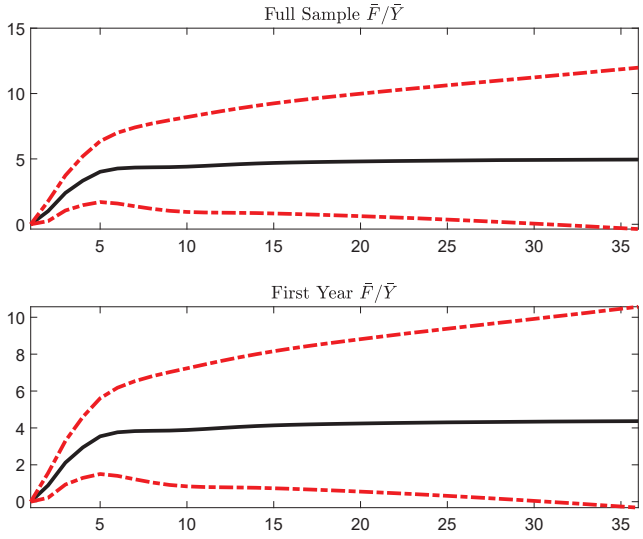


Figure C.5: Blanchard and Perotti (2002) output multipliers for government expenditures net of interest payments. Solid lines are posterior modes; dashed lines are 68 percent credible sets. Top panel takes mean of expenditures to output from full sample; bottom panel takes mean from first year of sample.

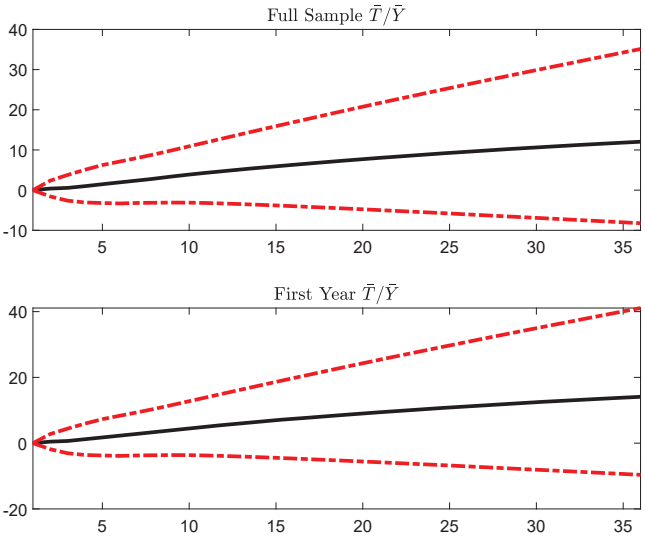


Figure C.6: Blanchard and Perotti (2002) output multipliers for government tax receipts. Solid lines are posterior modes; dashed lines are 68 percent credible sets. Top panel takes mean of receipts to output from full sample; bottom panel takes mean from first year of sample.

	Percent of P Due to Shocks in						
Months	**MP**	**MD**	**FP**	**B**	**GS**	**P**	**Y**
6	0.2	0.2	7.9	1.2	0.2	82.4	8.0
36	0.3	0.4	16.3	1.4	3.4	70.0	8.2
	Percent of Y Due to Shocks in						
Months	**MP**	**MD**	**FP**	**B**	**GS**	**P**	**Y**
6	0.4	0.3	8.9	0.1	0.1	0.2	90.0
36	0.1	0.3	17.8	0.1	0.3	0.0	81.4
	Percent of M Due to Shocks in						
Months	**MP**	**MD**	**FP**	**B**	**GS**	**P**	**Y**
6	17.7	50.9	19.4	1.4	1.4	1.4	7.9
36	18.9	29.8	39.1	2.8	2.4	0.7	6.3
	Percent of i Due to Shocks in						
Months	**MP**	**MD**	**FP**	**B**	**GS**	**P**	**Y**
6	82.8	8.0	2.7	2.7	0.9	1.1	1.7
36	79.9	7.2	5.2	3.5	1.0	2.1	1.2
	Percent of S Due to Shocks in						
Months	**MP**	**MD**	**FP**	**B**	**GS**	**P**	**Y**
6	0.5	1.1	92.2	5.1	0.3	0.2	0.5
36	0.5	1.1	92.1	5.1	0.4	0.2	0.5
	Percent of G^m Due to Shocks in						
Months	**MP**	**MD**	**FP**	**B**	**GS**	**P**	**Y**
6	4.3	1.0	15.3	4.1	69.3	2.2	3.8
36	2.5	0.4	26.9	4.9	59.3	3.3	2.6
	Percent of B Due to Shocks in						
Months	**MP**	**MD**	**FP**	**B**	**GS**	**P**	**Y**
6	3.0	7.6	6.2	75.1	4.3	1.7	2.2
36	1.2	5.5	8.1	79.9	1.6	1.4	2.2

Table C.4: Percentage of forecast error variance in GNP deflator (P), real GNP (Y), primary surplus (S), monetary base (M), commercial paper rate (i), monetary gold supply (G^m), and nominal market value of debt (B) attributable to shocks to each equation. Columns may not sum to 100 due to rounding.

D Fiscal Implications of Gold Sterilization

When following either the classical gold or gold exchange standard, gold imports have the potential to increase the monetary base. By sterilizing gold inflows, i.e. paying for imported gold in government bonds rather than bank reserves, policymakers can partially offset the increase in the monetary base. By June of 1934, both gold import operations and sterilization decisions shifted from the Federal Reserve to the Treasury. A series of presidential proclamations, executive orders, joint-resolutions, and Acts culminated in an embargo on gold exports[19] and the Treasury seizing the entire monetary gold stock including coins and bullion held by private citizens, business, and the Federal Reserve banks.[20]

Massive gold imports more than tripled the monetary gold stock from $4.3 billion at the start of 1933 to $14.4 billion at the end of 1938. Friedman and Schwartz (1963, p. 545) attribute the gold imports to the depreciation of the dollar, Hitler's rise to power, and the outbreak of war in Europe. Studenski and Krooss (1952, p. 394) include the Treasury's $35 an ounce purchase price for gold, favorable trade balances, and the creditor position of the United States as additional factors that increased gold imports.[21] To our knowledge, banks were required to sell newly imported gold to the Treasury due to the Gold Reserve Act of 1934's ban on private citizens holding monetary gold.[22] With gold inflows pushing up excess reserves, policymakers feared that the growing monetary base could ignite inflationary forces [Jaremski and Mathy (2018)]. Sterilization from December 1936 to April 1938 attempted to curb the growth of excess reserves and hence the monetary base.

Expanding on the example provided by Johnson (1939, p. 144), we illustrate the effects of the Treasury's non-sterilized and sterilized gold purchases on the balance sheets of the Treasury, the Federal Reserve, and member banks.

1. Gold imports by member banks: $1,000 worth of imported gold is funded by issuing $1,000 worth of deposits. Member bank assets and liabilities rise by $1,000.

Treasury	
Assets	Liabilities

Federal Reserve	
Assets	Liabilities

Member Banks	
Assets	Liabilities
+$1,000 gold	+$1,000 deposits
+$1,000	+$1,000

[19] Executive Order 6111 on Transactions in Foreign Exchange was implemented on April 20, 1933. See http://www.presidency.ucsb.edu/ws/index.php?pid=14621

[20] See Bordo, Humpage, and Schwartz (2015, pp. 56–57) for a detailed timeline of events. Jaremski and Mathy (2018, p. 6) report that most gold imports came through New York City's gold market and New York City banks continued to sell their gold to the Federal Reserve Bank of New York who acted as fiscal agent to the Treasury, the ultimate purchaser of the gold.

[21] Meltzer (2003, p. 459) notes that the Treasury purchased more than $4 billion of gold from 1934-1936.

[22] Bordo, Humpage, and Schwartz (2015, p. 65) explain that the Treasury issued special licenses for commercial banks to obtain gold for customers which suggets that banks were not allowed to keep gold on their balance sheets.

2. High powered money creation: member banks sell $1,000 of imported gold to the Federal Reserve in exchange for reserves that increase high-powered money by $1,000. Swapping gold for reserves does not change the aggregate asset position of member banks—both assets and liabilities remain elevated by the original $1,000. Prior to the Gold Act of 1934, the Federal Reserve maintained the sterilization decision which is shown in step 2b.

Treasury	
Assets	Liabilities

Federal Reserve	
Assets	Liabilities
+$1,000 gold	+$1,000 reserves
+$1,000	+$1,000

Member Banks	
Assets	Liabilities
-$1,000 gold +$1,000 reserves	$1,000 deposits
$1,000	$1,000

3. Gold transferred to Treasury: under the Gold Act of 1934, imported gold had to be turned over from the Federal Reserve to the Treasury. As noted by Jaremski and Mathy (2018, p. 6), the Treasury paid for the gold by drafting on its balances at the Federal Reserve. The transaction only changed the composition of the balance sheets of the Federal Reserve and the Treasury, but not not their aggregate asset position.

Treasury	
Assets	Liabilities
+$1,000 gold -$1,000 due from Fed	

Federal Reserve	
Assets	Liabilities
-$1,000 gold	$1,000 reserves -$1,000 due to Treasury

Member Banks	
Assets	Liabilities
$1,000 reserves	$1,000 deposits
$1,000	$1,000

4a. No sterilization under the Treasury: the Treasury replenished its balances at the Federal Reserve by issuing gold certificates and depositing them as final payment for gold purchases. Without sterilization, gold imports ultimately increase the balance sheets of the Treasury, the Federal Reserve, and member banks while leaving the amount of free-gold at the Treasury unchanged. There is no increase in Treasury indebtedness to the private sector because the Treasury transacts with the Federal Reserve via gold certificates.

Treasury	
Assets	Liabilities
+$1,000 due from Fed	+$1,000 gold certificates to Treasury
+$1,000	+$1,000

Federal Reserve	
Assets	Liabilities
+$1,000 gold certificates from Treasury	$1,000 reserves
+$1,000	+$1,000

Member Banks	
Assets	Liabilities
$1,000 reserves	$1,000 deposits
$1,000	$1,000

4b. Sterilization under the Treasury: when sterilizing gold imports, the Treasury sells government securities to member banks rather than issuing gold certificates to the Federal Reserve. Member banks pay for government securities by retiring outstanding reserves held at the Federal Reserve who then credits their own balances due to the Treasury to settle the transaction. By retiring reserves, the high powered money created in step 2 is withdrawn. In summary, sterilization of gold imports increases Treasury indebtedness to the private sector while also increasing the aggregate balance sheets of the Treasury and member banks, but not the Federal Reserve.

Treasury	
Assets	Liabilities
+$1,000 due from Fed	+$1,000 gov't securities
+$1,000	+$1,000

Federal Reserve	
Assets	Liabilities
	-$1,000 reserves +$1,000 due to Treasury

Member Banks	
Assets	Liabilities
-$1,000 reserves +$1,000 gov't securities purchased from Treasury	$1,000 deposits
$1,000	$1,000

2b. Sterilization under the Federal Reserve: when sterilizing gold imports, the Federal Reserve pays for gold by selling government securities to member banks rather than creating reserves as seen in 2. Sterilization leaves the aggregate balance sheets of the Federal Reserve and the Treasury unchanged while the balance sheet of member banks is expanded. In the case of sterilization under the Federal Reserve, there is no increase in Treasury indebtedness. Because security sales by the Federal Reserve prevent the creation of reserves, sterilization by the Federal Reserve is equivalent to contractionary open market operations.

Treasury	
Assets	Liabilities

Federal Reserve	
Assets	Liabilities
+$1000 gold -$1000 gov't securities	

Member Banks	
Assets	Liabilities
-$1000 gold +$1000 gov't securities	$1000 deposits
$1000	$1000

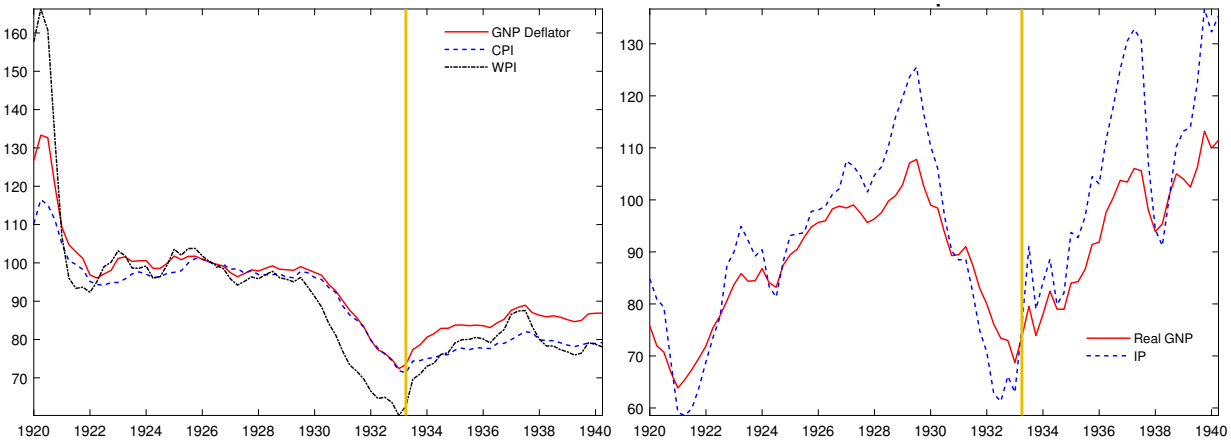
E Macroeconomic Indicators

This Appendix presents empirical facts about the state of the U.S. economy throughout the 1920s and 1930s. It offers evidence corroborating the interpretation that unbacked fiscal expansion spurred recovery. In the figures that follow we use quarterly data to contrast the performance of economic variables during the "gold standard" (January 1920 to March 1933) to their behavior during "unbacked fiscal expansion" (April 1933 to June 1940).

Panel E.1a shows that the price level, however measured, decreased by roughly 30 percent from the stock market crash in October 1929 to its trough in April 1933 when the gold

standard was abandoned. Although the GNP deflator and consumer and wholesale prices rose through most of the 1930s, they never regained the 1920s levels per Roosevelt's goal.

Like prices, output also plunged in 1929 and began a sustained recovery when gold was abandoned in April 1933. Panel E.1b shows that real GNP and industrial production fell by roughly 25 and 45 percent, respectively, from peak to trough, as measured on an annual basis. In contrast to prices, output eventually surpassed its pre-recession peak.



(a) Price levels (b) Output

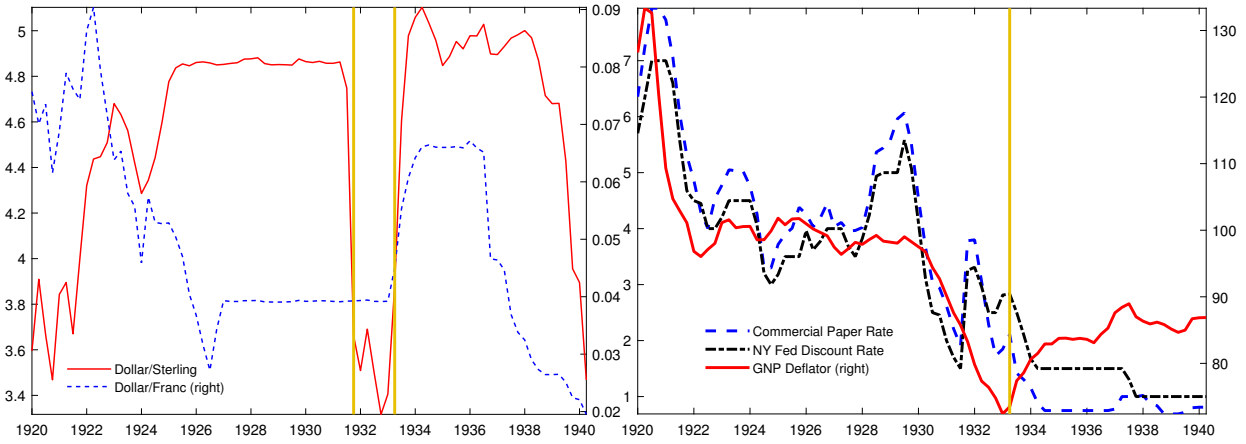
Figure E.1: Measures of price levels and real economic activity. All series use 1926 base year. Vertical line marks when the United States abandoned the gold standard. Sources: Balke and Gordon (1986), Federal Reserve Board, BEA and BLS from NBER Macrohistory Database.

Figure E.2 shows how the gold standard's focus on international considerations at the expense of domestic conditions affected exchange rates, interest rates, and the price level. Panel E.2a shows that the United Kingdom's departure from the gold standard in September 1931 (first vertical line) triggered a very large dollar appreciation. When the U.S. also left gold in April 1933 (second vertical line), this appreciation was completely reversed.

Panel E.2b shows that during the gold standard period interest rates generally followed the decline in the price level, albeit with several distinct deviations when rates rose sharply despite a flat or declining price level. For example, in October 1931, concerns about gold outflows after Britain left the gold standard induced most Federal Reserve banks to raise their discount rates even though prices were in free fall. Meltzer (2003, p. 280-282) claims that Federal Reserve policy decisions were mostly consistent with the Riefler-Burgess and real bills doctrines where policymakers focused on borrowed reserves and short-term market interest rates as key signals. But interest-rate hikes in the early 1930s were clear attempts by the Federal Reserve to follow the gold standard's "rules of the game" [p. 273] and stabilize exchange rates at the expense of domestic prices.[23] After the abandonment of the gold

[23]See Wicker (1966) for discussions of monetary policy constraints. Eichengreen (2000) argues that the gold standard prevented governments from reflating: "So long as the gold standard remained in place, the commitment to defend the central bank's gold reserves and stabilise the gold parity was an insurmountable obstacle to the adoption of expansionary policies." Apropos of fiscal policy under the gold standard, when taxes must back government debt, is Eichengreen's statement: "Deficit spending could not be used. . . if deficit spending could not be financed."

standard in April 1933, the Federal Reserve pegged the discount rate, changing it infrequently and certainly not adjusting it to combat higher prices.[24]



(a) Dollar valuation (b) Interest rates & price level

Figure E.2: Exchange rates, inflation, and interest rates. Exchange rates in dollars per foreign currency; inflation is annual (quarter over four quarters prior). First vertical line marks when the United Kingdom abandoned the gold standard; second line marks when the United States abandoned the gold standard. Sources: Federal Reserve Board (1943).

Figure E.3 shows the effects of Roosevelt's gold programs on the monetary base, the gold stock, and gold cover ratio. The large jumps in gold stock (top panel) and the cover ratio (bottom panel) in 1934 stem from the revaluation of gold to $35 an ounce—almost 60 percent above its previous covertibility price. The steady increase in the gold stock and the monetary base during the unbacked fiscal expansion period reflects Roosevelt's decision not to sterilize gold inflows. That decision was reversed in 1937, reducing the growth rate of the base [Irwin (2012)] (see Appendix D for details on sterilization). Because the gold cover ratio remained close to 0.90 from April 1933 onweard, gold no longer constrained policy behavior.[25]

Table E.1 reports the highs and lows of GNP and its components along with banking aggregates. By 1937, nominal GNP exceeded its 1929 high, but investment remained below. In current dollars, GNP and its components did not regain their 1929 peaks. Total deposits in all banks bounced back by 1937 after falling 30 percent between 1929 and the low point in 1932–33 as financial unrest lead to cash hoarding by the public. Loans, which declined over 50 percent never regained their previous level. Bank holdings of U.S. government obligations largely filled the asset void left by loans, tripling between 1929 and 1937.

[24]The Fed also made few changes to its market portfolio from 1933 to 1941 [Meltzer (2003, p. 413)].

[25]For a couple of years before the gold revaluation, the cover ratio was precariously low, imposing a severe constraint on the level of the monetary base. Eichengreen (1992) recounts events during February and March 1933 when the New York Fed was at its statutory 40 percent minimum gold cover ratio, which prevented it from rediscounting bills. Initially, other reserve banks discounted bills on New York's behalf. By March 3 the Chicago Fed, which held the bulk of the System's excess gold, refused to provide further assistance to New York for fear that it would be unable to help banks in the Chicago district. These tensions, which stemmed from the absence of a coherent *national* monetary policy, exacerbated the already tenuous state of commercial banks and raised doubts about the credibility of the System's commitment to gold parity.

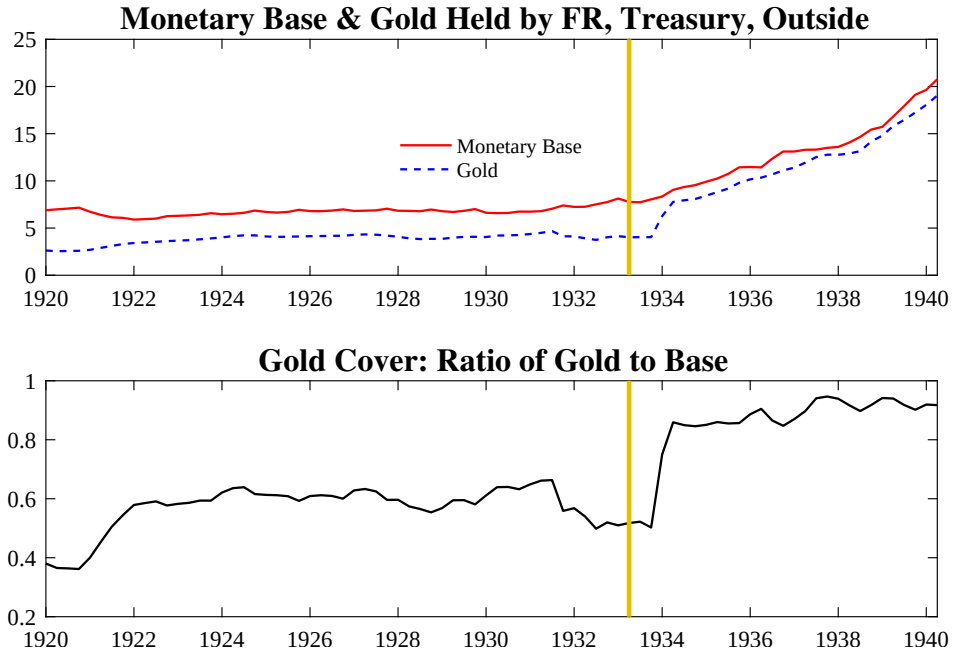


Figure E.3: Monetary base and gold held by Federal Reserve banks. Monetary base is currency in circulation plus non-borrowed reserves. Vertical line marks when the United States abandoned the gold standard. Source: Federal Reserve Board (1943) from NBER Macrohistory Database.

	1929 High	1932-33 Low	1937 High
Annual data			
In 1939 prices, billions of dollars			
GNP	85.9	61.5	87.9
Gross domestic investment	14.9	1.1	11.4
In current prices, billions of dollars			
GNP	103.8	55.8	90.2
Gross domestic investment	15.8	0.9	11.4
Consumption	78.8	46.3	67.1
Biannual data			
All banks, billions of dollars			
Total deposits	59.8	41.5	59.2
Loans	41.9	22.1	22.1
U.S. government obligations	5.5	8.2	17.0

Table E.1: Sources: Gordon (1952, p. 390) and Federal Reserve Board (1943).

F Market Value and Returns

This Appendix details calculations of the market value and the return on the U.S. bond portfolio. We use data from Hall, Payne, Sargent, and Szőke (2021), provided to us by the authors, as well as CRSP to obtain the quantity, price, accrued interest, interest rate, and coupon frequency of each government bond outstanding in a given month.

We begin by showing how we aggregate both prices and quantities across initial and

outstanding maturities. Let $B_{it}(t+j)$ denote the dollar value of bonds with initial maturity i that are outstanding at time t and maturing at time $t+j$. $B_t(t+j)$ thus aggregates over initial maturities.

$$B_t(t+j) = \sum_{i=1}^{N} B_{it}(t+j)$$

Because bonds maturing at time $t+j$ may not span all initial maturities $i = 1, \ldots, N$, it is possible for $B_{it}(t+j) = 0$ for some i.

The par value of all bonds outstanding at the end of time t—the face value of the bond portfolio—is the sum over all maturities.

$$B_t^M = \sum_{j=1}^{\infty} B_t(t+j) = \sum_{j=1}^{\infty} \sum_{i=1}^{N} B_{it}(t+j)$$

To calculate prices for bonds, we first define $\nu_{it}(t+j)$ as the share of bonds with initial maturities i that are outstanding at time t and maturing at time $t+j$,

$$\nu_{it}(t+j) = \frac{B_{it}(t+j)}{B_t(t+j)} = \frac{B_{it}(t+j)}{\sum_{i=1}^{N} B_{it}(t+j)}$$

where $\sum_{i=1}^{N} \nu_{it}(t+j) = 1$. The weighted dirty price $Q_t^D(t+j)$ is the price plus accrued interest of bonds outstanding at time t and maturing at time $t+j$,

$$Q_t^D(t+j) = Q_t(t+j) + AI_t(t+j) = \sum_{i=1}^{N} \Big(Q_{it}(t+j) + AI_{it}(t+j) \Big) \times \nu_{it}(t+j)$$

$Q_t(t+j)$ and $AI_t(t+j)$ are the clean price and accrued interest, respectively. For zero-coupon bonds, the dirty price is equal to the clean price.

To define the nominal price of the bond portfolio, we next define $\mu_t(t+j)$ as the share of bonds outstanding at time t and maturing at time $t+j$,

$$\mu_t(t+j) = \frac{B_t(t+j)}{B_t^M}$$

where $\sum_{j=1}^{\infty} \mu_t(t+j) = 1$. The nominal price of the bond portfolio P_t^M is obtained by aggregating all remaining maturities $t+j$,

$$P_t^M = \sum_{j=1}^{\infty} Q_t^D(t+j) \times \mu_t(t+j)$$

To define the market value of government debt and its returns, we next define the government's budget identity with a complete and general maturity structure,

$$\sum_{j=0}^{\infty} \big(Q_t^D(t+j) + IP_t(t+j) \big) \times B_{t-1}(t+j) = P_t s_t + \sum_{j=1}^{\infty} Q_t^D(t+j) \times B_t(t+j) \qquad \text{(F.35)}$$

Where $Q_t^D(t) \equiv 1$ and $IP_t(t+j)$ is the interest payable on bonds outstanding at time t and maturing at time $t+j$. Interest payable is a government expense at time t and is thus included in the government budget identity.

The market value of debt outstanding at time t is obtained by multiplying the prices of bonds by quantities and aggregating across all remaining maturities j

$$P_t^M B_t^M \equiv \sum_{j=1}^{\infty} Q_t^D(t+j) \times B_t(t+j)$$

The market value of debt outstanding at time $t-1$ is thus

$$P_{t-1}^M B_{t-1}^M \equiv \sum_{j=1}^{\infty} Q_{t-1}^D(t+j) \times B_{t-1}(t+j) = \sum_{j=1}^{\infty} Q_{t-1}^D\big((t-1)+(j+1)\big) \times B_{t-1}\big((t-1)+(j+1)\big)$$

To calculate returns, it is also useful to define the carry-over market value $P_t^C B_{t-1}^M$ which uses time $t-1$ bonds with time t dirty prices and intermediate coupon payments paid between time $t-1$ and t.

$$P_t^C B_{t-1}^M \equiv \sum_{j=0}^{\infty} \Big(Q_t^D(t+j) + IP_t(t+j)\Big) \times B_{t-1}(t+j)$$

$IP_t(t+j)$ is the interest payable on bonds outstanding at t that mature in $t+j$. P_t^C differs from its dirty-price analog P_t^M only when there is a coupon payment in month t. The timing of coupon payments is as follows:

Using the definitions of market value and carry over market value, the government budget identity given by equation (F.35) can be written as:

$$P_t^C B_{t-1}^M = P_t s_t + P_t^M B_t^M$$

Multiplying and dividing the left hand side by last period's market value $P_{t-1}^M B_{t-1}^M$ defines the rate of return on government debt:

$$\underbrace{\frac{P_t^C B_{t-1}^M}{P_{t-1}^M B_{t-1}^M}}_{\text{rate of return}} \times P_{t-1}^M B_{t-1}^M = P_t s_t + P_t^M B_t^M \tag{F.36}$$

The rate of return can also be derived by decomposing changes in market value into rates of return and changes in size. We start by expanding the ratio of time t market value to time $t-1$.

$$\frac{P_t^M B_t^M}{P_{t-1}^M B_{t-1}^M} \equiv \underbrace{\frac{P_t^C B_{t-1}^M}{P_{t-1}^M B_{t-1}^M}}_{\text{rate of return}} \times \underbrace{\frac{P_t^M B_t^M}{P_t^C B_{t-1}^M}}_{\text{size ratio}} \tag{F.37}$$

The rate of return is the same as that given in equation (F.36) and reflects the change in the value of the bond portfolio between time t and $t-1$, holding the bond portfolio fixed.

$$\frac{P_t^C B_{t-1}^M}{P_{t-1}^M B_{t-1}^M} = \frac{\sum_{j=0}^{\infty}\Big(Q_t(t+j) + AI_t(t+j) + IP_t(t+j)\Big) \times B_{t-1}(t+j)}{\sum_{j=1}^{\infty}\Big(Q_{t-1}(t+j) + AI_{t-1}(t+j)\Big) \times B_{t-1}(t+j)} \tag{F.38}$$

The size ratio in equation (F.37) incorporates new issues, redemptions, and coupon payments that occur between time t and $t-1$. The size ratio reflects the change in the value of the bond portfolio due to changes in the debt composition such as ny changes in maturity structure.

$$\frac{P_t^M B_t^M}{P_t^C B_{t-1}^M} = \frac{\sum_{j=1}^{\infty}\Big(Q_t(t+j) + AI_t(t+j)\Big) \times B_t(t+j)}{\sum_{j=0}^{\infty}\Big(Q_t(t+j) + AI_t(t+j) + IP_t(t+j)\Big) \times B_{t-1}(t+j)}$$

Given the definition of the nominal return in equation (F.38), the real return can then be defined by dividing by the inflation rate $\pi_t = P_t/P_{t-1}$.

$$r_t^M = \frac{P_t^C B_{t-1}^M/P_t}{P_{t-1}^M B_{t-1}^M/P_{t-1}} = \frac{\sum_{j=0}^{\infty}\Big(Q_t^D(t+j) + IP_t(t+j)\Big) \times B_{t-1}(t+j)/P_t}{\sum_{j=1}^{\infty} Q_{t-1}^D(t+j) B_{t-1}(t+j)/P_{t-1}} \tag{F.39}$$

The government budget identity (F.36) can also be expressed in real terms as:

$$r_t^M P_{t-1}^M b_{t-1}^M = s_t + P_t^M b_t^M \tag{F.40}$$

where $b_t^M \equiv B_t^M/P_t$ is the real par value of debt outstanding at t.
Panel F.1a shows that real returns to U.S. debt have a larger decline than nominal returns after the departure form the gold standard. Real returns are on average more volatile than nominal returns over the period shown.

The surprise component in the real return on the bonds portfolio allows us to attribute changes in the real return to inflation and bond prices.

$$\eta_t \equiv r_t^M - E_{t-1} r_t^M$$

We assume adaptive expectations so that expected prices equal their past values and there are no real expected capital gains or losses on the portfolio, $E_{t-1}[P_t] = P_{t-1}$ and $E_{t-1}\left[Q_t(t+j)\right] = Q_{t-1}(t+j)$.[26] The surprise in the real return can be written as:

$$\eta_t = \frac{P_t^c B_{t-1}^M/P_t}{P_{t-1}^M B_{t-1}^M/P_{t-1}} - \frac{\sum_{j=0}^{\infty}\Big(Q_{t-1}(t+j) + AI_t(t+j) + IP_t(t+j)\Big) \times B_{t-1}(t+j)/P_{t-1}}{P_{t-1}^M B_{t-1}^M/P_{t-1}}$$

Adding and subtracting $Q_t(t+j)$ from the numerator of the last term:

$$\eta_t = \underbrace{\frac{P_t^c B_{t-1}^M}{P_{t-1}^M B_{t-1}^M}}_{R_t^M}(1/\pi_t - 1) + \frac{\sum_{j=0}^{\infty}\Big(Q_t(t+j) - Q_{t-1}(t+j)\Big) \times B_{t-1}(t+j)}{P_{t-1}^M B_{t-1}^M}$$

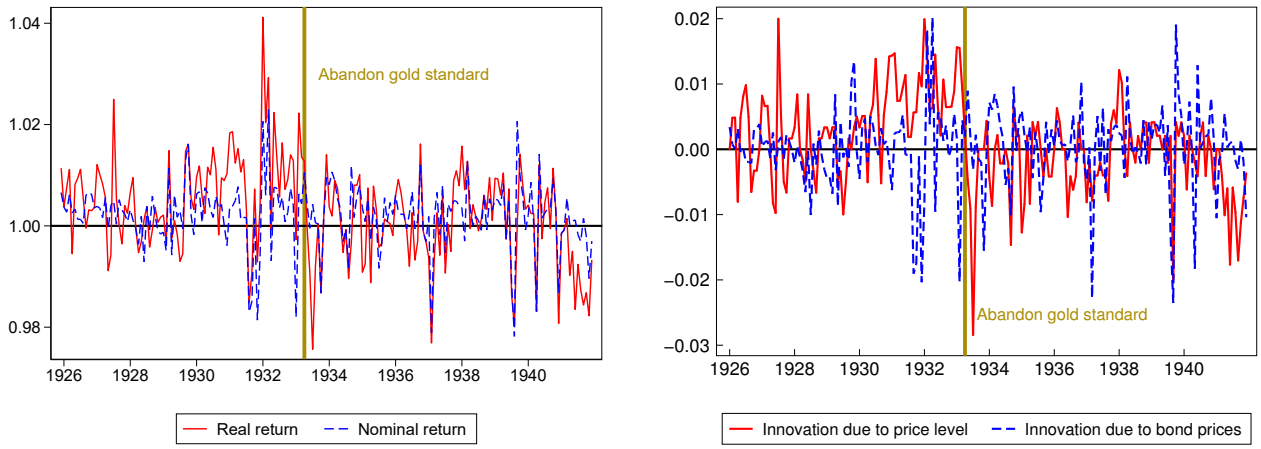
[26] Accrued interest, $AI_t(t+j)$, and interest payable, $IP_t(t+j)$, of bonds outstanding at time t and maturing at time $t+j$ are known in period $t-1$. Hence, $E_{t-1}[AI_t(t+j) + IP_t(t+j)] = AI_t(t+j) + IP_t(t+j)$.

Multiplying and dividing the final term by $P_t^c B_{t-1}^M$ yields the following decomposition[27]

$$\eta_t = R_t^M \underbrace{(1/\pi_t - 1)}_{\text{due to price level}} + R_t^M \underbrace{\left(\frac{\sum_{j=1}^{\infty} \big(Q_t(t+j) - Q_{t-1}(t+j)\big) \times B_{t-1}(t+j)}{P_t^c B_{t-1}^M} \right)}_{\text{due to bond prices}} \tag{F.41}$$

If there are neither changes in the price level between periods t and $t-1$, i.e. $\pi = 1$ nor aggregated bond prices, $\sum_{j=0}^{\infty} Q_t(t+j) - Q_{t-1}(t+j) = 0$, then $\eta_t = 0$ and there are no capital gains or losses. If there is only a change in aggregated bond prices but not the price level ($\pi_t = 1$), then $R_t^M(1/\pi_t - 1) = 0$ and capital gains or losses can be interpreted as the weighted change in bond prices as a share of market value scaled by nominal returns. If the opposite is true and $\big(\sum_{j=0}^{\infty} \big(Q_t(t+j) - Q_{t-1}(t+j)\big) = 0$, then capital gains or losses are changes in the price level scaled by nominal returns.

Panel (F.1b) shows that after the abandonment of the gold standard, the price level is largely responsible for the capital loss on holding government debt.



(a) Real and nominal price returns

(b) Innovations decomposition from eq. (F.41)

Figure F.1: Returns and innovations. Because there is a 0.99 correlation coefficient between returns with clean and dirty prices, the figure only shows series for dirty prices.

[27] Because $Q_t(t) = 1$ for all t, then then when $j = 0$, $Q_t(t) - Q_{t-1}(t) = 0$ and the maturity index j starts at value $j = 1$ instead of value $j = 0$.

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