Financial repression in general equilibrium: The case of the United States, 1948–1974[*]

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Abstract

Financial repression lowers the return on government debt and contributes, all else equal, towards its liquidation. However, its full effect on the debt-to-GDP ratio hinges on how repression impacts the economy at large because it alters investment and saving decisions. We develop and estimate a New Keynesian model with financial repression. Based on U.S. data for the period 1948–1974, we find, consistent with earlier work, that repression was pervasive but gradually phased out. A model-based counterfactual shows that GDP would have been 5 percent lower, and the debt-to-GDP ratio 20 percentage points *higher*, had repression not been phased out.

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1 Introduction

Public debt has recently reached record levels, as Panel (a) of Figure 1 illustrates for the U.S. based on various measures. There is consensus among policy makers that prudence calls for a reduction of debt, however gradual, in order to create fiscal space and prepare for future crises (IMF, 2023).[1] Classical debt reduction policies include boosting growth, primary surpluses, and inflation, all of which are difficult to engineer but are frequently deployed with varying intensity (Arslanalp and Eichengreen, 2023; Barro and Bianchi, 2023). Also, the same panel shows that the debt-to-GDP ratio declined strongly post-WW2. Next to the above mentioned policies, this was arguably also due to financial repression, which allows the government to borrow at artificially low rates (Reinhart and Sbrancia, 2015; Acalin and Ball, 2023). And while the notion of financial repression was originally developed in the context of developing economies (McKinnon, 1973; Shaw, 1973), Panel (b) of Figure 1 illustrates that (holding period) returns on U.S. government debt were indeed spectacularly low during and after after WW2. This holds not only relative to later periods, but also compared to short-term rates and inflation. Such low returns are also unique in a broader historical context (Hall and Sargent, 2021, 2022).

In this paper, we ask if and, if so, how financial repression contributed to the evolution of the debt-to-GDP ratio in the U.S. after WW2. This is challenging because, first, the interest rate which would have prevailed in the absence of repression—say, the "laissez-faire" interest rate—is not directly observable. Second, financial repression not merely redistributes from bond holders to the government but impacts investment and savings decisions, too, a point stressed by Chari, Dovis, and Kehoe (2020), or CDK for short. As a consequence, repression affects the evolution of the debt-to-GDP ratio not only directly by altering interest rates but also indirectly via growth, inflation, and tax revenues.

We build on CDK and model financial repression within a New Keynesian DSGE model that we estimate on U.S. time series data for the post-WW2 period. Our estimates show that repression was indeed pervasive but gradually phased out in the decades following the war. To understand its effects we construct a counterfactual, assuming that repression had not been phased out: In this case the debt-to-GDP ratio would have actually declined *less* because of lower GDP growth. Hence, if the point of repression was to bring down the debt-to-GDP ratio it was counterproductive. At the same time, we may rationalize earlier results suggesting that repression helped to bring down the debt-to-GDP ratio. In our framework, this holds, too, if we abstract from general equilibrium effects and consider the effect of financial repression on interest rates in isolation. In this case, we find it contributed to the decline of the debt-to-GDP ratio by some 30 percentage points, consistent with recent estimates by Acalin and Ball (2023).

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[1]Theory is more ambiguous: it identifies factors which determine how much debt can or, in fact, should be sustained (e.g. Barro, 1979; Aiyagari and McGrattan, 1998; Mian, Straub, and Sufi, 2022).

Figure 1: Government debt and yields

(a) Government debt per GDP   **(b)** Historical returns
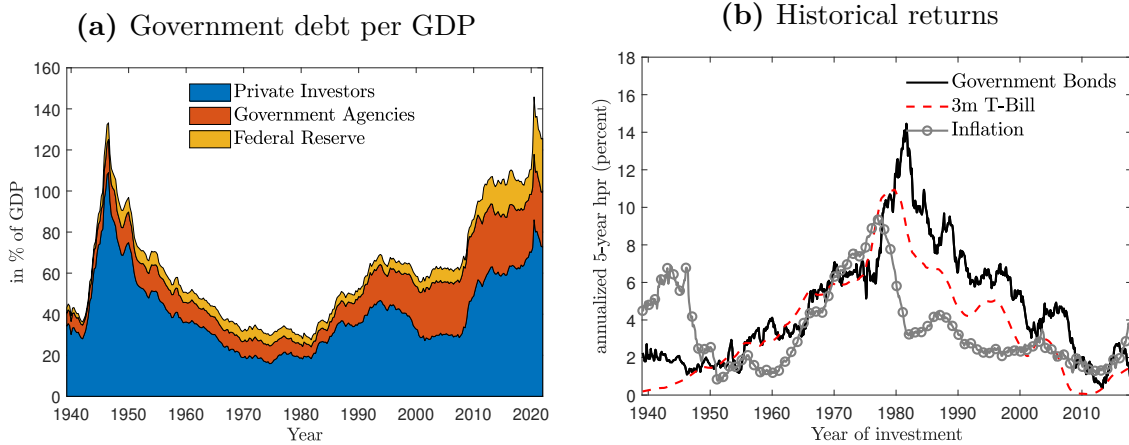
Notes: The left panel shows market value of interest bearing government debt in percent of GDP; the right panel shows average annualized returns on different assets for a 5-year holding period: the ex-post holding period return of an average maturity government bond portfolio (solid black line) and the average annualized return of 3-month Treasury bills (dashed red line); the grey circle line shows average inflation over the same holding period. Sources: Hall et al. (2021) and FRED Economic Data.

Financial repression may come in various forms, as discussed in detail by Reinhart and Sbrancia (2015). One prominent example includes explicit caps on interest rates such as Regulation Q that limited banks' interest rate payments on deposits, directing savings to bonds. Yet, the scope of financial repression is much broader as it aims at keeping long-term rates low. At some point this was explicit Fed policy. In the late 1940s, it allowed short rates to fluctuate, but maintained a ceiling of 2.5% for the long-term rate (Chandler, 1949). Similarly, during the early 1960s, "Operation Twist" sought to raise short-term rates while keeping long-term rates low. By end-1961, the Fed ended its "bills only" policy (Hetzel and Leach, 2001a,b). Moreover, to prevent arbitrage, financial repression requires a captive audience for government debt. In the case of banks, this may be the result of explicit regulatory requirements or implicitly via "moral suasion."[2]

We model financial repression as in CDK and assume a banking sector that faces a regulatory constraint: It mandates that banks hold a certain fraction of their assets as long-term government debt. In order to account for changes in the extent of financial repression, we allow this fraction to vary over time. This captures the notion that the banking sector is a captive audience for government debt while being agnostic about specific measures on which the government relies when it auctions off debt at elevated prices. CDK study conditions under which financial repression can be optimal. In particular, absent commitment, repression can enhance the credibility of the government as a borrower by raising the economic costs of default (see also Jeanne, 2023).

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[2]As an example, Reinhart and Sbrancia (2015) relate an episode from the 1960s in which the Fed asked commercial banks—via mail—for foreign-credit restraint.

We abstract from default altogether and we embed financial repression à la CDK in a New Keynesian framework with financial intermediation, using Gertler and Karadi (2013) as our point of departure. Our model also features a rich fiscal sector along the lines of Bianchi and Ilut (2017). For these reasons it is able to capture well the joint dynamics of government debt, interest rates, and inflation—all of which are, in turn, key to understanding why real rates have been particularly low in the post-WW2 period. More generally, our framework allows us to shed light on the interaction between financial repression, on the one hand, and conventional monetary and fiscal policies, on the other hand. As a caveat, we note upfront that our model does not capture all aspects of financial repression. Instead, we focus on the impact of repression on banks' balance sheets in order to quantify its adverse impact on investment and economic activity. In this way, we not only highlight an aspect of financial repression that is typically ignored in the literature which seeks to quantify its contribution to debt reduction. We also capture a key feature of financial repression highlighted in the literature: a readiness of the private sector to hold on to government debt at compressed yields.

We estimate the model on U.S. time series for the period 1948q2–1974q4 using standard macroeconomic and fiscal indicators but also time series specific to the banking sector: The share of outstanding government debt held by commercial banks and the share of government debt in banks' portfolios. For our sample period, we find that the estimated model explains the data best under a fiscal-led regime where monetary policy does not satisfy the Taylor principle, or put differently, fiscal policy is active and monetary policy is passive (Leeper, 1991). This finding confirms earlier results by, for example, Leeper, Traum, and Walker (2017) and Bianchi and Ilut (2017). The estimated model provides insights on the extent of financial repression. Bank portfolios were highly constrained immediately after WWII but gradually less so in the following decades. Our results conform with CDK's observation that governments "engage in financial repression when their fiscal needs are exceptionally high [. . . and then] run down their accumulated debt, reduce the extent of repression, and eventually cease it altogether when the level of debt is sufficiently low."

To assess the impact of repression on the evolution of the debt-to-GDP ratio and the economy more broadly, we construct a counterfactual scenario based on the estimated model. We solve the model for the estimated parameters and for the estimated shocks but assume—counterfactually—that the regulatory constraint had not been relaxed. Instead we impose a constant value corresponding to the estimate for the beginning of our sample period. We solve the model, in other words, under the assumption that repression had not been phased out. Once we do that, we find that if repression had stayed high, the debt-to-GDP ratio would have declined *less*. Taken at face value, the sign of the change is surprising. But it can be rationalized on the ground that the economy would have been on a less expansionary trajectory if repression had been maintained at high levels. In

this scenario, at the end of 1974, investment and GDP would have been 12% and 5% lower, respectively. As a result, keeping repression high would not have contributed to the liquidation of government debt at all. Rather, we find that any direct effect of repression on interest rates is more than offset by general equilibrium effects.

Finally, to reconcile our analysis with existing results, we isolate the direct effect of repression on interest rates by computing the laissez-faire rate, the interest rate without financial repression. We find it considerably higher than actual interest rates. Also according to this measure, repression was phased out during our sample period: The gap between the laissez-faire and the actual rate was largest in the late 1940s and the early 1950s, declined afterwards and was closed by the late 1960s. Importantly, if we compute the counterfactual evolution of the debt-to-GDP ratio assuming the government had paid the laissez-faire rate, *all else equal*, we find the debt ratio would have declined much less than in the data. In other words, had the government paid the higher laissez-faire rate, the debt-to-GDP ratio would have declined by only 30 percentage points, rather than by the 57 percentage points which we observe during our sample period. From an accounting perspective it thus appears that repression was conducive to lowering the debt-to-GDP ration—even though it was not.

The paper is structured as follows. In the remainder of the introduction we clarify the paper's connection to the existing literature. Section 2 presents our model which embeds financial repression à la CDK in a New Keynesian DSGE setup. Section 3 describes the data, the estimation as well as the estimation results. We inspect the mechanism in some detail in Section 4 and present our counterfactuals in Section 5. A final section offers a short conclusion.

Related literature. Our paper relates to several strands of the literature. First, we stress that our analysis is purely positive—in contrast to the normative analyses of financial repression by CDK and Jeanne (2023). Second, in addition to the studies mentioned above, there is earlier work which analyzes repression in various contexts. Giovannini and de Melo (1993) consider developing economies and proxy the laissez-faire interest rate with the interest rate a government pays on world capital markets. They document that the "repression tax" contributed handsomely to government revenues. An earlier survey by Fry (1997) concludes that financial repression contributed to government revenue in the order of 2 percent of GDP in a sample of developing economies. More recent empirical work suggests that repression has been under way during the recent euro area crisis (Becker and Ivashina, 2017; Ongena, Popov, and Van Horen, 2019). Reinhart, Reinhart, and Rogoff (2015) study debt reduction policies in 22 advanced economies from 1800 to 2014 and find that governments have often relied on "heterodox approaches". Yet all these studies take an "all-else-equal" perspective on financial repression, while we account its general-equilibrium effects.

Third, there are alternative ways to think of financial repression. In an early study, Roubini and Sala-i-Martin (1995) puts forward a model where financial repression raises money demand, say because of regulation that limits the use of checks, ATMs etc. This in turn raises the base on which the inflation tax operates. As result, their model predicts that inflation and financial repression go hand in hand, quite contrary to what our analysis suggests (see also Brock, 1989). More generally, financial regulation has been found to impact financial markets. Du, Tepper, and Verdelhan (2018), for instance, rationalize large and persistent deviations from covered interest rates in light of the new regulatory environment put in place after the crisis. It seems to impair the ability of financial intermediaries to arbitrage away spreads between the return of riskless securities. This mechanism operates at the heart of our model.

2   The model

Our analysis relies on a medium-scale New Keynesian model in which the financial and fiscal sectors take center stage. In modelling these sectors we build on earlier work by Gertler and Karadi (2013), Bianchi and Ilut (2017), and Chari, Dovis, and Kehoe (2020). The economy is populated by four types of agents: households, banks, firms, and a government sector. We discuss their decision problems in some detail in what follows.

2.1   Households

There is a continuum of identical households which consume, save and supply labor to an employment agency. As in Gertler and Karadi (2011, 2013), a fraction f of household members are bankers and a fraction $1 - f$ are workers. Workers are employed by an intermediate good firm and earn wage income. Bankers manage a financial intermediary, which collects deposits from all households, funds non-financial firms, and holds government bonds. There is perfect consumption smoothing within the household. Over time, each member may change its occupation, yet the fraction of household members in each occupation remains constant. In particular, with probability $1 - \sigma$ a banker quits and becomes a worker next period, while with probability $f(1 - \sigma)$ a worker becomes a banker. Once the banker exits its business, retained earnings are transferred to the household and the bank shuts down. This setup ensures that financial intermediaries are unable to finance all investment projects with retained earnings and thus remain dependent on deposits. Any new banker obtains constant startup funds, X, from the household. The representative household maximizes expected lifetime utility,

$$E_t \sum_{t=0}^{\infty} \beta^t e^{\varepsilon_{d,t}} \left[\ln \left(c_t - b c_{t-1}^a \right) - \Psi_L \frac{l_t^{1+\psi}}{1+\psi} \right],$$

with consumption, c_t, the predetermined stock of consumption habits, c_{t-1}^a, labor l_t, and preference parameters ψ and Ψ_L. The habit stock is external to the household; thus c_t^a denotes the average consumption in the economy with parameter $b \in (0,1)$, determining the extent of external habits. Parameter $\beta \in (0,1)$ is the discount factor and $\varepsilon_{d,t}$ a preference shock that follows an AR(1) process:

$$\varepsilon_{d,t} = \rho_d \varepsilon_{d,t-1} + \sigma_d \epsilon_{d,t}, \text{ with } \epsilon_{d,t} \overset{iid}{\sim} N(0,1). \tag{2.1}$$

The household budget constraint reads in nominal terms as follows:

$$P_t c_t + D_t + Q_t^b \left(B_t^h + f_b \left(B_t^h \right) \right) + Q_t^s \left(S_t^h + f_k \left(S_t^h \right) \right) \leq P_t w_t l_t + Div_t - P_t X -$$
$$P_t T_t + P_t T R_t + R_{t-1}^d D_{t-1} + R_t^b Q_{t-1}^b B_{t-1}^h + R_t^k Q_{t-1}^s S_{t-1}^h.$$

The household earns labor income, given by hours worked, l_t, and the real wage, w_t. It receives payouts from ownership of non-financial firms and financial firms, Div_t. The household pays taxes, T_t, and receives transfers, TR_t, from the government. The aggregate price level is given by P_t.

The household earns income on three kinds of assets: deposits, D_t, which earn a predetermined risk-free nominal return R_{t-1}^d; private securities S_t^h, and government bonds, B_t^h, which trade at prices Q_t^s and Q_t^b, respectively. Government debt is a perpetuity with geometrically decaying coupons as in Woodford (2001) in order to capture the maturity of government debt. The realized nominal return on government debt with an average maturity is given by

$$R_t^b = \frac{1 + \iota Q_t^b}{Q_{t-1}^b}, \tag{2.2}$$

where $\iota \in (0,1)$ denotes the rate of decay. Regarding the household's private security holdings, we let r_t^k denote the rental rate of capital which is the net period income flow from financing a unit of capital (see below for further details). Then, the realized nominal return of the private security, R_t^k, is given by

$$R_t^k = \frac{r_t^k + (1-\delta)Q_t^s}{Q_{t-1}^s} \Pi_t, \tag{2.3}$$

where Q_t^s is the market value of the security, δ the depreciation rate of a unit of capital, and $\Pi_t = P_t / P_{t-1}$ inflation.

Adjusting the portfolio is costly for the household. Specifically, as in Coenen et al. (2018) we assume:

$$f_k \left(S_t^h \right) = 1/2 \kappa_k \left(S_t^h - \tilde{S}^h \right)^2 / \tilde{S}^h. \tag{2.4}$$

$$f_b \left(B_t^h \right) = 1/2 \kappa_b \left(B_t^h - \tilde{B}^h \right)^2 / \tilde{B}^h, \tag{2.5}$$

where parameters $\tilde{S}^h$ and $\tilde{B}^h$ determine to which amount asset holding is costless. Opti-

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mality requires labor supply, consumption and deposits:

$$\Lambda_t = e^{\varepsilon_{d,t}} \left(c_t - b c_{t-1}^a \right)^{-1} \tag{2.6}$$

$$w_t = e^{\varepsilon_{d,t}} \Psi_L \frac{l_t^{\psi}}{\Lambda_t} \tag{2.7}$$

$$1 = R_t^d E_t \left[M_{t,t+1} \Pi_{t+1}^{-1} \right], \tag{2.8}$$

where $M_{t,t+1} = \beta \Lambda_{t+1}/\Lambda_t$ is the household's real stochastic discount factor and Λ_t the marginal utility of consumption. The optimal portfolio choice satisfies:

$$S_t^h = \left(1 + \frac{M_{t,t+1} \left(R_{t+1}^k - R_t^d \right)}{\Pi_{t+1} \kappa_k} \right) \tilde{S}^h \tag{2.9}$$

$$B_t^h = \left(1 + \frac{M_{t,t+1} \left(R_{t+1}^b - R_t^d \right)}{\Pi_{t+1} \kappa_b} \right) \tilde{B}^h + \varepsilon_{bh,t}. \tag{2.10}$$

$\varepsilon_{bh,t}$ is a shock to the demand for government bonds which evolves according to:

$$\varepsilon_{bh,t} = \rho_{bh} \varepsilon_{bh,t-1} + \sigma_{bh} \epsilon_{bh,t}, \text{ with } \epsilon_{bh,t} \overset{iid}{\sim} N\left(0, 1 \right). \tag{2.11}$$

2.2 Financial intermediaries

A representative financial intermediary, or bank, i relies on real deposits, $d_{i,t} = D_{i,t}/P_t$, and retained earnings to fund either the capital stock of non-financial firms or purchases of government debt. Letting $s_{i,t}^b$ denote the funding of non-financial firms by bank i, $b_{i,t}^b$ holdings of government debt and $n_{i,t}$ its real equity position (or real net worth), the balance sheet is given by:

$$Q_t^s s_{i,t}^b + Q_t^b b_{i,t}^b = d_{i,t} + n_{i,t},$$

where $s_{i,t}^b = S_{i,t}^b/P_t$ and $b_{i,t}^b = B_{i,t}^b/P_t$. Net worth evolves as follows:

$$n_{i,t+1} = \frac{1}{\Pi_{t+1}} \left[\left(R_{t+1}^k - R_t^d \right) Q_t^s s_{i,t}^b + \left(R_{t+1}^b - R_t^d \right) Q_t^b b_{i,t}^b + R_t^d n_{i,t} \right]. \tag{2.12}$$

The bank maximizes the expected value of its terminal value net worth:

$$V_{i,t} = \max \left\{ \left(1 - \sigma \right) E_t \sum_{j=1}^{\infty} \sigma^{j-1} M_{t,t+j} n_{i,t+j} \right\}, \tag{2.13}$$

where $1 - \sigma$ is the exogenous probability that a banker will close down its operations. Maximization is subject to two constraints. The first reflects the agency friction introduced by Gertler and Karadi (2011). A banker may divert a fraction $\theta \in (0, 1)$ of private-sector funding and $\Delta \theta$ for government debt, where $\Delta \in (0, 1)$.[3] For depositors to be willing to

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[3]This assumption reflects the notion that private-sector funding is easier to divert because it is harder for depositors to observe.

lend to the bank, we require the following *participation constraint* to be satisfied:

$$V_{i,t} \geq \theta \left(Q_t^s s_{i,t}^b + \Delta Q_t^b b_{i,t}^b \right). \tag{2.14}$$

The second constraint is central to our analysis. Following Chari, Dovis, and Kehoe (2020) we assume a *regulatory constraint*:

$$Q_t^b b_{i,t}^b \geq \tilde{\Gamma}_t \left(Q_t^b b_{i,t}^b + Q_t^s s_{i,t}^b \right).$$

Here $\tilde{\Gamma}_t$ is the minimum share of assets that banks need to hold as government debt. It captures a variety of measures such as those discussed by Reinhart and Sbrancia (2015). Such measures may not literally force financial intermediaries to hold a certain fraction of assets as government debt. Still, they effectively raise the demand for, and thus price of, government debt, which is precisely the implication of the regulatory constraint. We rearrange it slightly to

$$Q_t^b b_{i,t}^b \geq \Gamma_t Q_t^s s_{i,t}^b, \tag{2.15}$$

with $\tilde{\Gamma}_t = \frac{\Gamma_t}{1+\Gamma_t}$. Optimality requires:

$$E_t M_{t,t+1} \left(R_{t+1}^k - R_t^d \right) \frac{\Omega_{i,t+1}}{\Pi_{t+1}} = \frac{\lambda_{i,t}\theta + \mu_{i,t}\Gamma_t}{1+\lambda_{i,t}} \tag{2.16}$$

$$E_t M_{t,t+1} \left(R_{t+1}^b - R_t^d \right) \frac{\Omega_{i,t+1}}{\Pi_{t+1}} = \frac{\lambda_{i,t}\theta\Delta - \mu_{i,t}}{1+\lambda_{i,t}}, \tag{2.17}$$

where $\Omega_{i,t+1} = 1 - \sigma + \sigma \frac{\partial V_{i,t+1}}{\partial n_{i,t}}$ is the shadow value of one unit of net worth to the bank; $\lambda_{i,t}$ and $\mu_{i,t}$ are the multipliers on the participation and on the regulatory constraint, respectively. As such they measure the extent to which the two financial frictions constrain banks' behavior.

Against this background, a few remarks are in order. In particular, equation (2.16) relates the (expected) excess return on investment in intermediate-good firms (over the deposit rate) to the tightness of the participation constraint (2.14) and regulatory constraint (2.15). Intuitively, to the extent that bankers are leverage-constrained, expected excess returns persist in equilibrium. Additionally, due to the distortion of banks' portfolio choice through government regulation, a binding regulatory constraint (i.e. $\mu_{i,t} > 0$) reflects an artificially reduced demand for real capital that pushes up excess return, too. This leads to a crowding out of investment and reduces real activity as pointed out by Chari, Dovis, and Kehoe (2020).

Equation (2.17), in turn, relates the (expected) excess return on government debt to the tightness of both constraints. In our setup, there is market segmentation because households find it costly to adjust their debt holdings and banks are leverage-constrained. As a result, there are limits to arbitrage and differences in expected yields persist in equilibrium. In addition there is a "regulatory discount" which appears in Equation (2.17)

via $\mu_{i,t}$. Recall that this is the multiplier on the regulatory constraint. The tighter the constraint (2.15), the lower the expected excess return on government debt. Intuitively, to the extent that the regulatory constraint binds, the price of government debt is pushed up and (expected) returns are depressed—in other words, financial repression.

The limits to arbitrage stem from the following restriction that participation and regulatory constraint place on the size of a bank's portfolio relative to its net worth, the bank's "risk-weighted" leverage ϕ_t:[4]

$$\phi_t = \frac{Q_t^s s_{i,t}^b + \Delta Q_t^b b_{i,t}^b}{n_{i,t}}, \tag{2.18}$$

$$\text{with } \phi_t = \frac{E_t M_{t,t+1} \Omega_{i,t+1} \Pi_{t+1}^{-1} R_t^d}{\theta - E_t \frac{M_{t,t+1}\Omega_{i,t+1}}{(1+\Delta\Gamma_t)\Pi_{t+1}} \left[R_{t+1}^k - R_t^d + \Gamma_t \left(R_{t+1}^b - R_t^d\right)\right]}. \tag{2.19}$$

2.3 Firms

Firms produce a final good under perfect competition. It is an aggregate of intermediate goods:

$$y_t = \left(\int_0^1 y_{j,t}^{\frac{\theta_p-1}{\theta_p}} dj\right)^{\frac{\theta_p}{1-\theta_p}}, \tag{2.20}$$

where $\theta_p > 1$ is the elasticity of substitution across the intermediate goods. A representative firm takes the price of output, P_t, and the price of inputs, $P_t(j)$, as given. The resulting demand function for the intermediate good is

$$y_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\theta_p} y_t, \tag{2.21}$$

and the aggregate price level is defined as

$$P_t = \left(\int_0^1 P_{j,t}^{1-\theta_p} dj\right)^{\frac{1}{1-\theta_p}}. \tag{2.22}$$

The intermediate good j is produced by firms which operate under monopolistic competition. The production function is Cobb-Douglas:

$$y_{j,t} = k_{j,t-1}^\alpha \left(A_t l_{j,t}\right)^{1-\alpha} - A_t\Phi, \tag{2.23}$$

where $k_{j,t}$ and $l_{j,t}$ denote capital services and labor used for production by intermediate firm j, respectively. $\alpha \in (0,1)$ and $\Phi > 0$. The latter parameterizes the fixed costs of production that grow at the rate of technology progress: The variable A_t represents productivity and follows a stochastic trend. Specifically, defining $\exp\{z_t\} = A_t/A_{t-1}$, we assume

$$z_t = \left(1 - \rho_z\right)\bar{z} + \rho_z z_{t-1} + \sigma_z\epsilon_{z,t}, \text{ with } \epsilon_{z,t} \overset{iid}{\sim} N\left(0,1\right). \tag{2.24}$$

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[4]The appendix provides more detailed derivations.

Firms face perfectly competitive factor markets for capital and labor. Cost minimization implies that firms have identical marginal costs:

$$mc_t = \left(\frac{1}{1-\alpha}\right)^{1-\alpha} \left(\frac{1}{\alpha}\right)^{\alpha} \left(\frac{w_t}{A_t}\right)^{1-\alpha} \left(r_t^k\right)^{\alpha}, \tag{2.25}$$

$$\frac{k_{t-1}}{l_t} = \frac{w_t}{r_t^k} \frac{\alpha}{(1-\alpha)}, \tag{2.26}$$

where r_t^k and w_t represent the rental rate of capital and real wages, respectively, and mc_t denotes real marginal costs. The law of motion for capital is given by

$$k_t = (1-\delta) k_{t-1} + \mathcal{I}_t, \tag{2.27}$$

where δ is the depreciation rate and $\mathcal{I}_t$ new capital. This is produced by investment goods producers based on the following production function:

$$\mathcal{I}_t = e^{\varepsilon_{I,t}} \left[1 - S\left(\frac{I_t}{I_{t-1}}\right)\right] I_t \tag{2.28}$$

where $S(\cdot)$ is an investment adjustment costs function as in Christiano, Eichenbaum, and Evans (2005). We assume that $S(\cdot) = S'(\cdot) = 0$ and $\nu \equiv S''(\cdot) > 0$ along the steady state growth path with the adjustment cost parameter ν. Investment costs are subject to an investment-specific efficiency shock $\varepsilon_{I,t}$ which evolves according to the process:

$$\varepsilon_{I,t} = \rho_I \varepsilon_{I,t-1} + \sigma_i \epsilon_{I,t}, \text{ with } \epsilon_{I,t} \overset{iid}{\sim} N\left(0,1\right). \tag{2.29}$$

Price setting is constrained à la Calvo (1983): in a given period, firms are allowed to adjust prices with probability $(1 - \gamma_p)$ only. If a firm cannot adjust, its price evolves according to the indexation rule: $P_{j,t} = P_{j,t-1} \Pi_{t-1}^{\xi_p}$. If the firm is able to adjust its price, the price $\tilde{p}_t = P_{j,t}$ is set to maximize the value of its expected future dividend stream subject to the demand for its products. Optimality requires

$$\mathcal{K}_t^p = y_t \tilde{p}_t + \gamma_p E_t \left[M_{t,t+1} \left(\frac{\Pi_t^{\xi_p}}{\Pi_{t+1}}\right)^{1-\theta_p} \frac{\tilde{p}_t}{\tilde{p}_{t-1}} \mathcal{K}_{t+1}^p \right] \tag{2.30}$$

and

$$\mathcal{F}_t^p = y_t mc_t + \gamma_p E_t \left[M_{t,t+1} \left(\frac{\Pi_t^{\xi_p}}{\Pi_{t+1}}\right)^{-\theta_p} \mathcal{F}_{t+1}^p \right] \tag{2.31}$$

with

$$\mathcal{F}_t^p = \frac{\theta_p - 1}{\theta_p} \mathcal{K}_t^p, \tag{2.32}$$

which is the same for all firms that can adjust their price in period t. The evolution of

the aggregate price index is implicitly given by:

$$1 = \gamma_p \left(\frac{\Pi_{t-1}^{\xi_p}}{\Pi_t} \right)^{1-\theta_p} + (1 - \gamma_p) \left(\tilde{p}_t \right)^{1-\theta_p}. \tag{2.33}$$

2.4 Government

In each period the government finances purchases g_t, transfers TR_t and interest rate payments by raising taxes T_t and issuing nominal government debt B_t which trades at Q_t^b. Using $\mathcal{B}_t \equiv Q_t^b B_t / (P_t y_t)$ to denote the debt-to-GDP ratio, e_t the expenditure ratio (sum of purchases and transfers relative to GDP) and τ_t taxes relative to GDP, we write the period budget constraint of the government as follows:

$$\mathcal{B}_t + \tau_t = R_t^b \frac{\mathcal{B}_{t-1} y_{t-1}}{\Pi_t y_t} + e_t + \varepsilon_{tp,t}. \tag{2.34}$$

We follow Bianchi and Ilut (2017) and allows for a shock, $\varepsilon_{tp,t}$, to the budget constraint. The process evolves according to:

$$\varepsilon_{tp,t} = \rho_{tp} \varepsilon_{tp,t-1} + \sigma_{tp} \epsilon_{tp,t}, \text{ with } \epsilon_{tp,t} \overset{iid}{\sim} N(0,1). \tag{2.35}$$

We also follow Bianchi and Ilut (2017) as we specify the process for expenditures and purchases: the dynamics of total expenditures are driven by a short-term component $\tilde{e}_t^S$ and a long-term component $\tilde{e}_t^L$ ($\tilde{e}_t = \tilde{e}_t^L + \tilde{e}_t^S$).[5] The long-term component follows a highly persistent AR(1) process which is meant to capture the large and long-lasting government programs which are not explicitly modeled (for instance the "Great Society" and war spending). The short-term component captures adjustments over the business cycle. The processes for short- and long-term expenditures are given by:

$$\tilde{e}_t^S = \rho_{eS} \tilde{e}_{t-1}^S + (1 - \rho_{eS}) \eta_{eS} \hat{y}_t + \sigma_{eS} \epsilon_{eS}, \text{ with } \epsilon_{eS,t} \overset{iid}{\sim} N(0,1) \tag{2.36}$$

$$\tilde{e}_t^L = \rho_{eL} \tilde{e}_{t-1}^L + \sigma_{eL} \epsilon_{eL}, \text{ with } \epsilon_{eL,t} \overset{iid}{\sim} N(0,1). \tag{2.37}$$

Government purchases g_t are given by $g_t = \left(1 - \frac{1}{\chi_t} \right) y_t$ with the purchases-to-expenditure ratio $\chi_t = g_t / E_t$ evolving according to

$$\tilde{\chi}_t = \rho_\chi \tilde{\chi}_{t-1} + (1 - \rho_\chi) \eta_{\chi,y} \hat{y}_t + \sigma_\chi \epsilon_{\chi,t}, \text{ with } \epsilon_{\chi,t} \overset{iid}{\sim} N(0,1) \tag{2.38}$$

which allows for a contemporaneous feedback effect from output $(\eta_{\chi,y})$.

For monetary policy we assume a conventional interest-rate feedback rule:

$$R_t = \rho_R R_{t-1} + (1 - \rho_R) \left(\bar{R} + \eta_y \hat{\Xi}_t + \eta_\pi \hat{\Pi}_t \right) + \sigma_m \epsilon_{m,t}, \text{ with } \epsilon_{m,t} \overset{iid}{\sim} N(0,1), \tag{2.39}$$

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[5]Throughout the paper, $\hat{x}_t = \log(x_t/\bar{x})$ denotes the percentage deviation of a variable from its steady state and $\tilde{x}_t = x_t - \bar{x}$ denotes a linear deviation.

where ρ_R is a positive constant and η_π and η_y capture the reaction coefficients to inflation and output growth ($\Xi_t = y_t/y_{t-1}$), respectively. Finally, taxes adjust as follows:

$$\tilde{\tau}_t = \rho_\tau \tilde{\tau}_{t-1} + (1 - \rho_\tau) \left[\eta_b \tilde{\mathcal{B}}_{t-1} + \eta_{\tau,e} \tilde{e}_t + \eta_{\tau,y} \hat{y}_t \right] + \sigma_\tau \epsilon_{\tau,t}, \text{ with } \epsilon_{\tau,t} \overset{iid}{\sim} N(0,1), \quad (2.40)$$

where $\tilde{\tau}_t$ are taxes, measured in terms of GDP. There is adjustment to expenditures, output, and debt, according to coefficients $\eta_{\tau,e}$, $\eta_{\tau,y}$ and η_b. The last coefficient together with the response coefficient in the interest-rate rule η_π determines the specific monetary-fiscal regime, an issue we take up in section 3.2 below.

2.5 Aggregation and market clearing

For market clearing, we assume that deposits earn the same nominal risk-free rate as set by the monetary authority:

$$R_t^d = \exp(R_t). \quad (2.41)$$

Moreover, the total amount of private securities and long-term government bond outstanding are given by

$$s_t = s_t^h + s_t^b, \quad (2.42)$$
$$b_t = b_t^h + b_t^b. \quad (2.43)$$

Additionally, for market clearing in markets for private securities, we assume that the total supply of private securities s_t is equal the capital stock k_t. Because the bank's leverage ϕ_t does not depend on individual bank-level factors, we can aggregate the bank's balance sheet conditions into an aggregate balance sheet condition:

$$\phi_t = \frac{Q_t^s s_t^b + \Delta Q_t^b b_t^b}{n_t}.$$

Similarly, since the bank's real net worth is linear in the bank's choice variables, we can simply aggregate it. Because those banks that close down are randomly chosen, the sum of surviving banks is simply proportional to the aggregate. Newly born intermediaries are given, in aggregate, X of real start-up net worth.

$$n_t = \frac{\sigma}{\Pi_t} \left[\left(R_t^k - R_{t-1}^d \right) Q_{t-1}^s s_{t-1}^b + \left(R_t^b - R_{t-1}^d \right) Q_{t-1}^b b_{t-1}^b + R_{t-1}^d n_{t-1} \right] + X.$$

Good markets at the level of intermediates gives rise to an aggregate resource constraint:

$$p_t^+ y_t = k_{t-1}^\alpha (A_t l_t)^{1-\alpha} - A_t \Phi, \quad (2.44)$$

where $l_t = \int_0^1 l(j,t) \, dj$ and $k_t = \int_0^1 k_{j,t} \, dj$ are the aggregate labor and capital inputs, respectively. The term $p_t^+ = \int_0^1 \left(\frac{P_{j,t}}{P_t} \right)^{-\theta_p} dj$ measures the price dispersion arising from

staggered price setting. Price dispersion follows the law of motion

$$p_t^+ = (1 - \gamma_p) \left(\tilde{p}_t\right)^{-\theta_p} + \gamma_p \left(\frac{\Pi_{t-1}^{\xi_p}}{\Pi_t}\right)^{-\theta_p} p_{t-1}^+. \tag{2.45}$$

Finally, at the aggregate level, the following resource constraint needs to be satisfied

$$y_t = c_t + I_t + g_t. \tag{2.46}$$

3 Estimation

We estimate the model using Bayesian techniques. In what follows, we describe the dataset, outline the choice of the prior distributions of the parameters, and report the estimation results.

3.1 Data

We make use of ten quarterly time series to estimate the model: four series for macroeconomic indicators, four fiscal indicators, and two time series to capture developments in the banking sector. Specifically, we include GDP growth, investment growth (both in real terms), the annualized GDP deflator, and the short-term nominal interest rate as macroeconomic indicators. Our choice of fiscal indicators follows Bianchi and Ilut (2017), as we include the annualized debt-to-GDP ratio, measured at quarterly frequency, federal tax revenues and federal spending (both measured relative to GDP), and a broad measure of government expenditures, measured relative to GDP, and discussed in more detail below. Finally, we include the holdings of government debt by commercial banks, measured in percent of outstanding public debt, as well as the holdings of government debt by commercial banks, measured in percent of banks' total assets. In this way we measure the importance of banks in the market for government debt as well as the importance of government debt in terms of banks' balance sheets. For the estimation, we focus on the period of debt reduction after WW2 and limit the sample to the period 1948q2–1974q4.[6] Appendix B provides further details on the data.

3.2 Calibration and prior choice

Prior to the estimation, we calibrate a set of parameters that are not the focus of our study at customary values. Table 1 provides a summary. In particular, in the top panel of the table we report the values of parameters which determine private sector behavior.

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[6]For years prior to 1948 we lack data for U.S. commercial banks. They are regularly reported by the Board of Governors of the Federal Reserve System and provided by Fraser digital library only from the second half of 1947 onwards.

Table 1: Calibrated parameters.

| Name	Symbol	Value
Discount factor	β	0.9985
Capital share in production	α	1/3
Depreciation rate	δ	0.025
Price markup	$\theta_p/(\theta_p - 1)$	1.10
Steady-state labor supply	$\bar{l}$	1/3
Frisch elasticity of labor supply	$1/\psi$	1
Steady-state quarterly government debt	$\bar{b}/4\bar{y}$	0.375
Steady-state government purchases	$\bar{g}/\bar{y}$	0.11
Steady-state government expenditures	$\bar{e}/\bar{y}$	0.165
AR parameter log-run exp.	ρ_{eL}	0.95
S.d. long-run expenditures	$100\sigma_{eL}$	0.1
Duration government debt (in quarters)	$(1 - \iota\beta)^{-1}$	20
Portfolio adjustment cost capital	κ_k	0.1
Share of government bond holdings by households	$\bar{B}^h/\bar{B}$	0.70
Share of private capital holdings by households	$\bar{S}^h/\bar{S}$	0.85
Steady-state net worth/total assets ratio	$n/(Q^s k^b + Q^b b^b)$	0.1
Spread nominal return capital/deposit rate	$400(R^k - R^d)$	2
Spread nominal government debt/deposit rate	$400(R^b - R^d)$	0.5
Surviving probability of a banker	σ	0.95
Proportional advantage in seizure rate of government debt	Δ	0.5

The discount factor, β, is set to 0.9985, the capital income share α is set to 1/3, and the quarterly depreciation rate for private capital, δ, is set to 0.025, which implies an annual depreciation rate of 10 percent. The price markup is fixed at 10 percent, steady state labor supply is calibrated to 1/3 and the Frisch elasticity of labor supply is set to 1.

In the second panel of the table, we report the values of the fiscal variables in steady state. They are set to the mean values during our sample period. The steady-state value for the debt-to-GDP ratio on quarterly basis is equal to 1.47 which corresponds to 0.375 on an annual basis. Federal government purchases as a share of GDP, g/y, and federal expenditures, e/y, are are set to 0.11 and 0.165, respectively. We set the parameter capturing the persistence of the long-term component of government expenditure, ρ_{eL} to 0.95 and the corresponding standard deviation of its innovations to $\sigma_{eL} = .1\%$, similar to Bianchi and Ilut (2017).

In the bottom panel of Table 1, we report the values for parameters which capture key aspects of household behavior and bank portfolios. We set the parameter ι so that the average maturity of government debt is 20 quarters, which corresponds to the U.S. average between 1952 and 2020 as reported by the Treasury Bulletin, see also Leeper, Traum, and Walker (2017) or Bianchi and Ilut (2017).[7] We set the portfolio adjustment

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[7]Hall and Sargent (2011) and Acalin and Ball (2023) highlight the role of changes in the average maturity of outstanding government debt. In particular, they illustrate that the average maturity of

Figure 2: Holdings of Government Debt by Commercial Banks . . .

(a) as fraction of total public debt

(b) as a fraction of banks' assets
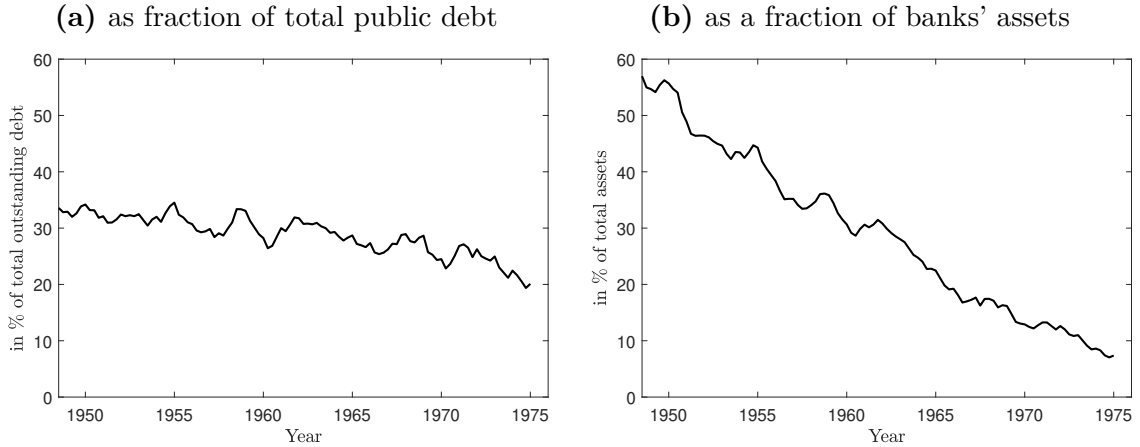
Notes: The figures shows U.S. government obligations held by all commercial banks divided by the par value of government interest bearing debt held by private investors from Hall et al. (2021), in the left panel, and divided by total loans and investments held by all commercial banks (both from the Board of Governors of the Federal Reserve System, provided by Fraser digital library) in the right panel.

cost of private capital, κ_k, to 0.1 and estimate the corresponding portfolio adjustment cost for government debt. Given these parameters, the constants $\tilde{B}^h$ and $\tilde{S}^h$ in the portfolio adjustment cost functions of the households are chosen such that, in steady state, 70 percent of total government bonds and 85 percent total private securities are held by households. This implies that commercial banks hold 30 percent of government debt in steady state, consistent with the data shown in panel (a) of Figure 2. We set the ratio of net worth to total assets equal to 10 percent corresponding to the historical average for commercial banks over our sample period. The annualized spread on corporate loans and the spread on government bonds are set to 200 basis points and 50 basis points, respectively. For corporate loans this is in line with Moody's Seasoned BAA corporate bond spreads between 1947 and 1974. For government bonds the value is slightly smaller then the spread between the 5-year government bond yield and the 3-month T-Bill of 0.6 between 1962 and 1974. The survival rate of the banker, σ, is set to 0.95 as in Sims and Wu (2021). We set Δ which captures the proportional advantage in the seizure rate of government debt to 0.5 as in Gertler and Karadi (2013).

This calibration implies values for parameters X, Γ, μ, and θ. In particular, for θ, which is the fraction of capital that can be diverted, we obtain a value of 0.54, which is between the values used by Gertler and Karadi (2013) and Sims and Wu (2021). The new equity infusion to new intermediaries, X is about 0.93 percent of total equity. Γ is equal to 0.31 which implies that government bond holdings of banks are around 23.5 percent of

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outstanding debt increased in the aftermath of WWII, before the trend reversed after the Fed-Treasury Accord of March 1951 until the mid-1970s. The Treasury Bulletin reports an average maturity of about 6.5 years for 1951 and about 2.9 years in 1974.

total assets, $\Gamma/(\Gamma + 1)$, in line with the historical average as illustrated in panel (b) of Figure 2. Finally, the repression discount μ in steady state at 0.51 turns out to be almost identical to that reported by Reinhart and Sbrancia (2015). They find that repression is around 2 percent per year.

We estimate the remaining parameters. For this purpose we set prior distributions in line with the literature. In what follows, we highlight those that are particularly relevant. Following Leeper, Traum, and Walker (2017), we focus on the two distinct regions of the parameter subspace which yield unique bounded rational expectations equilibria. Applying the terminology by Leeper (1991), the regions are characterized as either an active monetary/passive fiscal policy regime (Regime M) or a passive monetary/active fiscal policy regime (Regime F). To this end, we consider two sets of priors for the policy parameters which place nearly all probability mass on regions of the parameter space consistent with either Regime F or with Regime M. In particular, the prior for the Taylor-rule parameter η_π is beta-distributed with mean 0.5 under Regime F and gamma-distributed with mean 1.8 under Regime M, respectively. At the same time, the response coefficient in the tax rule, $\eta_{\tau,b}$, is set to 0 under Regime F and assumed to be gamma-distributed with mean 0.1 under Regime M.

We also highlight the prior choice for the parameter which captures the costs of adjusting the holdings of government bonds in the household portfolio. These adjustment costs are a crucial determinant of the overall level of financial frictions, and in particular of financial repression. For example, if adjustment costs are zero, households can flexibly purchase government bonds from the banks which makes the banks' balance sheet constraints less tight. We assume that κ_b is gamma-distributed with mean 0.01 and standard deviation 0.075, in line with but less tight than in Coenen et al. (2018). The right panel of Table 2 summarizes these and the remaining priors for Regime F which we find is preferred by the data.

3.3   Estimation results

We approximate the posterior distribution using a random walk Metropolis-Hastings algorithm. Specifically, we run two chains of 400k draws each, discarding the first 80% of the draws as burn-in. Table 2 report the posterior mode and the 90-percent credible intervals of the estimated parameters for Regime F. Below, we focus much of our analysis on this regime because it is favored by the data according to the log marginal data densities calculated using Geweke's (1999) modified harmonic mean estimator. For Regime F and Regime M the log data densities are 3181.04 and 3178.46, respectively. This implies a Bayes factor of around 13.2 which indicates strong support for Regime F from the data: The posterior model probability for Regime F is approximately 93 percent vs 7 percent

Figure 3: Smoothed model variables

(a) HPR (nominal) of government bond

(b) Government expenditures / GDP
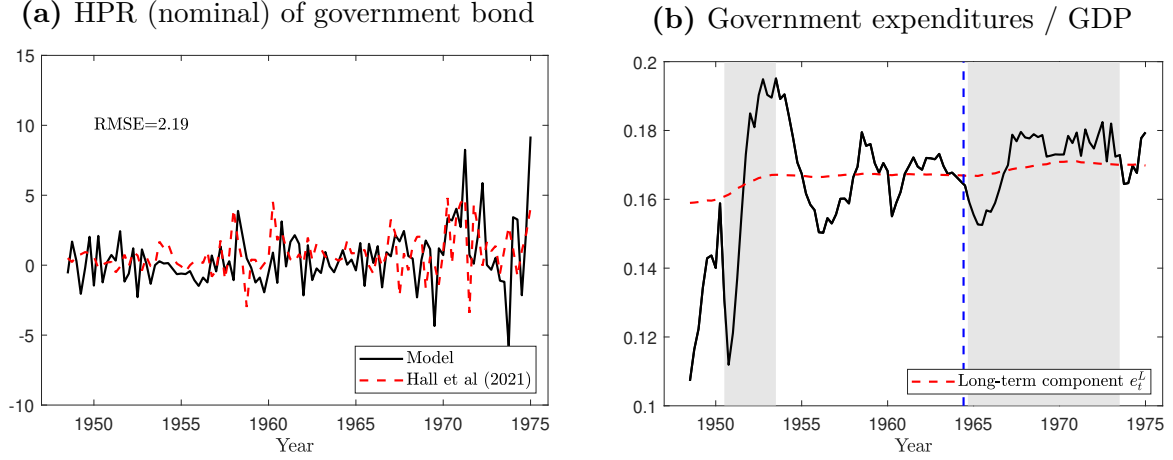
Notes: The left panel shows nominal holding period return of a government bond portfolio implied by the model and estimates by Hall et al. (2021). The right panel shows government expenditure-to-GDP ratio and e_t^L its long-term component (red-dashed). The shaded areas are the Korean and Vietnam wars and the blue vertical line corresponds to president Lyndon B. Johnson's first announcement of the "Great Society."

for Regime M.[8] Table C.1 in the appendix shows the corresponding estimates for Regime M. It also also plots the prior and the posterior distribution of each parameter for both regimes.

To assess the performance of the model, we compare its predictions for times series that have not been used in the estimation with actual data as well as with relevant narratives. For this purpose, we display, in panel (a) of Figure 3, the ex-post nominal return on the average-maturity government debt portfolio predicted by the model and a time series compiled by Hall et al. (2021). They use market prices for all marketable public bonds and calculate the ex-post holding period return. This measure captures changes in bond valuations which are not reflected in interest rate expenses calculated on actual coupon payments and is therefore an appropriate benchmark for the model prediction. And indeed, we find that the prediction of the model performs quite well in this regard.[9]

In panel (b) of Figure 3 we show government expenditures as a ratio of GDP (e_t) and its long-term component (e_t^L). Benchmarking the expenditure ratio against this component, we see that expenditures are particularly high during the Korean and Vietnam wars, both highlighted by the gray areas in the figure. Moreover, it is noteworthy that the long-term component e_t^L moves upward after the first announcement of the Great

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[8]Applying a Laplace approximation results in a similar but slightly higher Bayes factor and, therefore, indicates even more support by the data for Regime F.

[9]When computing the model-implied ex-post return for Regime M, we find that the root mean squared error is approximately 64% higher then for Regime F (RMSE=3.59 vs. RMSE=2.19, for regimes M and F respectively). This result provides additional support for Regime F relative to Regime M.

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Table 2: Prior and posterior distribution of parameters (Regime F)

Name	Symbol	Posterior				Pior		
		Mode	Mean	5%	95%	Type	Mean	Std
Calvo parameter	γ_p	0.550	0.545	0.489	0.600	B	0.5	0.05
Price indexation	ζ_p	0.285	0.312	0.162	0.460	B	0.3	0.10
Investment adjustment	ν	4.823	4.783	3.628	5.999	G	4.0	0.75
Habit formation	b	0.442	0.451	0.370	0.533	B	0.75	0.10
Portfolio adj. cost	κ_b	0.033	0.038	0.019	0.056	G	0.01	0.0075
Interest rate AR coefficient	ρ_R	0.829	0.831	0.797	0.865	B	0.8	0.1
Interest rate inflation coefficient	η_π	0.723	0.701	0.605	0.797	B	0.5	0.1
Interest rate output coefficient	η_y	0.030	0.047	0.005	0.087	G	0.15	0.1
AR coefficient Tax rate	ρ_τ	0.674	0.679	0.615	0.741	B	0.5	0.1
Tax rate expenditure coefficient	$\eta_{\tau,e}$	0.216	0.227	0.089	0.352	N	0.5	0.2
Tax rate output coefficient	$\eta_{\tau,y}$	0.116	0.118	0.036	0.194	N	0.2	0.2
AR coefficient gov. spending	ρ_χ	0.927	0.924	0.900	0.949	B	0.5	0.1
Gov. spending output coefficient	$\eta_{\chi,y}$	0.100	0.095	-0.230	0.412	N	0.1	0.2
AR coefficient short-run exp.	ρ_{eS}	0.608	0.601	0.529	0.677	B	0.2	0.05
Short-run exp. output coefficient	η_{eS}	0.152	0.139	0.038	0.248	N	0.1	0.2
Steady state growth rate	$100\bar{z}$	0.411	0.413	0.338	0.491	N	0.50	0.05
Steady state inflation	$100\left(\bar{\Pi}-1\right)$	0.722	0.720	0.639	0.802	N	0.75	0.05
AR coefficient preference	ρ_d	0.980	0.979	0.967	0.991	B	0.5	0.1
AR coefficient investment	ρ_i	0.448	0.463	0.337	0.589	B	0.5	0.1
AR coefficient long-run growth	ρ_z	0.232	0.236	0.161	0.309	B	0.5	0.1
AR coefficient repression	ρ_Γ	0.995	0.993	0.989	0.997	B	0.5	0.1
AR coefficient term premium	ρ_{tp}	0.087	0.099	0.033	0.160	B	0.5	0.1
AR coefficient bond holdings	ρ_{bh}	0.977	0.975	0.964	0.986	B	0.5	0.1
S.d. preference	$100\sigma_d$	1.855	1.899	1.638	2.142	IG	0.5	2.0
S.d. investment	$100\sigma_i$	1.872	1.874	1.578	2.174	IG	0.5	2.0
S.d. monetary policy shock	$100\sigma_m$	0.190	0.194	0.168	0.216	IG	0.5	2.0
S.d. government spending ratio	$100\sigma_\chi$	3.492	3.547	3.135	3.962	IG	0.5	2.0
S.d. short-run expenditures	$100\sigma_{eS}$	0.783	0.801	0.696	0.913	IG	0.5	2.0
S.d. term premium shock	$100\sigma_{tp}$	4.122	4.100	3.339	4.822	IG	0.5	2.0
S.d. tax rate	$100\sigma_\tau$	0.476	0.486	0.426	0.544	IG	0.5	2.0
S.d. long-run growth	$100\sigma_z$	1.800	1.833	1.514	2.127	IG	0.5	2.0
S.d. repression	$100\sigma_\Gamma$	1.710	1.754	1.545	1.947	IG	0.5	2.0
S.d. bond holdings	$100\sigma_{bh}$	4.934	5.245	3.844	6.536	IG	0.5	2.0
Log data density	3181.038							

Notes: Posterior statistics based on MCMC with two chains of 400k draws each, 80% of draws discarded, and an acception rate of approx. 23%. The part of the table reports the priors. In the column "Type", G, N, B, and IG correspond to gamma, normal, beta, and inverse gamma distributions, respectively.

society by President Lyndon B. Johnson in May 1964. In light of this, we consider the estimates for e_t^L plausible: It captures large expenditure programs that arise as the result of a political process that is not explicitly modeled here.

4 Inspecting the mechanism

In what follows we develop some intuition for how financial repression impacts public finances in particular and the economy in general. In a first step, we take a partial equilibrium perspective and zoom in on the market for government debt. To keep things simple, we assume for the moment that debt is held exclusively by banks: $b_t^b = b_t$. Further, we abstract from inflation and assume a constant fiscal surplus f. A simplified version of the government budget constraint then reads as follows:

$$Q_t^b b_t = \frac{1 + \iota Q_t^b}{Q_{t-1}^b} Q_{t-1}^b b_{t-1} - f.$$

This expression implicitly defines the supply curve of government debt: it relates the current price of debt Q_t^b to the quantity of bonds b_t, given outstanding liabilities and bond prices in the previous period. The supply curve is downward sloping because a higher bond price reduces the amount of debt which needs to be placed with banks in order to redeem a given amount of outstanding debt net of the surplus. We depict the supply curve as the blue solid in Figure 4. It is labeled "S."

The same figure also features a demand curve for government debt, labeled "D", that determines the demand for government debt in the absence of repression or, equivalently, in case the regulatory constraint is not binding. Without loss of generality we assume it to be horizontal. As $R_t^b = \frac{1 + \iota Q_t^b}{Q_{t-1}^b}$, it is implicitly determined by the bankers' optimality condition (2.17) that ties the return on government debt to the deposit rate. The deposit rate, in turn, is proportional to the time-discount factor thanks to optimality condition (2.10). The intersection of "D" and "S" in Figure 4 determines the "laissez-faire" price $\tilde{Q}^b$ of debt that prevails in the absence of repression.

For a given market value of private securities held by the bank, $Q_t^s s_t^b$, the regulatory constraint (2.15) defines a downward sloping relationship between the price of debt and the amount of debt that needs to be held by banks whenever the regulatory constraint binds.

$$Q_t^b b_t^b \geq \Gamma_t Q_t^s s_t^b.$$

It is shown as a hyperbola in Figure 4, depicted in red and labeled RC. Intuitively, a binding constraint implies that either the volume held by banks is high and the price is low, or vice versa.

What determines the equilibrium in the market for government debt? Since we assume that the regulatory constraint binds, the equilibrium price Q^b is given by the intersection

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Figure 4: Financial repression either . . .

(a) Pushes up the price of debt or   **(b)** Increases fiscal space
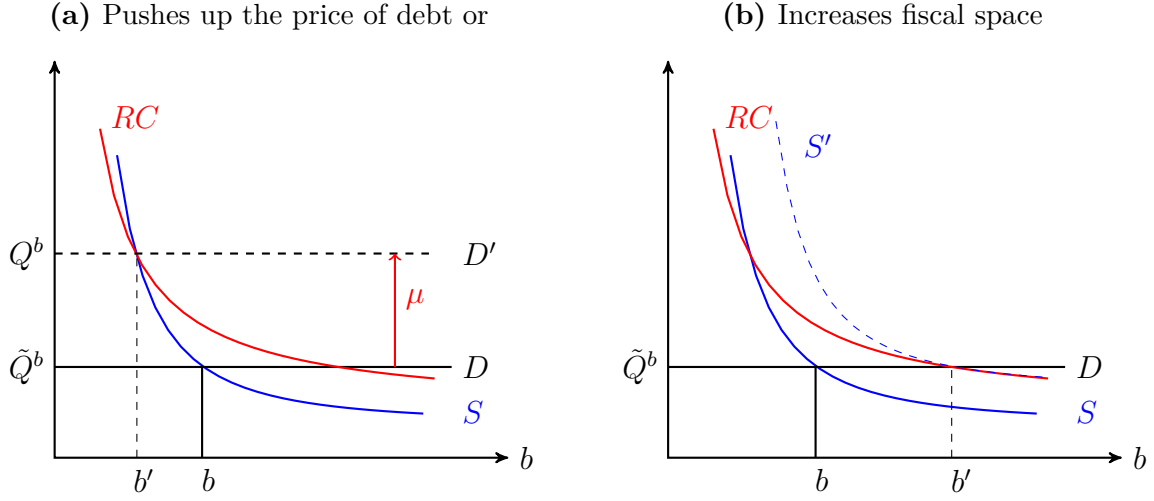
Notes: Stylized representation of the market for government debt. Supply (demand) of debt is represented by the blue (black) line. Regulatory constraint represented by the RC curve. $\tilde{Q}^b$ is the laissez-faire price of debt. Q^b is the actual price. Repression either shifts demand for government debt upward (left panel) or supply outward (right panel).

of RC and S. It exceeds the laissez-faire price. This price is consistent with the demand curve, because in case of repression the demand for government debt shifts upward in panel (a) (from D to D'). Formally, this is brought about by a positive realization of the Lagrange multiplier μ in the bankers' optimality condition equation (2.17). Because holding an additional unit of government debt provides additional value to the bank if the regulatory constraint binds, bankers are ready to purchase government debt at a price which exceeds the laissez-faire price. Equivalently, for a given price of government debt in the next period, repression lowers the yield on government debt, as observed by Reinhart and Sbrancia (2015) and Acalin and Ball (2023), and the government needs to issue less debt in order to meet a given financing requirement.

A complementary perspective is that financial repression increases fiscal space, as stressed by Jeanne (2023). Panel (b) of Figure 4 illustrates this, by showing that repression allows the government to issue a larger amount of debt at the laissez-faire price. This is consistent with the observation by Chari, Dovis, and Kehoe (2020) that governments are likely to "engage in financial repression when their fiscal needs are exceptionally high, such as during wartime." For instance, during WW2, the U.S. debt-to-GDP ratio rose by around 60 percentage points and the additional debt was placed with the private sector, and commercial banks in particular (Martin and Younger, 2020). Over our sample period, bank holdings of government debt as share of their total assets, and the debt-to-GDP ratio are accordingly at their highest levels at the beginning of our sample period, just after WW2.

Financial repression, however, is not confined to the regulatory constraint that operates

in our model. Other policy measures which may be understood as financial repression include yield-curve control and specific regulatory changes by the Federal Reserve (Alfriend, 1988; Garbade, 2020).[10] While these measures differ along specific dimensions, we think that the regulatory constraint in our model captures their overall gist rather well and, hence, allows us to asses the effects of financial repression in quantitatively meaningful way, as we do below.

Prior to that, to illustrate how repression impacts the economy at large, we study the transmission of a repression shock in the estimated model (Regime F). Specifically, we assume that the economy is initially in steady state as the regulatory constraint tightens temporarily: Γ_t increases.[11] Figure 5 shows the adjustment dynamics by way of impulse response functions. Here the horizontal axis measures time in quarters and the vertical axis measures the deviation of a variable from its steady state. In response to the shock, banks' holdings of government debt, relative to their total assets, increase by one percentage point. Increased financial repression—via a tighter regulatory constraint—requires banks to hold a higher fraction of their portfolio as government debt. This is shown in in panel (a) by the solid (black) line. Government debt, measured relative to GDP, *goes up* by about 0.2 percentage points (dashed blue line) for reasons that will become clear below.

As banks' demand for government debt increases, its price goes up, as discussed above. This, in turn, lowers the expected return, as shown in panel (b) of Figure 5 for government debt with an average maturity of five years (solid black line) and for short term debt (dashed blue line).[12] In panel (c), we display the adjustment of the HPR over a one year period, again for a debt portfolio with average maturity of 5 years (solid black line) and, to illustrate the maturity effect, for a counterfactual portfolio with short-term debt only. Recall that the HPR is key for the evolution of government debt (Hall and Sargent, 2011). So it is noteworthy that the HPR increases initially: this reflects the revaluation of outstanding debt, as repression goes up, reducing the ex ante return. The effect is larger, the higher the average maturity of the portfolio. The revaluation effect is short-lived, however. In the medium term, the overall effect of repression is to lower the HPR, although to a lesser extent if the debt maturity is high.
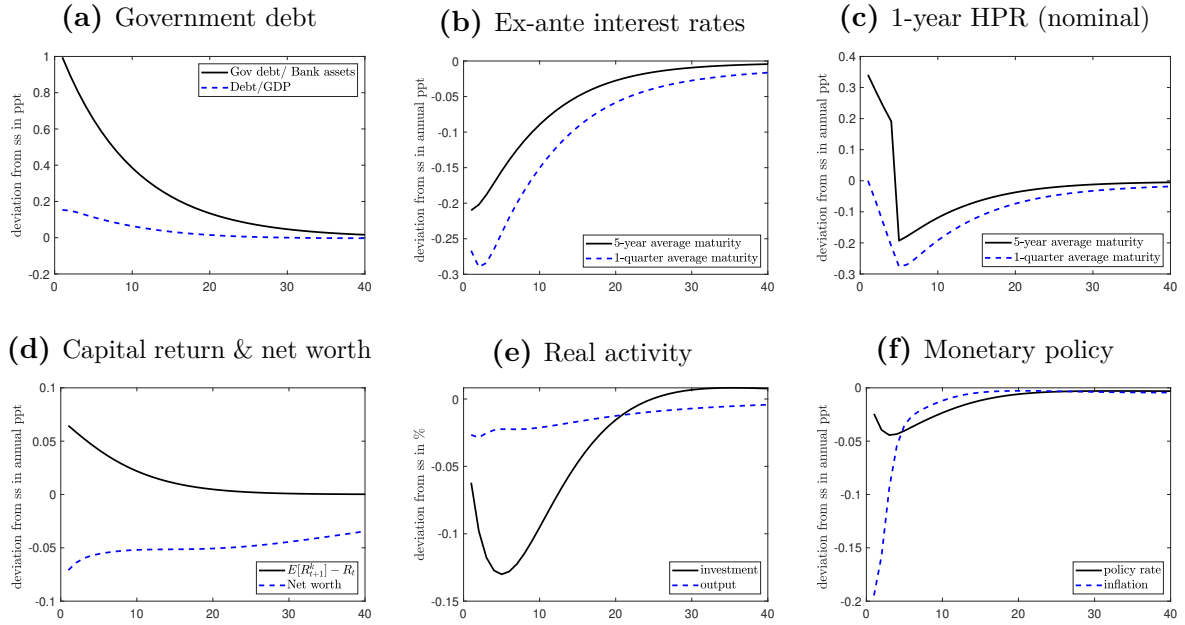
A tighter regulatory constraint also increases the expected return of capital (relative to the deposit rate), which makes holding capital more costly, see equation (2.16) above. And indeed, the ex ante spread on capital increases in response to the repression shock, as the solid (black) line in panel (d) shows. In the panel, we also show the evolution of banks'

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[10]Between 1942 and 1972, the FED treated government bond holdings by banks as "riskless" to avoid penalizing them for holding these low-yield bonds. However, as shown by Fueki, Hürtgen, and Walker (2024) and Abad (2019), zero-risk weights for government bonds lead to capital misallocation and constrain the overall supply of credit.

[11]Given that we find a very persistent effect of such a regulatory change when estimating the model, here we assume a more temporary effect ($\rho_\Gamma = 0.9$) to make the dynamics more transparent.

[12]To illustrate the effect on short-term debt, we rerun the model assuming the government debt issues only short-term debt.

Figure 5: Impulse responses to repression shock

(a) Government debt **(b)** Ex-ante interest rates **(c)** 1-year HPR (nominal)

(d) Capital return & net worth **(e)** Real activity **(f)** Monetary policy

Notes: Repression shock is a temporary increase of Γ_t by one standard deviation. The vertical axis measures deviation from steady state, while the horizontal axis measures time in quarters.

net worth which declines (dashed blue line). A direct consequence is that investment and real activity decline (panel (e)), because banks respond by rebalancing their portfolios, reducing their funding of firms as they are forced to hold more government debt. As stressed by Chari, Dovis, and Kehoe (2020), repression distorts the optimal allocation of capital: Repression crowds out investment via this *portfolio effect*. In addition, there is a *net worth effect*: since the value of investment and the return on government debt fall, banks net worth declines, see again panel (d). This kicks off a second-round effect. First, since banks' lending is directly linked to net worth, investment drops even further which drives the economy into a prolonged recession. Second, since net equity is reduced, households withdraw their deposits from the banks, as the value of staying a banker falls and households only have limited enforcement capabilities. This reduces lending further and amplifies the drop in investment.

The overall reduction of real activity induces a decline of inflation and, in turn, the policy rate, as shown by the dashed (blue) and solid (black) lines in panel (f). This transmits into lower funding costs for the government and, *all else equal*, brings about a reduction of the debt-to-GDP ratio. At the same time, lower inflation and reduced real activity, push up the debt-to-GDP ratio. In our estimated model the latter effect dominates, hence the increase of government debt-to-GDP shown in panel (a). Importantly, this result emerges independently of the underlying fiscal-monetary regime in place. The

general pattern of adjustment is the same under Regime M (not shown).[13] In sum, evaluating financial repression solely based on funding costs can be misleading because it neglects general equilibrium effects.

5 Financial repression in the U. S., 1948–1974

We are finally in a position to address the question that motivate our analysis: did financial repression impact how the debt-to-GDP ratio evolved during our sample period, and, if so, through which channels?
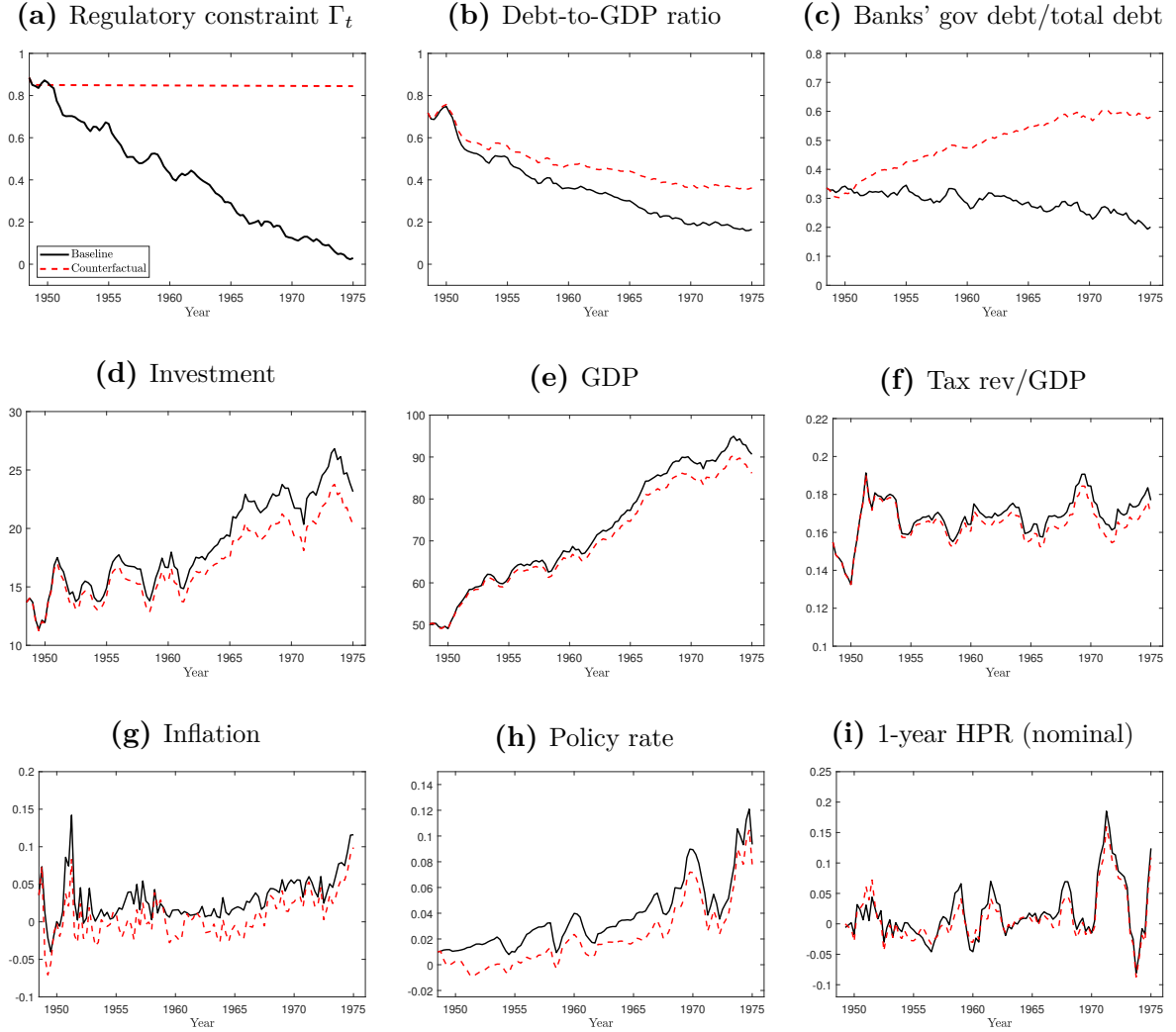
5.1 What if? A general-equilibrium counterfactual

We proceed by constructing a counterfactual based on the estimated model. Our starting point is the observation, that according to our estimates, financial repression declined steadily over our sample period, in line with the narrative of repression discussed in the introduction. The top-left panel of Figure 6 shows the estimate of Γ_t which, in our model, represents the regulatory constraint on banks' balance sheets. For the beginning of our sample period in 1948, we obtain a value of 0.9. It declines to almost zero in 1975. Against this background, to illustrate the effects of repression, we first compute a model-based counterfactual for which we assume that financial repression had not been phased out. Below we also discuss an alternative scenario for which we assume instead that repression was completely removed at the beginning of the sample. Both counterfactuals deliver the same insights of how repression works in the model. The first counterfactual of repression being constantly high, however, is more straightforward to implement because it is nested in the baseline model.

We contrast the results for a scenario of constantly high repression with the actual outcomes in the panels of Figure 6: the solid (black) line represents the outcome according to the estimated model (that is, our baseline), the dashed (red) line shows the counterfactual outcome in case repression is not phased out. This is reflected, in panel (a) of Figure 6 by a value for Γ_t which is constantly high during our sample period.

Panel (b) displays what is perhaps the most striking result of this experiment: it shows that the debt-to-GDP ratio would have come down *less*, had financial repression not been phased out. To understand this result it is helpful to compare the behavior of key economic indicators shown in the other panels. Consider panel (c) first. Here we see the fraction of government debt held by banks: it declines gradually during our sample period, but increases substantially in the counterfactual. In the counterfactual banks are effectively forced to twist their portfolio heavily towards public debt, and much more so

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[13]A proviso is the maturity of government debt: if government debt is short term (rather than having an average maturity of 5 years), the debt-to-GDP ratio declines in response to a repression shock, but only in Regime M.

Figure 6: General-equilibrium counterfactual

(a) Regulatory constraint Γ_t

(b) Debt-to-GDP ratio

(c) Banks' gov debt/total debt

(d) Investment

(e) GDP

(f) Tax rev/GDP

(g) Inflation

(h) Policy rate

(i) 1-year HPR (nominal)

Notes: Solid (black) lines represent actual outcomes, as predicted by the model. Dashed (red) lines show results for counterfactual in which repression is kept high at the level observed at the beginning of the sample period; see panel (a).

than in the baseline where repression is phased out. This matters for real activity. In panel (d) we show the evolution of investment in real terms. It increases over time in both cases. But investment is clearly subdued in the counterfactual if benchmarked against the actual development. Our estimates illustrate, in other words, the extent to which financial repression crowds out of private investment. A direct implication is that also GDP is lower if repression is kept up, as shown in panel (e). This has direct fiscal implications. Tax revenues, measured as a fraction of GDP and depicted in panel (f), are quite a bit lower if the level of repression is kept high. This, just like the evolution of GDP, accounts for the result that the debt-to-GDP ratio declines *less* in case repression is kept high.

As financial repression depresses economic activity, inflation is also lower, a point stressed in Section 4 above. We observe this effect for the counterfactual in panel (g): As

Figure 7: Quantifying the difference due to repression for . . .
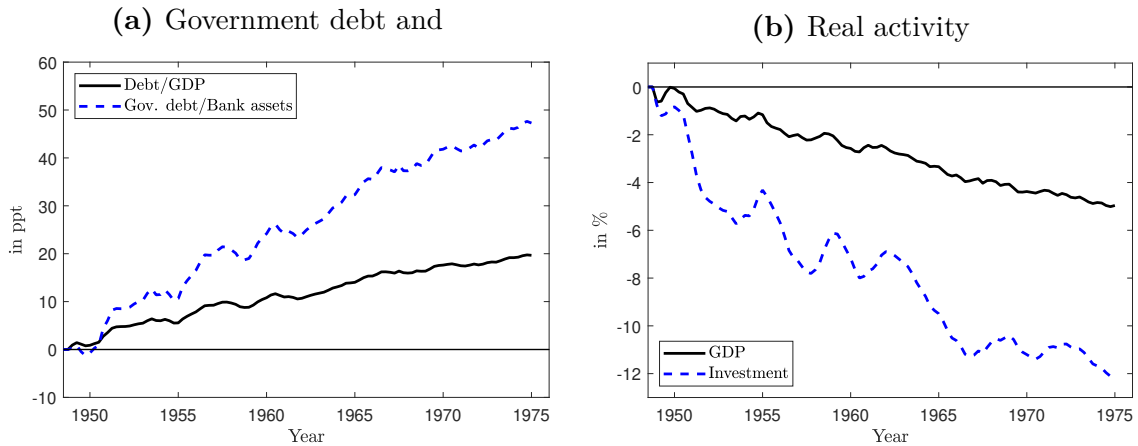
(a) Government debt and

(b) Real activity

Notes: Difference for key variables across counterfactual outcome w/ repression and baseline w/ phasing out of repression. The figure shows the difference across outcomes shown in Figure 6.

the dashed (red) line shows, inflation is consistently lower in the repression counterfactual. Monetary policy, in turn, keeps its rate also below the actual rate; see panel (h). Finally, we note that the HPR on the government-debt portfolio does not differ much across the baseline and the counterfactual. This is noteworthy, because—for a given inflation rate— the nominal HPR is key for the evolution of the debt-to-GDP ratio. In the counterfactual, the HPR turns out not to be much different from the baseline because as repression lowers the return on government debt *ex ante*, it revalues the outstanding debt. For our estimated model which assumes (in line with the data) an average maturity of government debt of 5 years, this effect can be substantial: This explains why the HPR is not much reduced under the repression counterfactual and why, in sum, the unintended consequences of repression—repressed economic activity—dominate, resulting in a higher debt-to-GDP ratio (compared to the baseline).

To illustrate the quantitative importance of the effects of financial repression, Figure 7 zooms in on key variables, showing the difference between the counterfactual outcome, assuming that repression is kept in place, and the baseline, where repression is phased out. Panel (a) shows the difference for the public debt ratio (solid black line) and the share of government debt in banks' assets (blue dashed line). Differences are large. In the counterfactual the ratio of public debt is 20 percentage points higher at the end of the sample period. Banks' holdings of government debt are 50 percentage points higher. Hence, we can conclude that phasing out repression has actually *lowered* the public debt ratio significantly. To a large extent this is because phasing out repression provided a boost to real activity. In panel (b) we observe that investment would have been depressed by up to 12 percent, and output by up to five percent, had repression not been phased out. In terms of per-capita GDP at the beginning of the sample period, the cumulative

shortfall amounts to 2.9 ×$15, 500 (1948q2) or around $45, 250.[14]

Our counterfactual illustrates the effect of financial repression by contrasting the outcome in case of a fixed level of repression to the actual developments where repression was phased out. A natural alternative is to consider a counterfactual in which repression was fully removed at the start of the sample period in 1948:q2. Conceptually, this is more demanding because in our model, the absence of repression is not nested for a specific parameter value. However, we may still compute such a counterfactual outcome by removing the regulatory constraint altogether from the model, in which case the banking sector essentially boils down to the version put forward by Gertler and Karadi (2013). To make outcomes comparable, we start the counterfactual simulation at the same initial values as before. The results show that our insights into how repression impacts the economy are robust across counterfactuals: if repression is removed immediately, banks reduce their government bond holdings, nominal bond returns increase, investment booms, and real activity as well as inflation go up. Eventually, this leads to a faster decline of the debt-to-GDP ratio, at least initially, see Figures D.4 and D.5.

5.2 An accounting perspective

Our results seem to contradict the received wisdom according to which financial repression is a means to bring down government debt. And indeed, in influential earlier work, Reinhart and Sbrancia (2015) and, more recently, Acalin and Ball (2023) argue that financial repression helped to reduced the debt-to-GDP in the U.S. after WW2. These studies take a somewhat narrower perspective on the effects of repression, zooming in on the direct effect of repression on interest rates. Our framework allows us to do so as well. Abstracting from general-equilibrium effects, we may simply compute the laissez-faire interest rate which would prevail in the absence of repression. We can then compute the evolution of government debt assuming that, all else equal, the government had paid this rate rather than the actual one.

Formally, we define the laissez-faire rate on the basis of Equation (2.16): by setting $\mu_{i,t} = 0$ at all times, we obtain the interest rate which would clear the market for government debt, assuming that banks were not constrained by financial repression. The laissez-faire rate, R_{t+1}^{LF}, is then implicitly defined by the following expression:

$$E_t M_{t,t+1} \left(R_{t+1}^{LF} - R_t^d \right) \frac{\Omega_{t+1}}{\Pi_{t+1}} = \frac{\lambda_t \theta \Delta}{1 + \lambda_t}. \qquad (5.1)$$

Based on the ex ante laissez-faire rate we can also compute the laissez-faire HPR R_t^{LF} which enters the law of motion for the laissez-faire debt-to-GDP ratio, $\mathcal{B}_t^{LF}$, in our

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[14]Source: Fred Economic Data (series A939RX0Q048SBEA), seasonally adjusted and in 2017 dollars.

Figure 8: Actual developments v partial-equilibrium counterfactual
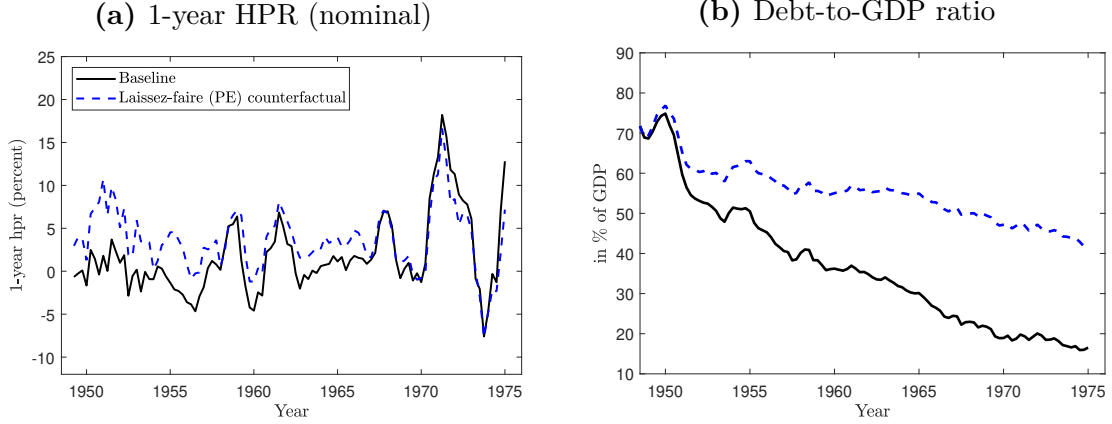
(a) 1-year HPR (nominal)　　　　　　**(b)** Debt-to-GDP ratio

Notes: The baseline is given by the solid (black) line and the laissez-faire counterpart by the dashed (blue) line. The laissez-faire scenario is based on a partial-equilibrium perspective: It obtains as we set $\mu_t = 0$ in eq. (2.17), all else equal.

accounting counterfactual:

$$\mathcal{B}_t^{LF} = R_t^{LF} \frac{\mathcal{B}_{t-1}^{LF} y_{t-1}}{\Pi_t y_t} - \tau_t + e_t + \varepsilon_{TP,t}. \tag{5.2}$$

Figure 8 shows the results, contrasting the baseline (solid black line) and the counterfactual laissez-faire outcome (dashed blue line). Panel (a) displays the 1-year HPR: in line with the results of Reinhart and Sbrancia (2015) and Acalin and Ball (2023), the laissez-faire HPR is considerably higher than what we obtain for the baseline. The gap lasts until the end of the 1960s, reflecting our assessment that, while repression was phased out during our sample period, there was non-trivial repression for most of the time—see again the estimate for Γ_t shown in panel (a) of Figure 6.

Taken at face value, these estimates suggest that the government was indeed able to borrow at reduced interest rates. How strongly did this contribute to the reduction of public debt? To address this question under our partial-equilibrium perspective, we simply compute the evolution of debt based on Equation (5.1) and Equation (5.2) and show the result in panel (b) of Figure 8.[15] During our sample period the debt-to-GDP ratio declined by around 57 percentage points (solid black line). Instead, had the government paid the higher laissez-faire rate, the debt-to-GDP ratio would have declined by 30 percentage points only (dashed blue line). Hence—*all else equal*—the debt-to-GDP ratio would have been about 27 percentage points higher at the end of 1974. This finding is very much in line with Acalin and Ball (2023): They report that "distorted interest rates" account for 28 percentage points of lower debt-to-GDP ratio in 1974.[16]

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[15]In the appendix, we repeat the same exercise for regime M and obtain very similar results.

[16]Acalin and Ball (2023) only investigate the effects of distorted rates before 1951, but argue that these

6 Conclusion

In line with received wisdom we find evidence for financial repression in the U.S. after WW2. Did repression contribute to the liquidation of public debt during this period? In contrast to earlier work we find that this is not the case, quite the opposite. Our results differ because they are based on counterfactual simulations within an estimated general equilibrium model. The model features financial repression as in CDK and allows us, first, to quantify the extent of repression. We find that repression was pervasive in the sense that banks had to hold a sizeable share of their portfolio as government debt. A direct implication is that the holding period return on debt was low compared to the laissez-faire rate. Our estimates also show that repression was phased out over our sample period. By the mid-1960s the holding period return and the laissez-faire rate no longer differ systematically, consistent with narrative accounts of repression.

We show, second, that financial repression did not contribute to the reduction of the debt-to-GDP ratio. Rather it was counterproductive because of general equilibrium effects. This result emerges from a model-based counterfactual where we assume that repression is not phased out. In this case, output and inflation would have been lower, most importantly because repression depresses investment activity. In the end, the debt-to-GDP ratio would have been significantly higher if repression had been left in place at levels directly observed after WW2.

Finally, we demonstrate that, when examining solely the direct effect of financial repression on interest rates, it does appear that it contributed to the liquidation of government debt. This is intuitive and, hence, policy makers might be tempted into repression. But this comes at the risk of overlooking its indirect adverse effects on the debt-to-GDP ratio which operate in general equilibrium and which we find to be dominating during our sample period. In sum, our analysis cautions somewhat against the use of financial repression. In any case, the individual and collective trade-offs that it gives rise to need to be better understood in order to minimize the negative impact on risk-taking of banks, investment, and, eventually the debt-to-GDP ratio itself.

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28 percentage point reduction mark the lower bound of the impact of financial repression during our sample.

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A Model solution

A.1 Equilibrium system

Because the economy features a permanent shock to technology A_t, we have to induce stationarity. In particular, we transform the variables as following: $x_t = X_t/P_t/A_t$ with x_t the real stationary variable, X_t the nominal non-stationary variable and the variables P_t and A_t representing the price level and technology, respectively.

A.1.1 Households

First-order conditions of the household:

$$\Lambda_t = e^{\varepsilon_{d,t}} \left(c_t - \frac{b c_{t-1}}{e^{z_t}} \right)^{-1} \tag{A.1}$$

$$M_t = \beta e^{-z_t} \frac{\Lambda_t}{\Lambda_{t-1}} \tag{A.2}$$

$$1 = M_{t+1} \frac{R_t^d}{\Pi_{t+1}} \tag{A.3}$$

$$s_t^h = \left(1 + \frac{M_{t+1} \left(R_{t+1}^k - R_t^d \right)}{\Pi_{t+1} \kappa_k} \right) \tilde{s}^h \tag{A.4}$$

$$b_t^h = \left(1 + \frac{M_{t+1} \left(R_{t+1}^b - R_t^d \right)}{\Pi_{t+1} \kappa_b} \right) \tilde{b}^h + \varepsilon_{bh,t} \tag{A.5}$$

$$R_t^d = \exp \left(R_t \right) \tag{A.6}$$

Returns of private securities and government bonds:

$$R_t^k = \frac{r_t^k + Q_t^s \left(1 - \delta \right)}{Q_{t-1}^s} \Pi_t \tag{A.7}$$

$$R_t^b = \frac{1 + \iota Q_t^b}{Q_{t-1}^b} \tag{A.8}$$

A.1.2 Intermediate & investment goods firms

$$p_t^+ y_t = \left(\frac{k_{t-1}}{e^{z_t}} \right)^{\alpha} \left(l_t \right)^{1-\alpha} - \Phi \tag{A.9}$$

$$k_{t-1}/l_t = e^{\varepsilon_{d,t}} \frac{\Psi_L l_t^{\Psi}}{\Lambda_t r_t^k} \frac{\alpha}{\left(1 - \alpha \right)} e^{z_t} \tag{A.10}$$

$$mc_t = \left(\frac{1}{1-\alpha} \right)^{1-\alpha} \left(\frac{1}{\alpha} \right)^{\alpha} \left(e^{\varepsilon_{d,t}} \frac{\Psi_L l_t^{\Psi}}{\Lambda_t} \right)^{1-\alpha} \left(r_t^k \right)^{\alpha} \tag{A.11}$$

$$k_t = (1-\delta) \frac{k_{t-1}}{e^{z_t}} + e^{\varepsilon_{I,t}} \left(1 - \frac{\nu}{2} \left(\frac{i_t e^{z_t}}{i_{t-1}} - e^{\bar{z}} \right)^2 \right) i_t \tag{A.12}$$

$$1 = Q_t^s \left(1 - \frac{\nu}{2} \left(\frac{i_t e^{z_t}}{i_{t-1}} - e^{\bar{z}} \right)^2 - \nu \left(\frac{i_t e^{z_t}}{i_{t-1}} - e^{\bar{z}} \right) \frac{i_t e^{z_t}}{i_{t-1}} \right) e^{\varepsilon_{I,t}}$$
$$+ E_t \left[M_{t+1} Q_{t+1}^s \nu \left(\frac{i_{t+1} e^{z_{t+1}}}{i_t} - e^{\bar{z}} \right) e^{\varepsilon_{I,t+1}} \left(\frac{i_{t+1} e^{z_{t+1}}}{i_t} \right)^2 \right] \quad (A.13)$$

First-order conditions related to price setting:

$$K_t^p = \Lambda_t y_t \tilde{p}_t + \beta \gamma_p E_t \left[\left(\frac{\Pi_t^{\xi_p}}{\Pi_{t+1}} \right)^{1-\theta_p} \frac{\tilde{p}_t}{\tilde{p}_{t-1}} K_{t+1}^p \right] \quad (A.14)$$

$$F_t^p = \Lambda_t mc_t y_t + \beta \gamma_p E_t \left[\left(\frac{\Pi_t^{\xi_p}}{\Pi_{t+1}} \right)^{-\theta_p} F_{t+1}^p \right] \quad (A.15)$$

$$F_t^p = \frac{\theta_p - 1}{\theta_p} K_t^p \quad (A.16)$$

$$1 = \gamma_p \left(\frac{\Pi_{t-1}^{\xi_p}}{\Pi_t} \right)^{1-\theta_p} + (1 - \gamma_p) (\tilde{p}_t)^{1-\theta_p} \quad (A.17)$$

$$p_t^+ = (1 - \gamma_p) (\tilde{p}_t)^{-\theta_p} + \gamma_p \left(\frac{\Pi_{t-1}^{\xi_p}}{\Pi_t} \right)^{-\theta_p} p_{t-1}^+ \quad (A.18)$$

A.1.3 Financial intermediaries

In the following, we present a more detailed description of model solution regarding financial intermediaries. In particular, we follow quite closely the derivations by Gertler and Karadi (2013) but extended with the regulatory constraint as proposed by Chari, Dovis, and Kehoe (2020).

First, we assume a fixed mass of intermediaries index by i. Intermediaries hold government bonds B_t^b and private securities S_t^b; and they finance themselves with their own equity N and deposits D. The balance sheet in nominal terms looks like:

$$Q_t^s S_{i,t}^b + Q_t^b B_{i,t}^b = D_{i,t} + N_{i,t}$$

Each period an exogenous fraction $1 - \sigma$ dies, they return their net worth to households. The household replaces the dying intermediaries with the same number of new banks with start-up net worth of X. Nominal net worth evolves according to:

$$N_{i,t} = \left(R_t^k - R_{t-1}^d \right) Q_{t-1}^s S_{i,t-1}^b + \left(R_t^b - R_{t-1}^d \right) Q_{t-1}^b B_{i,t-1}^b + R_{t-1}^d N_{i,t-1}$$

In period t, the bank maximizes the expected value of its terminal value net worth, so the corresponding value function looks like this:

$$V_{i,t} = \max (1 - \sigma) E_t \sum_{j=1}^{\infty} \sigma^{j-1} M_{t,t+j} n_{i,t+j} \quad (A.19)$$

with $M_{t,t+j}$ the household's stochastic discount factor and $n_{i,t}$ real net worth,

$$n_{i,t} = \left(R_t^k - R_{t-1}^d\right) \frac{Q_{t-1}^s}{\Pi_t} s_{i,t-1}^b + \left(R_t^b - R_{t-1}^d\right) \frac{Q_{t-1}^b}{\Pi_t} b_{i,t-1}^b + \frac{R_{t-1}^d}{\Pi_t} n_{i,t-1}.$$

Moreover, the bank faces the standard participation constraint as in Gertler and Karadi (2013)

$$V_{i,t} \geq \theta \left(Q_t^s s_{i,t}^b + \Delta Q_t^b b_{i,t}^b\right) \tag{A.20}$$

and a regulatory constraint (see Chari, Dovis, and Kehoe, 2020)

$$Q^b t b_{i,t}^b \geq \Gamma_t Q_t^s s_{i,t}^b. \tag{A.21}$$

Letting $\lambda_{i,t}$ and $\mu_{i,t}$ be the multiplier on the enforcement constraint and the participation constraint, respectively, the Lagrangian in the recursive form of the value function looks like:

$$\begin{aligned}
L = &(1 + \lambda_{i,t}) \left[(1 - \sigma) E_t M_{t,t+1} n_{i,t+1} + \sigma E_t M_{t,t+1} V_{i,t+1}\right] \\
&- \lambda_{i,t}\theta \left(Q_t^s s_{i,t}^b + \Delta Q_t^b b_{i,t}^b\right) \\
&+ \mu_{i,t} \left(Q_t^b b_{i,t}^b - \Gamma_t Q_t^s s_{i,t}^b\right)
\end{aligned} \tag{A.22}$$

The derivatives of the maximization problem are:

$$(1 + \lambda_{i,t}) E_t \left\{(1 - \sigma) M_{t,t+1} \left(R_{t+1}^k - R_t^d\right) \frac{Q_t^s}{\Pi_{t+1}} + \sigma M_{t,t+1} \frac{\partial V_{i,t+1}}{\partial n_{i,t}} \frac{\partial n_{i,t+1}}{\partial s_{i,t}^b}\right\} = \lambda_{i,t}\theta Q_t^s + \mu_{i,t}\Gamma_t Q_t^s$$

$$(1 + \lambda_{i,t}) E_t \left\{(1 - \sigma) M_{t,t+1} \left(R_{t+1}^b - R_t^d\right) \frac{Q_t^b}{\Pi_{t+1}} + \sigma M_{t,t+1} \frac{\partial V_{i,t+1}}{\partial n_{i,t}} \frac{\partial n_{i,t+1}}{\partial b_{i,t}^b}\right\} = \lambda_{i,t}\theta \Delta Q_t^b - \mu_{i,t} Q_t^b$$

Given the definition for the shadow value of a unit of net worth to the bank

$$\Omega_{i,t+1} = 1 - \sigma + \sigma \frac{\partial V_{i,t+1}}{\partial n_{i,t}} \tag{A.23}$$

and

$$\frac{\partial n_{i,t+1}}{\partial s_{i,t}^b} = \left(R_{t+1}^k - R_t^d\right) \frac{Q_t^s}{\Pi_{t+1}}$$

$$\frac{\partial n_{i,t+1}}{\partial b_{i,t}^b} = \left(R_{t+1}^b - R_t^d\right) \frac{Q_t^b}{\Pi_{t+1}}$$

we can write the FOCs as:

$$E_t M_{t,t+1} \left(R_{t+1}^k - R_t^d\right) \frac{\Omega_{i,t+1}}{\Pi_{t+1}} = \frac{\lambda_{i,t}\theta + \mu_{i,t}\Gamma_t}{1 + \lambda_{i,t}} \tag{A.24}$$

$$E_t M_{t,t+1} \left(R_{t+1}^b - R_t^d\right) \frac{\Omega_{i,t+1}}{\Pi_{t+1}} = \frac{\lambda_{i,t}\theta\Delta - \mu_{i,t}}{1 + \lambda_{i,t}} \tag{A.25}$$

For aggregation, we have to show that the solution does not depend on i. To this end,

let's guess that the value function is linear in net worth:

$$V_{i,t} = a_t n_{i,t}$$

and when the participation constraint binds, then

$$a_t n_{i,t} = \theta \left(Q_t^s s_{i,t}^b + \Delta Q_t^b b_{i,t}^b \right).$$

Now, we define the individual leverage ratio

$$\phi_{i,t} = \frac{Q_t^s s_{i,t}^b + \Delta Q_t^b b_{i,t}^b}{n_{i,t}}.$$

If we guess that a_t does not vary with i, then neither can ϕ_t. Then it also holds that:

$$\Omega_t = 1 - \sigma + \sigma\theta\phi_t \tag{A.26}$$

$$\phi_t = \frac{Q_t^s s_t^b + \Delta Q_t^b b_t^b}{n_t} \tag{A.27}$$

Now, we start from the law of motion for the real net worth of an individual bank i, multiply both sides with $M_{t,t+1}\Omega_{t+1}$ and take expectations of both sides:

$$E_t M_{t,t+1}\Omega_{t+1} n_{i,t+1} = E_t M_{t,t+1}\Omega_{t+1} \left[\left(R_{t+1}^k \Pi_{t+1} - R_t^d \right) \frac{Q_t^s}{\Pi_{t+1}} s_{i,t}^b + \left(R_{t+1}^b - R_t^d \right) \frac{Q_t^b}{\Pi_{t+1}} b_{i,t}^b \right]$$

$$+ E_t M_{t,t+1}\Omega_{t+1} \frac{R_t^d}{\Pi_{t+1}} n_{i,t}$$

Let's go back to the value function:

$$V_{i,t} = (1 - \sigma) E_t M_{t,t+1} n_{i,t+1} + \sigma E_t M_{t,t+1} V_{i,t+1}$$

and remember our guess of the value function, which gives us:

$$a_t n_{i,t} = (1 - \sigma) E_t M_{t,t+1} n_{i,t+1} + \sigma E_t M_{t,t+1} a_{t+1} n_{i,t+1}$$
$$= E_t M_{t,t+1} n_{i,t+1} (1 - \sigma + \sigma a_{t+1})$$
$$= E_t M_{t,t+1} n_{i,t+1} \Omega_{t+1}$$

Afterwards, we plug this into the equation for real net worth above and divide both sides by $n_{i,t}$:

$$a_t = E_t M_{t,t+1}\Omega_{t+1}\Pi_{t+1}^{-1} \left[\left(R_{t+1}^k - R_t^d \right) \frac{Q_t^s s_{i,t}^b}{n_{i,t}} + \left(R_{t+1}^b - R_t^d \right) \frac{Q_t^b b_{i,t}^b}{n_{i,t}} \right]$$

$$+ E_t M_{t,t+1}\Omega_{t+1}\Pi_{t+1}^{-1} R_t^d$$

Given that $a_t = \theta \phi_t$ and the binding regulatory constraint $Q_t^b b_{i,t}^b = \Gamma_t Q_t^s s_{i,t}^b$, it follows

$$\theta \phi_t = E_t M_{t,t+1} \Omega_{t+1} \Pi_{t+1}^{-1} \left[\left(R_{t+1}^k - R_t^d + \Gamma_t \left(R_{t+1}^b - R_t^d \right) \right) \frac{Q_t^s s_{i,t}^b}{n_{i,t}} \right]$$
$$+ E_t M_{t,t+1} \Omega_{t+1} \Pi_{t+1}^{-1} R_t^d.$$

Leverage, participation, and regulatory constraint, all put together, gives $\phi_{i,t} n_{i,t} = Q_t s_{i,t}^b (1 + \Delta \Gamma_t)$, which eventually yields:

$$\phi_t = \frac{E_t M_{t,t+1} \Omega_{t+1} \Pi_{t+1}^{-1} R_t^d}{\theta - E_t \frac{M_{t,t+1} \Omega_{t+1}}{(1+\Delta \Gamma_t) \Pi_{t+1}} \left[R_{t+1}^k - R_t^d + \Gamma_t \left(R_{t+1}^b - R_t^d \right) \right]} . \tag{A.28}$$

To sum up, the financial intermediary sector is described by the following equations:

$$E_t M_{t,t+1} \left(R_{t+1}^k - R_t^d \right) \frac{\Omega_{t+1}}{\Pi_{t+1}} = \frac{\lambda_t \theta + \mu_t \Gamma_t}{1 + \lambda_t} \tag{A.29}$$

$$E_t M_{t,t+1} \left(R_{t+1}^b - R_t^d \right) \frac{\Omega_{t+1}}{\Pi_{t+1}} = \frac{\lambda_t \theta \Delta - \mu_t}{1 + \lambda_t} \tag{A.30}$$

$$\Omega_t = 1 - \sigma + \sigma \theta \phi_t \tag{A.31}$$

$$\phi_t = \frac{Q_t^s s_t^b + \Delta Q_t^b b_t^b}{n_t} \tag{A.32}$$

$$Q_t^b b_t^b = \Gamma_t Q_t^s s_t^b \tag{A.33}$$

$$Q_t^s s_t^b + Q_t^b b_t^b = d_t + n_t \tag{A.34}$$

$$\phi_t = \frac{E_t M_{t,t+1} \Omega_{t+1} \Pi_{t+1}^{-1} R_t^d}{\theta - E_t \frac{M_{t,t+1} \Omega_{t+1}}{(1+\Delta \Gamma_t) \Pi_{t+1}} \left[R_{t+1}^k - R_t^d + \Gamma_t \left(R_{t+1}^b - R_t^d \right) \right]} \tag{A.35}$$

$$nw_t = \frac{\sigma}{\Pi_t e^{z_t}} \left[\left(R_t^k - R_{t-1}^d \right) Q_{t-1}^s s_{t-1}^b + \left(R_t^b - R_{t-1}^d \right) Q_{t-1}^b b_{t-1}^b + R_{t-1}^d n_{t-1} \right] + X \tag{A.36}$$

A.1.4 Aggregation and government sector

Aggregate resource constraint:

$$y_t = c_t + i_t + g_t \tag{A.37}$$

Government budget constraint:

$$\mathcal{B}_t = R_t^b \frac{\mathcal{B}_{t-1} y_{t-1}}{\Pi_t e^{z_t} y_t} - \tau_t + e_t + \varepsilon_{tp,t} \tag{A.38}$$

$$\text{with } \mathcal{B}_t = \frac{Q_t^b b_t}{y_t} \tag{A.39}$$

Remember, we have defined that throughout the paper $\hat{x}_t = \log(x_t/\bar{x})$ denotes the percentage deviation from its steady state and $\tilde{x}_t = x_t - \bar{x}$ denotes a linear deviation.

Moreover, we define the following variables:

$$\tilde{e}_t = e_t - \bar{e} = \tilde{e}_t^S + \tilde{e}_t^L \tag{A.40}$$

$$\tilde{\chi}_t = \frac{1}{\bar{\mathcal{G}} - 1}\hat{\mathcal{G}}_t - \frac{1}{\bar{e}}\left(\tilde{e}_t^S + \tilde{e}_t^L\right) \tag{A.41}$$

$$\mathcal{G}_t = 1 / \left(1 - \frac{g_t}{y_t}\right) \tag{A.42}$$

Eventually, tax and spending policy rules can written as:

$$\tilde{\tau}_t = \rho_\tau \tilde{\tau}_{t-1} + (1 - \rho_\tau)\left[\eta_b \tilde{\mathcal{B}}_{t-1} + \eta_{\tau,e}\tilde{e}_t + \eta_{\tau,y}\hat{y}_t\right] + \sigma_\tau \epsilon_{\tau,t} \tag{A.43}$$

$$\tilde{\chi}_t = \rho_\chi \tilde{\chi}_{t-1} + (1 - \rho_\chi)\eta_{\chi,y}\hat{y}_t + \sigma_\chi \epsilon_{\chi,t} \tag{A.44}$$

$$\tilde{e}_t^S = \rho_{eS}\tilde{e}_{t-1}^S + (1 - \rho_{eS})\eta_{eS}\hat{y}_t + \sigma_{eS}\epsilon_{eS} \tag{A.45}$$

$$\tilde{e}_t^L = \rho_{eL}\tilde{e}_{t-1}^L + \sigma_{eL}\epsilon_{eL} \tag{A.46}$$

Monetary policy rule:

$$R_t = \rho_R R_{t-1} + (1 - \rho_R)\left(\bar{R} + \eta_y \hat{\Xi}_t + \eta_\pi \hat{\Pi}_t\right) + \sigma_m \epsilon_{m,t} \tag{A.47}$$

$$\text{with } \Xi_t = \frac{y_t e^{z_t}}{y_{t-1}} \tag{A.48}$$

Regulation rule:

$$\Gamma_t = (1 - \rho_\Gamma)\bar{\Gamma} + \rho_\Gamma \Gamma_{t-1} + \sigma_\Gamma \epsilon_{\Gamma,t} \tag{A.49}$$

Market clearing of private securities and long-term government bond holdings:

$$k_t = s_t^h + s_t^b \tag{A.50}$$

$$b_t = b_t^h + b_t^b \tag{A.51}$$

A.1.5   Remaining exogenous shocks:

$$\varepsilon_{I,t} = \rho_I \varepsilon_{I,t-1} + \sigma_I \epsilon_{I,t} \tag{A.52}$$

$$\varepsilon_{d,t} = \rho_d \varepsilon_{d,t-1} + \sigma_d \epsilon_{d,t} \tag{A.53}$$

$$z_t - \bar{z} = \rho_z (z_{t-1} - \bar{z}) + \sigma_z \epsilon_{z,t} \tag{A.54}$$

$$\varepsilon_{bh,t} = \rho_{bh}\varepsilon_{bh,t-1} + \sigma_{bh}\epsilon_{bh,t} \tag{A.55}$$

$$\varepsilon_{tp,t} = \rho_{tp}\varepsilon_{tp,t-1} + \sigma_{tp}\epsilon_{tp,t} \tag{A.56}$$

A.2   Deterministic steady state

Given our calibration summarized in Table 1 the deterministic steady state can be solved
as follows:

$$\bar{\tilde{p}} = \left[\frac{1 - \gamma_p \bar{\Pi}^{(\xi_p-1)(1-\theta_p)}}{1 - \gamma_p} \right]^{\frac{1}{1-\theta_p}} \tag{A.57}$$

$$\bar{p}^+ = \frac{(1 - \gamma_p) \bar{\tilde{p}}^{-\theta_p}}{1 - \gamma_p \bar{\Pi}^{(1-\xi_p)\theta_p}} \tag{A.58}$$

$$\bar{R} = \ln \left(\frac{\bar{\Pi}}{\beta} \right) + \bar{z} \tag{A.59}$$

$$\bar{R}^d = \exp \left(\bar{R} \right) \tag{A.60}$$

$$\tag{A.61}$$

Both capital and long-term bond returns, $\bar{R}^k$ and $\bar{R}^b$, face a spread above the riskless return $\exp \bar{R}$. The spreads are given by sp_k and sp_b respectively and are in annualized percentage points. Moreover, we assume a average maturity ($AvMaturity$) for the outstanding government debt.

$$\bar{R}^k = \exp \left(sp_k/400 + \bar{R} \right) \tag{A.62}$$

$$\bar{R}^b = \exp \left(sp_b/400 + \bar{R} \right) \tag{A.63}$$

$$\iota = (1 - 1/AvMaturity)/\beta \tag{A.64}$$

$$\bar{Q}^b = 1/ \left(\bar{R}^b - \iota \right) \tag{A.65}$$

We express throughout the paper all government bonds at market value, so let's redefine $b_t \equiv Q_t^b b_t$. The solution to the real economy is straightforward:

$$\bar{Q}^s = 1 \tag{A.66}$$

$$\bar{M} = \beta \exp \left(-\bar{z} \right) \tag{A.67}$$

$$\bar{r}^k = \bar{R}^k/\bar{\Pi} - (1 - \delta) \tag{A.68}$$

$$\overline{mc} = \bar{\tilde{p}} \frac{\theta_p - 1}{\theta_p} \frac{\left(1 - \gamma_p \beta \bar{\Pi}^{(1-\xi_p)\theta_p} \right)}{\left(1 - \gamma_p \beta \bar{\Pi}^{(\xi_p-1)(1-\theta_p)} \right)} \tag{A.69}$$

$$\bar{k} = \bar{l} \left(\frac{\overline{mc}\alpha}{\bar{r}^k} \right)^{\frac{1}{1-\alpha}} \exp \left(\bar{z} \right) \tag{A.70}$$

$$\bar{w} = \overline{mc} \left(1 - \alpha \right) \left(\frac{\overline{mc}\alpha}{\bar{r}^k} \right)^{\frac{\alpha}{1-\alpha}} \tag{A.71}$$

$$\bar{y} = \bar{r}^k \left(\frac{\bar{k}}{\exp \left(\bar{z} \right)} \right) + \bar{w}\bar{l} \tag{A.72}$$

$$\Phi = \left(\frac{\bar{k}}{\exp \left(\bar{z} \right)} \right)^{\alpha} \bar{l}^{1-\alpha} - \bar{y}\bar{p}^+ \tag{A.73}$$

$$\bar{i} = \left(1 - \frac{1-\delta}{\exp(\bar{z})}\right)\bar{k} \tag{A.74}$$

$$\bar{g} = \left(\frac{\bar{g}}{\bar{y}}\right)\bar{y} \tag{A.75}$$

$$\bar{c} = \bar{y} - \bar{g} - \bar{i} \tag{A.76}$$

$$\bar{\Lambda} = \left(\bar{c} - \frac{b\bar{c}}{\exp(\bar{z})}\right)^{-\gamma} \tag{A.77}$$

$$\Psi_L = \bar{w}\bar{\Lambda}\bar{l}^{-\psi} \tag{A.78}$$

$$\bar{F}^p = \frac{\bar{y}\bar{mc}\bar{\Lambda}}{1 - \gamma_p\beta\bar{\Pi}^{(1-\xi_p)\theta_p}} \tag{A.79}$$

$$\bar{K}^p = \frac{\theta_p}{\theta_p - 1}\bar{F}^p \tag{A.80}$$

$$\bar{\mathcal{G}} = 1/\left(1 - \frac{\bar{g}}{\bar{y}}\right) \tag{A.81}$$

$$\bar{b} = \frac{\bar{b}}{\bar{y}}\bar{y} \tag{A.82}$$

$$\bar{\tau} = \left(\frac{\bar{R}^b}{\bar{\Pi}\exp(\bar{z})} - 1\right)\bar{b} + \bar{e} \tag{A.83}$$

Given that $\bar{s} = \bar{k}$, the share of households' capital holdings $\bar{s}^h/\bar{s}$, and bond holdings $\bar{b}^h/\bar{b}$, we can solve for

$$\bar{s}^h = \left(\bar{s}^h/\bar{s}\right)\bar{s} \tag{A.84}$$

$$\bar{b}^h = \left(\bar{b}^h/\bar{b}\right)\bar{b} \tag{A.85}$$

$$\tilde{s}^h = \bar{s}^h/\left(1 + \frac{\left(\bar{R}^k - \bar{R}^d\right)}{\bar{R}^d\kappa_k}\right) \tag{A.86}$$

$$\tilde{b}^h = \bar{b}^h/\left(1 + \frac{\left(\bar{R}^b - \bar{R}^d\right)}{\bar{R}^d\kappa_b}\right) \tag{A.87}$$

$$\bar{s}^b = \bar{s} - \bar{k}^h \tag{A.88}$$

$$\bar{b}^b = \bar{b} - \bar{b}^h \tag{A.89}$$

Regarding the banking sector, given the calibrated asset-net worth ratio $AssetNW\,Ratio$, so we can solve for:

$$\bar{n} = \left(\bar{s}^b + \bar{b}^b\right)/AssetNW\,Ratio \tag{A.90}$$

$$\bar{d} = \left(\bar{s}^b + \bar{b}^b\right) - \bar{n} \tag{A.91}$$

$$X = \bar{n} - \frac{\sigma}{\bar{\Pi}\exp(\bar{z})}\left[\left(\bar{R}^k - \bar{R}^d\right)\bar{k}^b + \left(\bar{R}^b - \bar{R}^d\right)\bar{b}^b + \bar{R}^d\bar{n}\right] \tag{A.92}$$

$$\bar{\Gamma} = \frac{\bar{b}^b}{\bar{s}^b} \tag{A.93}$$

$$\bar{\phi} = \left(1 + \Delta\bar{\Gamma}\right) \frac{\bar{s}^b}{\bar{n}} \tag{A.94}$$

Finally, we have to solve the following system of equations with respect to $\bar{\lambda}$, $\bar{\mu}$, θ, and $\bar{\Omega}$:

$$\left(\bar{R}^k - \bar{R}^d\right) \frac{\bar{\Omega}}{\bar{R}^d} = \frac{\bar{\lambda}\theta + \bar{\mu}\Gamma}{1 + \bar{\lambda}} \tag{A.95}$$

$$\left(\bar{R}^b - \bar{R}^d\right) \frac{\bar{\Omega}}{\bar{R}^d} = \frac{\bar{\lambda}\theta\Delta - \bar{\mu}}{1 + \bar{\lambda}} \tag{A.96}$$

$$\bar{\Omega} = 1 - \sigma + \sigma\theta\bar{\phi} \tag{A.97}$$

$$\bar{\phi} = \frac{\bar{\Omega}}{\theta - \frac{\Omega}{(1+\Delta\Gamma)\bar{R}^d}\left[\bar{R}^k - \bar{R}^d + \bar{\Gamma}\left(\bar{R}^b - \bar{R}^d\right)\right]} \tag{A.98}$$

B Data

We use ten different time series to perfom the estimation. The construction and definition of the observables are explained in the following. The fiscal variables are calculated following Leeper, Plante, and Traum (2010). Most of the raw data are from the National Income and Product Accounts Tables housed at the Bureau of Economic Analysis; if otherwise, the data source is given.

GDP: Gross Domestic Product Y (Table 1.1.5, lines 1).

Investment: Investment I, is defined as gross private domestic investment (Table 1.1.5, line 7) and personal consumption expenditures on durables (Table 1.1.5, line 4).

Inflation: The annualized gross inflation rate π is defined using the GDP implicit deflator, index 2012=100, seasonally adjusted from the U.S. Bureau of Economic Analysis.

Interest rate: The nominal interest rate R^f, is defined as the average of monthly figures of the federal funds rate from 1954q3 onward. Before that, the time series is extended by using average numbers of daily figures of the 3-month Treasury Bill Secondary Market Rate (both series from the Board of Governors of the Federal Reserve System).

Government purchases: Government purchases G are computed as the sum of consumption expenditure (line 25), gross government investment (line 45), and net purchases of non-produced assets (line 47), minus consumption of fixed capital (line 48). All series are from NIPA Table 3.2.

Total government expenditure: Total government expenditure E is obtained by adding government purchases G and transfers. Transfers are given by the sum of net current transfer payments (line 26-19), subsidies (line 36), and net capital transfer payments (line 46-42). All series are from NIPA Table 3.2.

Tax revenues: Tax revenues T are given by the difference between current receipts (line 1) and current transfer receipts (line 19). All series are from NIPA Table 3.2.

Government debt-GDP: Market value of government interest bearing debt held by private investors and divided by GDP. The US debt data are from Hall et al. (2021) and are available on George Hall's website. `https://people.brandeis.edu/~ghall/`

Banks' debt holdings-assets: Banks' government debt holding, is defined as U.S. government obligations held by all commercial banks. We divide the data by total loans

and investments held by all commercial banks (both from the Board of Governors of the Federal Reserve System). The data are taken from balance sheets provided by Fraser digital library.
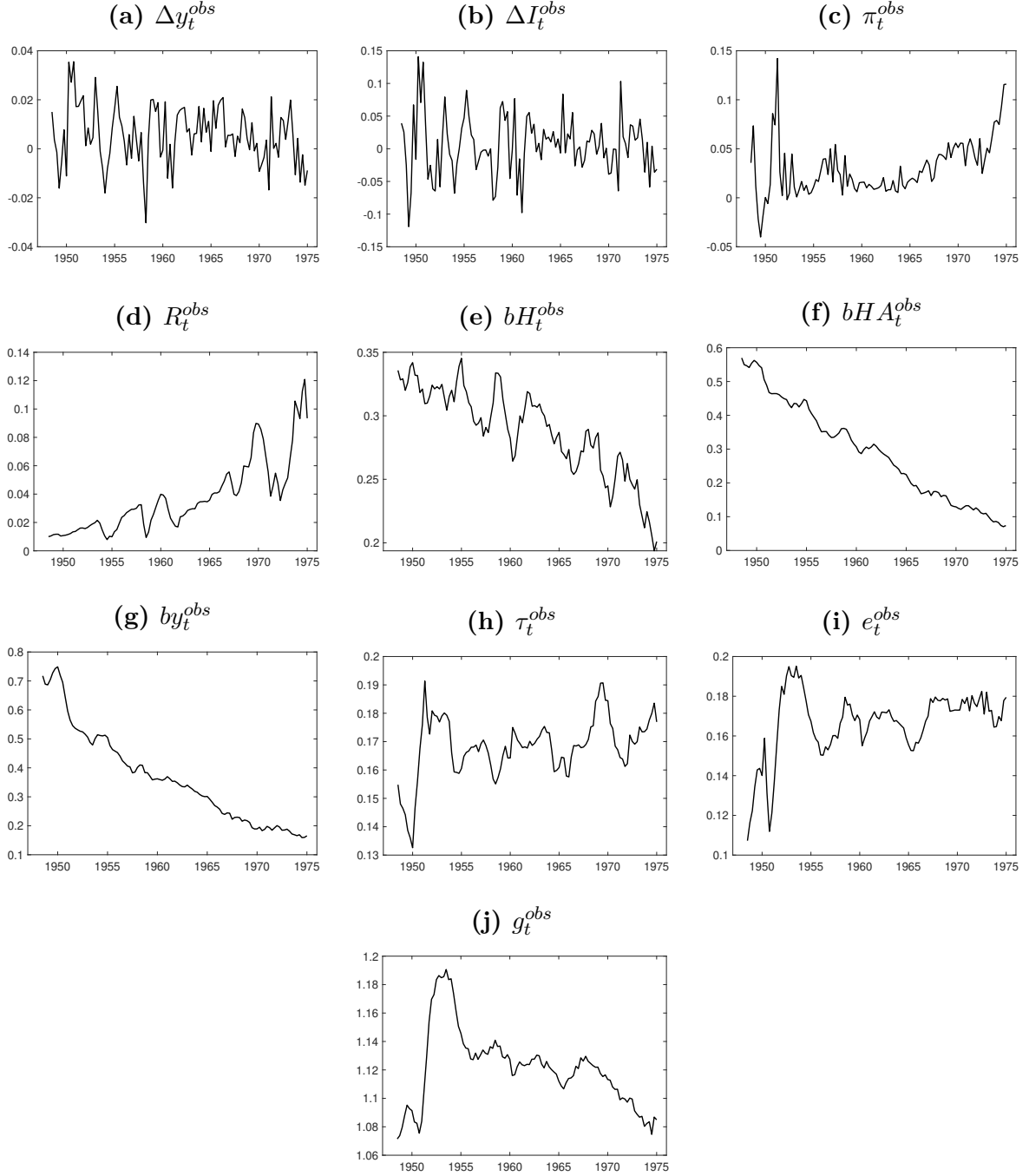
`https://fraser.stlouisfed.org/`

Banks' debt holdings-total debt: Banks' government debt holdings as defined above and divided by par value of government interest-bearing debt held by private investors; also taken from Hall et al. (2021) and available on George Hall's website.

Pop: We use a population index *Pop* to convert all variables in levels into per capita. Therefore we use the time series civilian noninstitutional population in thousands, ages 16 years and over, from the Bureau of Labor Statistics. The data are seasonally adjusted using the US Census Bureau's X13-ARIMA-SEATS. Finally, the series is transformed into an index such that 2012q3=1.

GDP and investment are converted into real per capita growth rates by taking first difference of log transformed data which were prefiously divided by the GDP deflator and the population index *Pop*. The fiscal variables are expressed relative to GDP. Finally, the observables are linked to model variables as follows:

$$\Delta y_t^{obs} = \ln\left(e^{z_t} y_t / y_{t-1}\right)$$
$$\Delta I_t^{obs} = \ln\left(e^{z_t} i_t / i_{t-1}\right)$$
$$g_t^{obs} = \mathcal{G}_t = 1/\left(1 - g_t/y_t\right)$$
$$e_t^{obs} = e_t$$
$$\tau_t^{obs} = \tau_t$$
$$\pi_t^{obs} = 4\ln\left(\Pi_t\right)$$
$$R_t^{obs} = 4R_t$$
$$by_t^{obs} = \mathcal{B}_t/4$$
$$bHA_t^{obs} = Q_t^b b_t^b / \left(nw_t + d_t\right)$$
$$bH_t^{obs} = b_t^b / b_t$$

Figure B.1: Observable variables.

(a) Δy_t^{obs}

(b) ΔI_t^{obs}

(c) π_t^{obs}

(d) R_t^{obs}

(e) bH_t^{obs}

(f) bHA_t^{obs}

(g) by_t^{obs}

(h) τ_t^{obs}

(i) e_t^{obs}

(j) g_t^{obs}

C Additional results

C.1 Estimation

Figure C.1: Prior and posterior plots
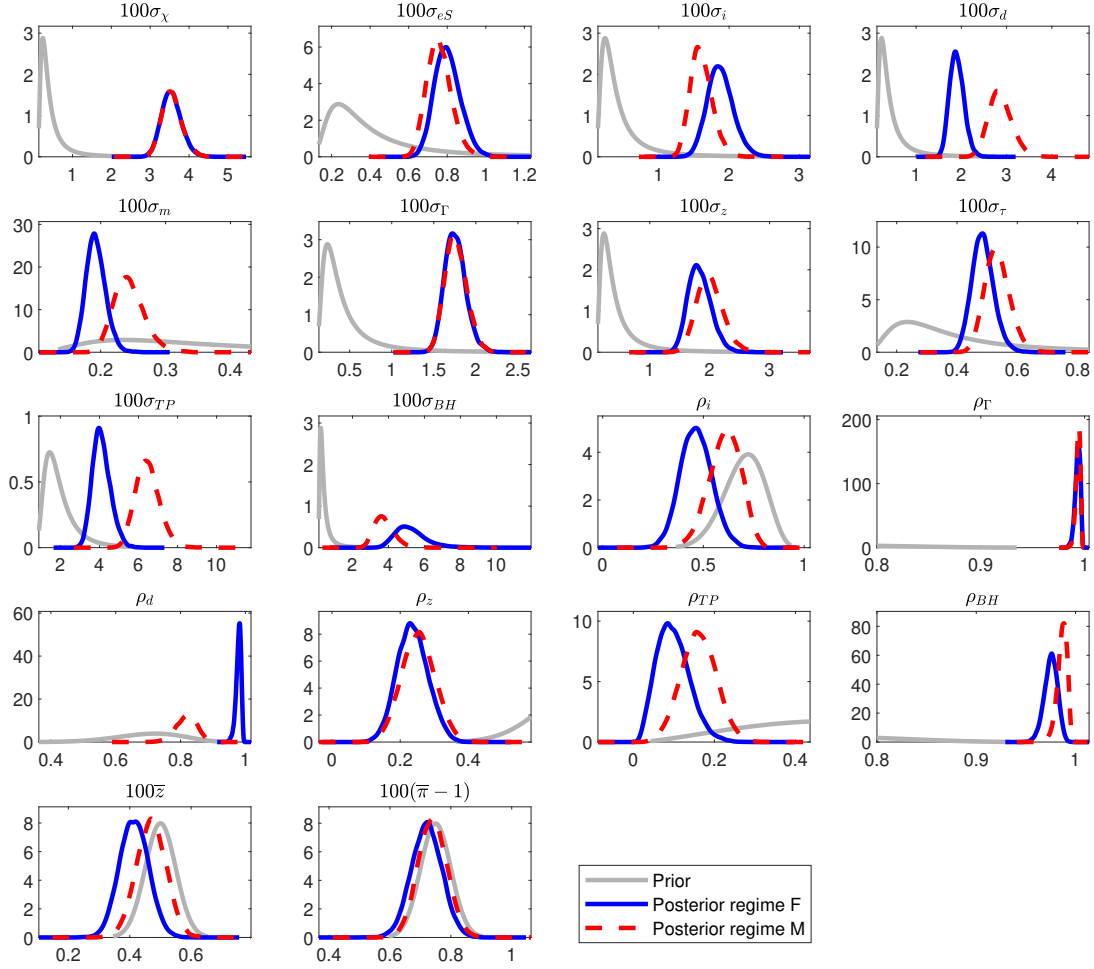
Figure C.2: Prior and posterior plots
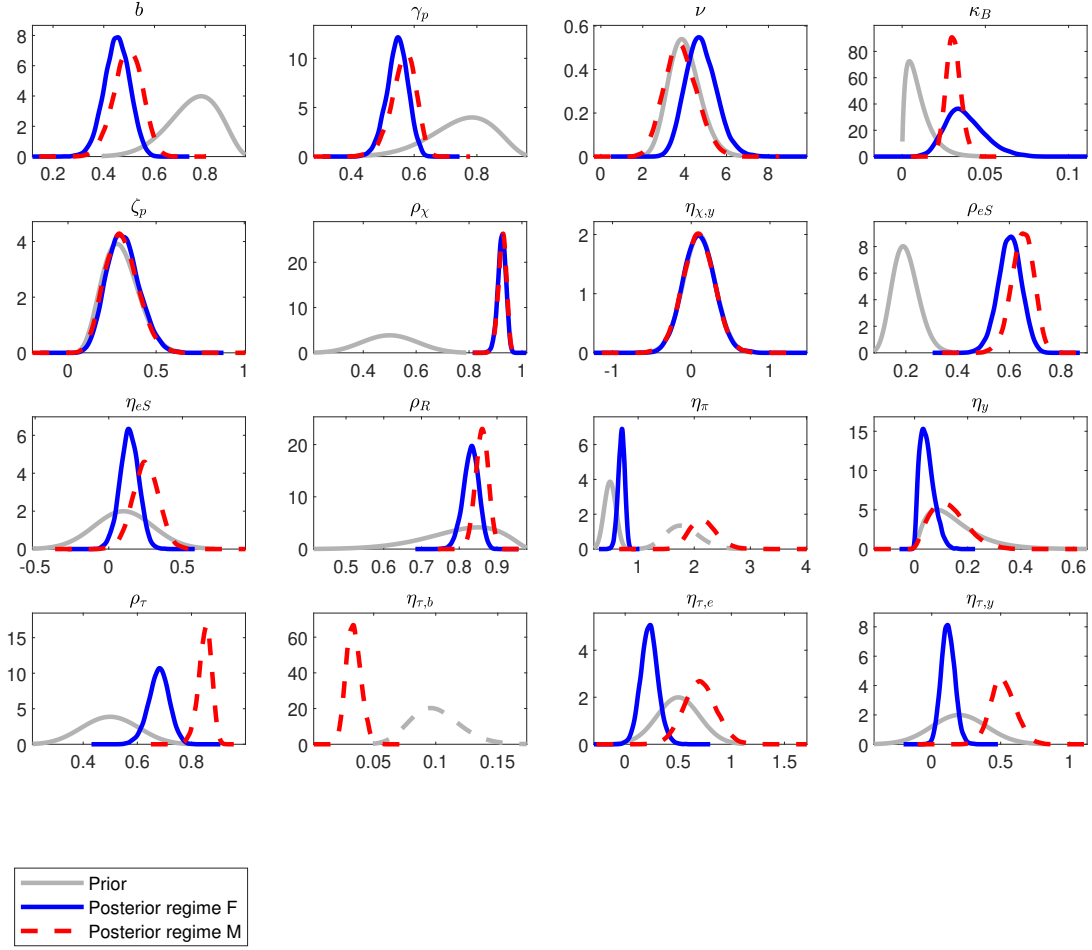
Figure C.3: Smoothed model variables under Regime M

(a) Ex-post government bond return

(b) Government expenditures / GDP
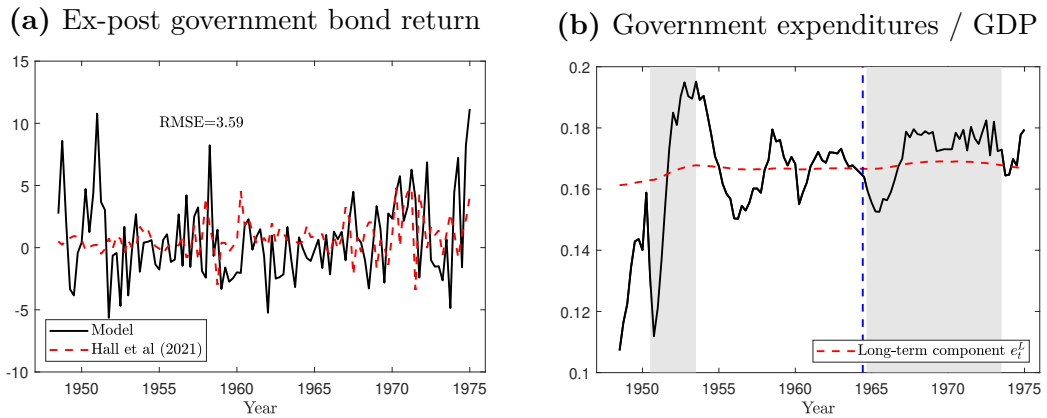
Notes: The left panel shows the ex-post return of a government bond portfolio implied by the model and estimated by Hall et al. (2021). the right panel shows the government expenditure-to-GDP ratio and, e_t^L, its long-term component (red-dashed). The shaded areas are the Korean and Vietnam wars, while the blue vertical line corresponds to president Lyndon B. Johnson's first announcement of the "Great Society."

Table C.1: Prior and posterior distribution of parameters (Regime M)

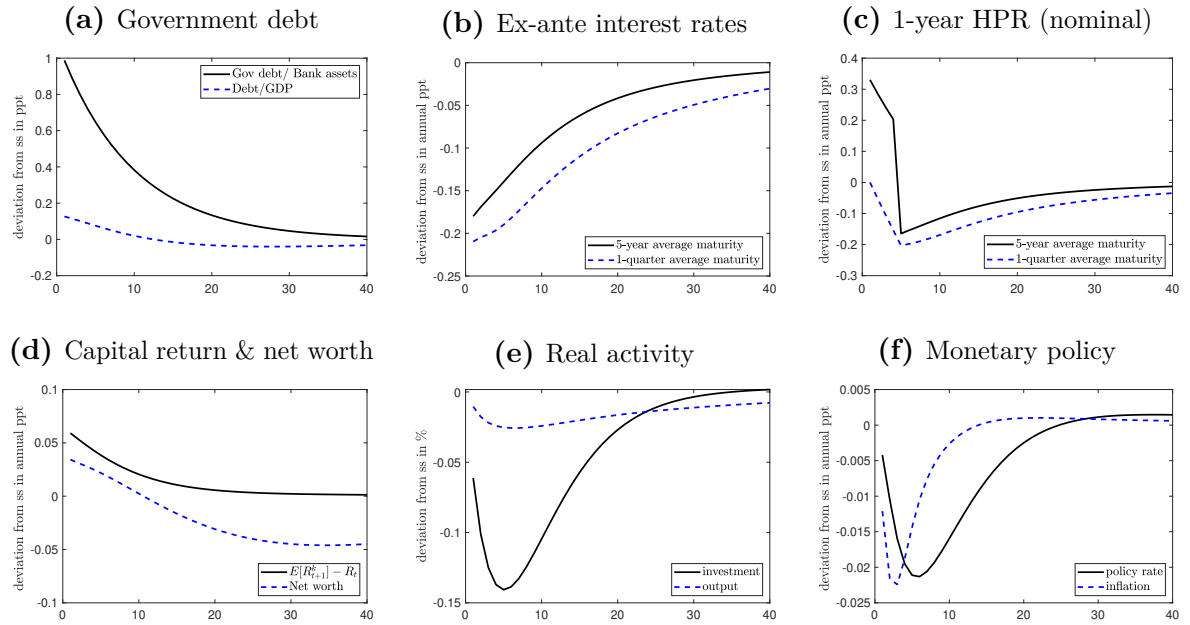| Name	Symbol	Posterior				Pior		
		Mode	Mean	5%	95%	Type	Mean	Std
Calvo parameter	γ_p	0.567	0.565	0.503	0.628	B	0.5	0.05
Price indexation	ζ_p	0.286	0.303	0.147	0.447	B	0.3	0.10
Investment adjustment	ν	3.500	3.816	2.530	5.064	G	4.0	0.75
Habit formation	b	0.497	0.495	0.406	0.587	B	0.75	0.10
Portfolio adj. cost	κ_b	0.029	0.031	0.023	0.038	G	0.01	0.0075
Interest rate AR coefficient	ρ_R	0.859	0.860	0.831	0.888	B	0.8	0.1
Interest rate inflation coefficient	η_π	2.129	2.163	1.768	2.533	G	1.8	0.3
Interest rate output coefficient	η_y	0.098	0.130	0.022	0.230	G	0.15	0.1
AR coefficient Tax rate	ρ_τ	0.849	0.849	0.809	0.889	B	0.5	0.1
Tax rate debt coefficient	$\eta_{\tau,b}$	0.033	0.034	0.024	0.044	G	0.1	0.05
Tax rate expenditure coefficient	$\eta_{\tau,e}$	0.704	0.701	0.450	0.941	N	0.5	0.2
Tax rate output coefficient	$\eta_{\tau,y}$	0.485	0.518	0.373	0.666	N	0.2	0.2
AR coefficient gov. spending	ρ_χ	0.928	0.925	0.901	0.951	B	0.5	0.1
Gov. spending output coefficient	$\eta_{\chi,y}$	0.092	0.091	-0.243	0.408	N	0.1	0.2
AR coefficient short-run exp.	ρ_{eS}	0.658	0.650	0.584	0.724	B	0.2	0.05
Short-run exp. output coefficient	η_{eS}	0.272	0.251	0.108	0.393	N	0.1	0.2
Steady state growth rate	$100\bar{z}$	0.466	0.469	0.390	0.547	N	0.50	0.05
Steady state inflation	$100\left(\bar{\Pi}-1\right)$	0.739	0.740	0.664	0.819	N	0.75	0.05
AR coefficient preference	ρ_d	0.827	0.817	0.769	0.870	B	0.5	0.1
AR coefficient investment	ρ_i	0.648	0.606	0.482	0.736	B	0.5	0.1
AR coefficient long-run growth	ρ_z	0.250	0.253	0.173	0.332	B	0.5	0.1
AR coefficient repression	ρ_Γ	0.995	0.994	0.990	0.997	B	0.5	0.1
AR coefficient term premium	ρ_{tp}	0.164	0.161	0.086	0.230	B	0.5	0.1
AR coefficient bond holdings	ρ_{bh}	0.989	0.986	0.979	0.994	B	0.5	0.1
S.d. preference	$100\sigma_d$	2.804	2.861	2.447	3.279	IG	0.5	2.0
S.d. investment	$100\sigma_i$	1.521	1.604	1.358	1.853	IG	0.5	2.0
S.d. monetary policy shock	$100\sigma_m$	0.239	0.244	0.206	0.281	IG	0.5	2.0
S.d. government spending ratio	$100\sigma_\chi$	3.497	3.555	3.119	3.957	IG	0.5	2.0
S.d. short-run expenditures	$100\sigma_{eS}$	0.735	0.757	0.651	0.856	IG	0.5	2.0
S.d. term premium shock	$100\sigma_{tp}$	6.200	6.453	5.451	7.415	IG	0.5	2.0
S.d. tax rate	$100\sigma_\tau$	0.523	0.533	0.465	0.599	IG	0.5	2.0
S.d. long-run growth	$100\sigma_z$	1.967	2.004	1.639	2.345	IG	0.5	2.0
S.d. repression	$100\sigma_\Gamma$	1.724	1.762	1.564	1.978	IG	0.5	2.0
S.d. bond holdings	$100\sigma_{bh}$	3.472	3.766	2.850	4.600	IG	0.5	2.0
Log data density	3178.458							

Notes: Posterior statistics based on MCMC with two chains of 400k draws each, 80% of draws discarded, and an acception rate of approx. 23%. The right-hand side of the table reports the priors. In the column "Type", G, N, B, and IG correspond to gamma, normal, beta, and inverse gamma distributions, respectively.
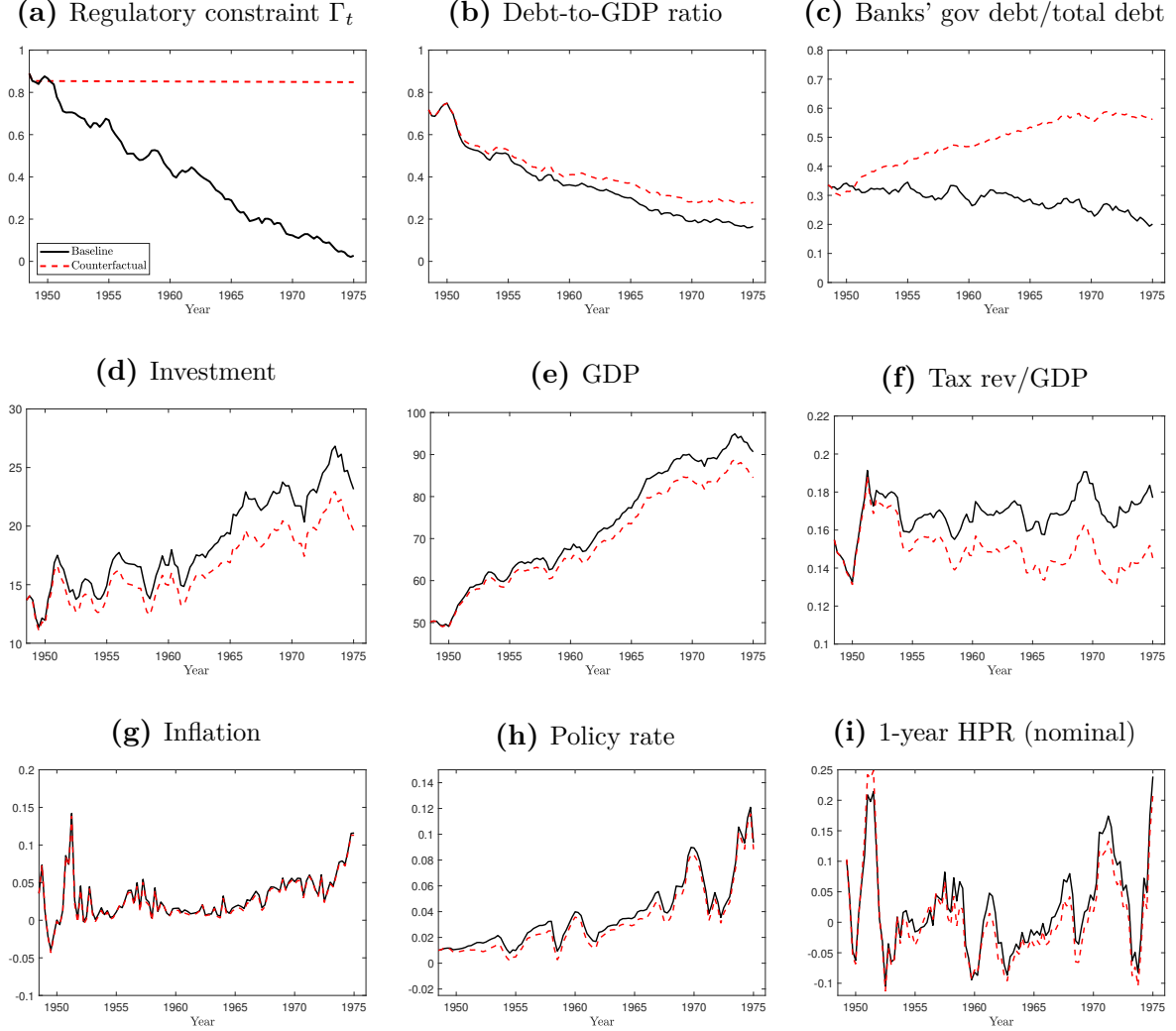
C.2 Mechanism

Figure C.4: Impulse responses to repression shock under Regime M

(a) Government debt

(b) Ex-ante interest rates

(c) 1-year HPR (nominal)

(d) Capital return & net worth

(e) Real activity

(f) Monetary policy

Notes: Repression shock is a temporary increase of Γ_t by one standard deviation under Regime M. The vertical axis measures deviation from steady state, while the horizontal axis measures time in quarters.

D Counterfactual experiments

Figure D.1: General-equilibrium counterfactual (Regime M)

(a) Regulatory constraint Γ_t **(b)** Debt-to-GDP ratio   **(c)** Banks' gov debt/total debt

(d) Investment   **(e)** GDP   **(f)** Tax rev/GDP

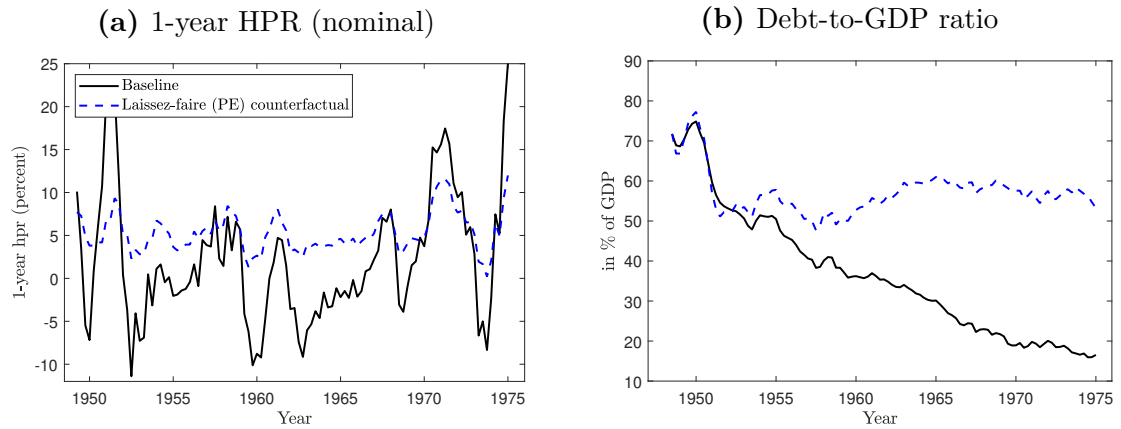**(g)** Inflation   **(h)** Policy rate   **(i)** 1-year HPR (nominal)

Notes: Solid (black) lines represent actual outcomes, as predicted by the model based on estimates for Regime M. The dashed (red) line shows results for a counterfactual in which repression is kept high at the level observed at the beginning of the sample period (see panel (a)). Smoothed variables and shocks based on estimates as presented in table C.1.

Figure D.2: Quantifying the difference under regime M due to repression for . . .
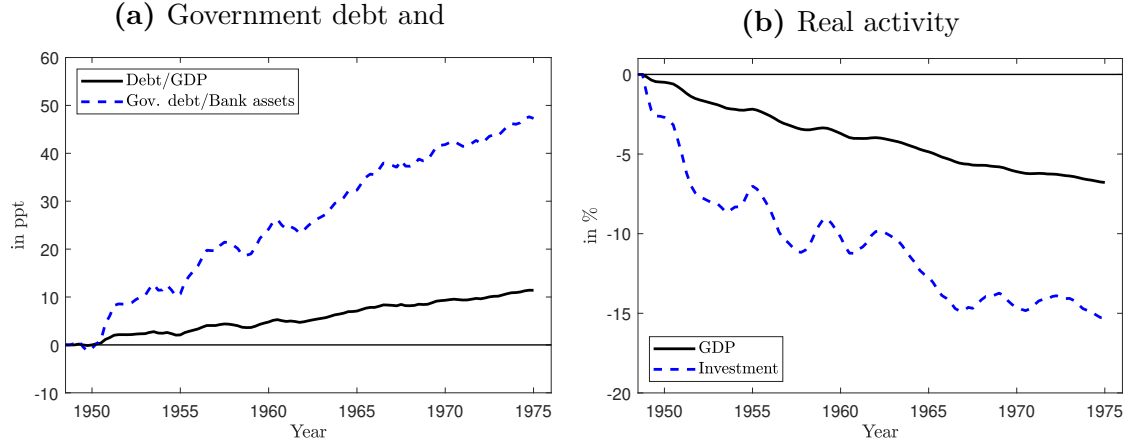
(a) Government debt and
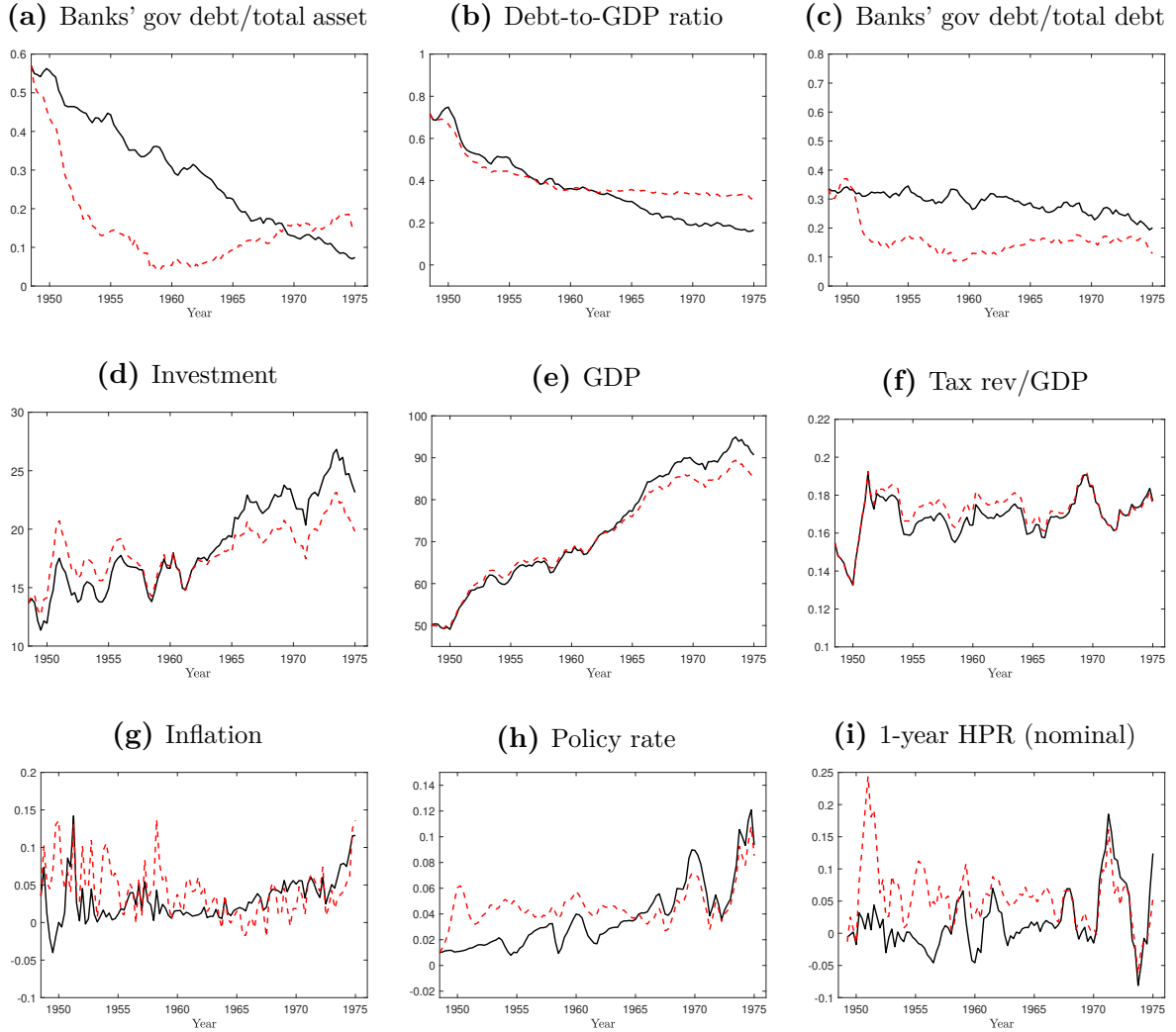
(b) Real activity

Notes: Difference for key variables across counterfactual outcome w/ repression and baseline w/ phasing out of repression. Smoothed variables and shocks are based on estimates presented in table C.1 for Regime M. The figure shows the difference across outcomes shown in FigureD.1.

Figure D.3: Actual developments v partial-equilibrium counterfactual (Regime M)

(a) 1-year HPR (nominal)
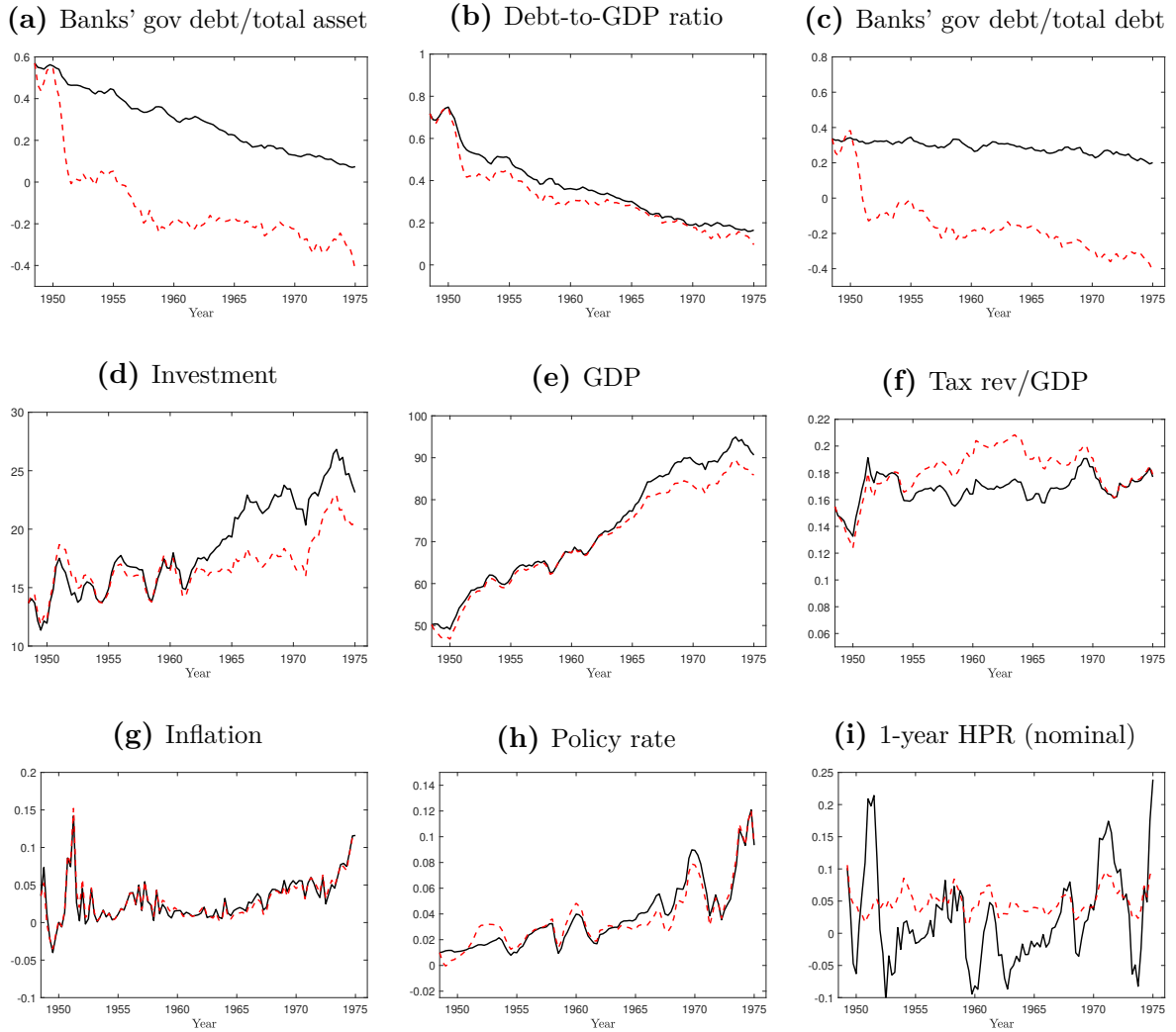
(b) Debt-to-GDP ratio

Notes: The baseline is given by the solid (black) line and the laissez-faire counterpart by the dashed (blue) line. The laissez-faire scenario is based on a partial-equilibrium perspective: It obtains as we set $\mu_t = 0$ in eq. (2.17), all else equal. Smoothed variables and shocks are based on estimates presented in table C.1 for Regime M.

Figure D.4: Counterfactual without repression (regime F)

(a) Banks' gov debt/total asset

(b) Debt-to-GDP ratio

(c) Banks' gov debt/total debt

(d) Investment

(e) GDP

(f) Tax rev/GDP

(g) Inflation

(h) Policy rate

(i) 1-year HPR (nominal)

Notes: Solid (black) lines represent actual outcomes, as predicted by the model based on estimates for Regime F. The dashed (red) line shows results for a counterfactual without repression. The model itself behaves as in Gertler and Karadi (2013) with only one constraint, the counterfactual is based on shocks identified in the baseline model, also the initial values are taken from the baseline model. Since the shocks ϵ_Γ and ϵ_{bh} play no role for real economic activity in a model without financial repression, these shocks are set to zero throughout the simulation.

Figure D.5: Counterfactual without repression (Regime M)

(a) Banks' gov debt/total asset

(b) Debt-to-GDP ratio

(c) Banks' gov debt/total debt

(d) Investment

(e) GDP

(f) Tax rev/GDP

(g) Inflation

(h) Policy rate

(i) 1-year HPR (nominal)

Notes: Solid (black) lines represent actual outcomes, as predicted by the model based on estimates for Regime M. The dashed (red) line shows results for a counterfactual without repression. The model itself behaves as in Gertler and Karadi (2013) with only one constraint, the counterfactual is based on shocks identified in the baseline model, also the initial values are taken from the baseline model. Since the shocks ϵ_Γ and ϵ_{bh} play no role for real economic activity in a model without financial repression, these shocks are set to zero throughout the simulation.