Appendix to "Unemployment, Partial Insurance, and the Multiplier Effects of Government Spending"

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A The Baseline Flexible Price Model

In this section I report the full set of general equilibrium conditions for the shirking model with flexible prices and fixed capital. I also prove Proposition 1 and derive an analytical expression for C_t^u/C_t^e in the case of zero insurance.

A.1 Proof of Proposition 1

Combining (A.4) with (A.5), (A.9), and (A.8) produces an aggregate labor supply condition

$$w_t h = \frac{1}{1-s}\left(\frac{\tilde{C}-1}{\tilde{C}}\right)\frac{Y_t - G_t}{(1-\mu)N_t + \mu}.$$

Balancing labor supply with labor demand (A.3) gives

$$\frac{1}{1-s}\left(\frac{\tilde{C}-1}{\tilde{C}}\right)\frac{Y_t - G_t}{(1-\mu)N_t + \mu} = (1-\alpha)\overline{K}^{\alpha}(N_t eh)^{-\alpha} eh.$$

Differentiating the market-clearing condition with respect to G_t and collecting terms gives

$$\frac{dY_t}{dG_t} = 1 + C_t\left[\frac{(1-\mu)N_t}{(1-\mu)N_t + \mu} - \alpha\right]\frac{1}{N_t}\frac{dN_t}{dG_t}.$$

The production function (A.6) implies $dY_t/dG_t = (1-\alpha)(Y_t/N_t)dN_t/dG_t$. Substituting this

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Table A.1
The Baseline Shirking Model with Flexible Prices

Average marginal utility	$\lambda_t = N_t/C_t^e + (1-N_t)/C_t^u$	(A.1)
Euler equation	$\lambda_t = \beta E_t \lambda_{t+1} r_t$	(A.2)
Marginal product of labor	$w_t h = (1-\alpha)\overline{K}^{\alpha}(N_t eh)^{-\alpha} eh$	(A.3)
No-shirking condition	$C_t^e = (1-s)(\tilde{C}/(\tilde{C}-1))w_t h$	(A.4)
Risk-sharing condition	$C_t^u = \mu(\sigma) C_t^e$	(A.5)
Production function	$Y_t = \overline{K}^{\alpha}(N_t eh)^{1-\alpha}$	(A.6)
Family consumption	$C_t^f = C_t - w_t h N_t$	(A.7)
Resource constraint	$Y_t = C_t + G_t$	(A.8)
Aggregate consumption	$C_t = N_t C_t^e + (1-N_t) C_t^u$	(A.9)
Government spending	$G_t = (1-\rho)G + \rho G_{t-1} + \varepsilon_t$	(A.10)

into the previous expression and evaluating the result at the steady state gives

$$\frac{dY_t}{dG_t} = \left[1 + \frac{1-g}{1-\alpha}\left(\alpha - \frac{(1-\mu)N}{(1-\mu)N+\mu}\right)\right]^{-1}.$$

It follows from (A.8) that $dC_t/dG_t = dY_t/dG_t - 1$.

To establish part (*ii*) of Proposition 1, evaluate the partial derivative of dY_t/dG_t with respect to μ. After some rearranging, the partial can be written as

$$\frac{\partial}{\partial\mu}\frac{dY_t}{dG_t} = -\left(\frac{dY_t}{dG_t}\right)^2 \left(\frac{1-g}{1-\alpha}\right) \frac{N}{((1-\mu)N+\mu)^2} < 0.$$

This term is negative for all feasible values of (N, g, α, μ). And from (A.8), it follows that $(\partial/\partial\mu)(dC_t/dG_t) = (\partial/\partial\mu)(dY_t/dG_t) < 0$.

Part (*iii*) of Proposition 1 establishes conditions on μ consistent with $dY_t/dG_t > 1$ and $dC_t/dG_t > 0$. Given $g \in (0,1)$ and $\alpha \in (0,1)$, it is obvious that $dY_t/dG_t > 1$ requires the term in parentheses to be negative, or

$$\alpha < \frac{(1-\mu)N}{(1-\mu)N+\mu}.$$

Moving μ to the left-hand-side yields

$$\mu < \frac{(1-\alpha)N}{(1-\alpha)N+\alpha}.$$

A.2 The Case of Zero Insurance

To find an expression for $\mu(0)$, recall that equations (2) and (4) in the text imply

$$\begin{aligned} C^e(\sigma) &= C^f + wh - \sigma(1-N)wh \\ C^u(\sigma) &= C^f + \sigma N wh \end{aligned}$$

in the steady state. When $\sigma = 0$, these two equations become

$$\frac{C^e(0)}{Y} = \frac{C^f}{Y} + \frac{wh}{Y} \qquad \text{and} \qquad \frac{C^u(0)}{Y} = \frac{C^f}{Y}$$

after dividing through by steady-state output.

It turns out that the ratio of family consumption to output in the steady state is independent of σ, and given (A.7), can be expressed as

$$\begin{aligned} \frac{C^f}{Y} &= \frac{C}{Y} - \frac{whN}{Y} \\ &= 1 - g - \frac{(1-\alpha)\overline{K}^{\alpha}(Neh)^{-\alpha}ehN}{Y} \\ &= \alpha - g. \end{aligned}$$

It follows that

$$\begin{aligned} \mu(0) &= \frac{C^u(0)}{C^e(0)} = \frac{C^u(0)/Y}{C^e(0)/Y} = \frac{C^f/Y}{C^f/Y + wh/Y} \\ &= \frac{\alpha - g}{\alpha - g + (1-\alpha)\frac{1}{N}}. \end{aligned}$$

B A Sticky Price Model with Fixed Capital

In this section I report the set of log-linearized general equilibrium conditions for a version of the shirking model with sticky prices and fixed capital. The multiplier properties are summarized in Proposition 2 (see proof below), which generalizes Proposition 1 to the case of sticky prices. I go on to provide a full analysis of these findings and discuss their sensitivity to variations in some of the key structural parameters.

Table B.1
The Shirking Model with Sticky Prices and Fixed Capital

Average marginal utility	$\hat{\lambda}_t = -\hat{C}^e_t - \frac{(1-\mu)N}{1-(1-\mu)N}\hat{N}_t$	(B.1)
Euler equation	$\hat{\lambda}_t = E_t\hat{\lambda}_{t+1} + \hat{R}_t - E_t\hat{\pi}_{t+1}$	(B.2)
Marginal product of labor	$\hat{w}_t = \hat{mc}_t - \alpha\hat{N}_t$	(B.3)
No-shirking condition	$\hat{C}^e_t = \hat{w}_t$	(B.4)
Risk-sharing condition	$\hat{C}^u_t = \hat{C}^e_t$	(B.5)
Production function	$\hat{Y}_t = (1-\alpha)\hat{N}_t$	(B.6)
Resource constraint	$\hat{Y}_t = (1-g)\hat{C}_t + g\hat{G}_t$	(B.7)
Aggregate consumption	$\hat{C}_t = \hat{C}^e_t + \frac{(1-\mu)N}{(1-\mu)N+\mu}\hat{N}_t$	(B.8)
Phillips curve	$\hat{\pi}_t = \beta E_t\hat{\pi}_{t+1} + \frac{(1-\chi)(1-\chi\beta)}{\chi}\hat{mc}_t$	(B.9)
Monetary policy	$\hat{R}_t = \phi_\pi\hat{\pi}_t$	(B.10)
Government spending	$\hat{G}_t = \rho\hat{G}_{t-1} + \hat{\varepsilon}_t$	(B.11)

Notes: All variables are expressed as log deviations from the nonstochastic steady state and are denoted with the ˆ symbol.

B.1 Government Spending Multipliers

Below I explain how the fiscal multipliers depend on unemployment insurance and if sticky prices alter this relationship vis-à-vis flexible prices.

PROPOSITION 2: *In the shirking model with fixed capital and Calvo-Yun prices,*

(*i*) *the impact multipliers for output and consumption are*

$$\frac{dY_t}{dG_t} \equiv \Sigma_y = \frac{(1-\rho)+\kappa\left(\frac{\phi_\pi-\rho}{1-\beta\rho}\right)}{(1-\rho)\left[1-\left(\frac{1-g}{1-\alpha}\right)f(\mu)\right]+\kappa\left(\frac{\phi_\pi-\rho}{1-\beta\rho}\right)\Gamma_y^{-1}} \qquad \frac{dC_t}{dG_t} \equiv \Sigma_c = \Sigma_y - 1,$$

where $\kappa \equiv \frac{(1-\chi)(1-\chi\beta)}{\chi}$ *and* $f(\mu) \equiv \frac{(1-\mu)N}{(1-\mu)N+\mu} - \frac{(1-\mu)N}{1-(1-\mu)N} < 0$ *for* $N > \frac{1}{2}$,

(*ii*) $\Sigma_y > 1$ *and* $\Sigma_c > 0$ *if and only if*

$$\alpha - f(\mu)\left(\frac{(1-\rho)(1-\beta\rho)}{\kappa(\phi_\pi-\rho)}\right) < \frac{(1-\mu)N}{(1-\mu)N+\mu}, \textit{ and}$$

(*iii*) $\Sigma_y > \Gamma_y$ *and* $\Sigma_c > \Gamma_c$ *if and only if*

$$\alpha > \frac{(1-\mu)N}{1-(1-\mu)N} \quad \Leftrightarrow \quad \mu > 1 - \frac{\alpha}{1+\alpha}\frac{1}{N} \equiv \mu^*.$$

The first part shows that the multipliers, denoted Σ_y and Σ_c, are more complicated than their flexible-price counterparts, Γ_y and Γ_c. Each is itself a function of Γ_y in addition to other common terms like the discount factor β and the persistence of government spending

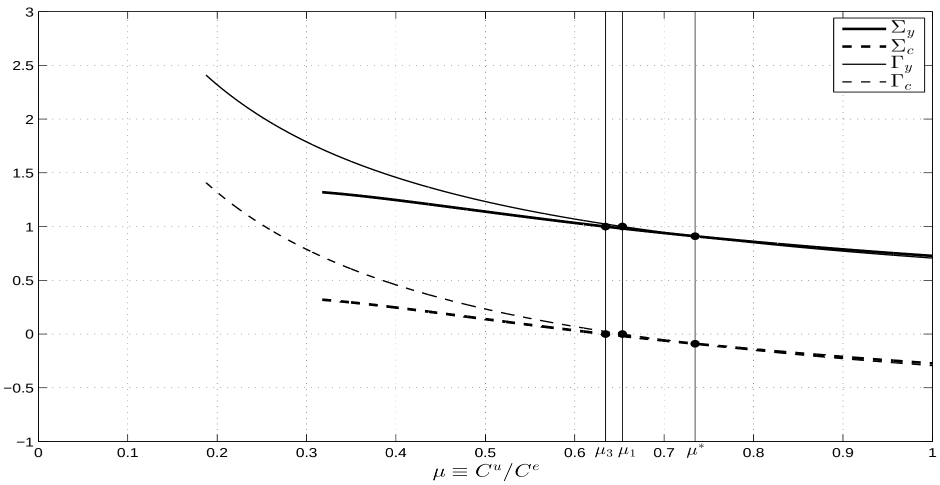

Fig. B.1. Impact multipliers

Notes: Impact multipliers for output (Σ_y) and consumption (Σ_c) under sticky prices are shown as functions of the insurance coefficient μ. Also shown are the multipliers for output (Γ_y) and consumption (Γ_c) under flexible prices. Computations are based on the following calibration: $\beta = 0.99$, $g = 0.17$, $\rho = 0.90$, $N = 0.942$, $\alpha = 1/3$, $\chi = 2/3$, $\eta = 6$, $\phi_\pi = 1.50$.

ρ. Note also that Σ_y and Σ_c depend on two concepts unique to the sticky price model, the fraction of fixed-price firms χ and the monetary policy response coefficient ϕ_π.

One implication of this added complexity is that the multipliers are no longer universally decreasing with respect to unemployment insurance. For typical parameter values though, Σ_y and Σ_c still increase as μ gets smaller. How elastic the relationship is can be seen in Figure B.1, which graphs Σ_y (solid line) and Σ_c (dashed line) as functions of μ. For the sake of comparison, the figure also shows Γ_y and Γ_c. When unemployment insurance is high, flexible and sticky prices produce nearly identical results. Daylight between the two emerges only when the economy moves far away from full insurance, with Σ_y and Σ_c being smaller.

Part (*ii*) reasserts the central finding of the paper. A positive consumption multiplier and hence an output multiplier greater than one is still possible under sticky prices if unemployment insurance is low enough. The critical value of μ, call it μ_3, for which $\Sigma_c = 0$ and $\Sigma_y = 1$ is about 0.63. This is slightly less than the value under flexible prices (μ_1) and implies a consumption drop of 37 percent for members who lose their job.

The mechanism behind this result is really no different than before. Rising employment pushes up aggregate consumption through a composition effect that offsets the drop in individual consumption induced by higher taxes. The only nuance concerns the exact degree of risk sharing at which the composition effect becomes the dominant force. Under flexible prices, the relevant sufficient condition was that the no-shirking condition be steeper than labor demand (i.e., $(1-\mu)N/[(1-\mu)N+\mu] > \alpha$). This same condition is necessary but no longer sufficient under sticky prices. Now μ must be small enough so that the slope of the no-shirking condition exceeds the slope of labor demand by an amount greater than or equal to $-f(\mu)(1-\rho)(1-\beta\rho)/[\kappa(\phi_\pi-\rho)] > 0$.[1]

A closer look at the labor market reveals why the insurance criteria is generally more restrictive under sticky prices. An increase in government spending shifts both the no-shirking locus and the labor demand schedule simultaneously. However, for the range of insurance options consistent with $\Sigma_y \geq 1$, the shift in labor demand undermines some of the positive employment effects brought about by a lower incentive-compatible real wage.

To see how this dynamic plays out in the model, consider the log-linearized labor demand equation (B.3) $\hat{w}_t = -\alpha\hat{N}_t + \hat{mc}_t$. At any given wage, employment demand depends positively on real marginal cost (or inversely on the markup). Whether marginal cost goes up or down after a fiscal shock though depends on the degree of unemployment insurance. In this case I find it helpful to look at the analytical solution

$$\hat{mc}_t = \frac{g}{1-g}\left(\frac{\Sigma_y}{\Gamma_y} - 1\right)\hat{G}_t. \tag{B.12}$$

The key term here is Σ_y/Γ_y. When this ratio is below one, as it is for $\mu = \mu_3$, marginal cost falls (markups rise) after an increase in government spending. This reduces labor demand, which for a given wage, partially offsets the positive impetus on employment caused by firms' realignment of the incentive compatibility constraint (i.e., the outward shift in the no-shirking condition). Generating an output multiplier bigger than one therefore requires a smaller amount of insurance than the flexible price case. A lower value of μ effectively compensates for the offsetting labor demand effect under sticky prices.

By contrast, if marginal cost were to respond procyclically (or markups countercyclically), the ensuing increase in labor demand would strengthen any positive employment effects originating from the supply side of the market. Impact multipliers in this case would be larger than the ones observed under flexible prices where labor demand remains fixed.

Part (*iii*) describes this scenario and identifies conditions on μ that make it possible. Evidently there is a critical value of μ, call it μ^*, for which $\Sigma_y = \Gamma_y$ and $\Sigma_c = \Gamma_c$. At this level of insurance there will be no reaction of marginal cost to a spending shock, no shift in labor demand, and therefore no difference in outcomes between the two models. On the

[1]The critical value μ_3 is defined implicitly by $\frac{(1-\mu_3)N}{(1-\mu_3)N+\mu_3} = \alpha - f(\mu_3)\left(\frac{(1-\rho)(1-\beta\rho)}{\kappa(\phi_\pi-\rho)}\right)$.

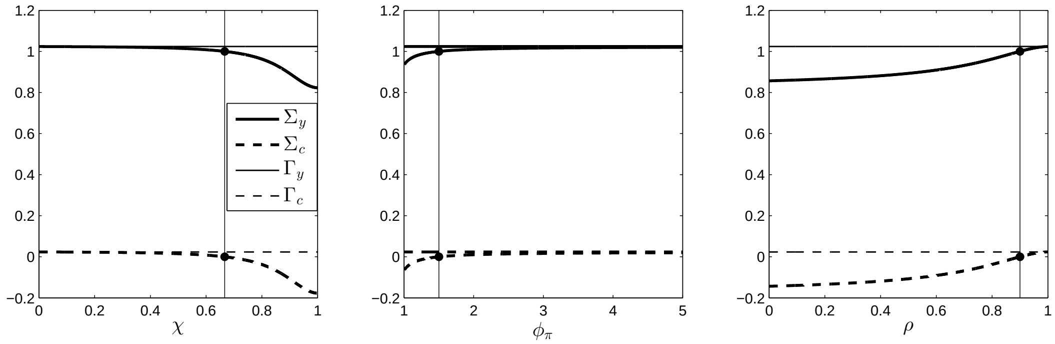

Fig. B.2. Impact multipliers

Notes: Impact multipliers for output (Σ_y) and consumption (Σ_c) under sticky prices are shown as functions of χ, ϕ_π, and ρ. Also shown are the multipliers for output (Γ_y) and consumption (Γ_c) under flexible prices. Computations are based on the following calibration: $\mu = \mu_3$, $\beta = 0.99$, $g = 0.17$, $\rho = 0.90$, $N = 0.942$, $\alpha = 1/3$, $\chi = 2/3$, $\eta = 6$, $\phi_\pi = 1.50$.

other hand, values above μ^* elicit a positive response of marginal cost, producing multipliers that exceed Γ_y and Γ_c. But results show these gains to be small and present only at insurance levels that give $\Sigma_c < 0$ and $\Sigma_y < 1$.

B.2 Sensitivity Checks

Most of the parameter values used in Figure B.1 are standard. But for some there is less consensus about ideal values, namely, the share of fixed-price firms χ, the policy rule coefficient ϕ_π, and the persistence of government spending ρ. Given their prominence in the model, it is worthwhile to examine the sensitivity of the results to variations in all three.

Figure B.2 graphs Σ_y (solid lines) and Σ_c (dashed lines) as functions of χ, ϕ_π, and ρ. Vertical lines mark the baseline values of 2/3, 1.5, and 0.9. In constructing each graph, μ is held fixed at the level that generates a zero consumption multiplier in the sticky price model ($\mu = \mu_3$). As a reference, the figure also displays Γ_y and Γ_c.

The left panel illustrates the effect of variations in χ. As the share of fixed-price firms decline, Σ_c and Σ_y increase rapidly towards Γ_c and Γ_y. Recall from (B.12) that a rise in government spending reduces marginal cost when $\mu = \mu_3$. This provokes a left shift in labor demand that offsets some, but not all, of the expansionary effects of the shock on employment. As prices become more flexible, the shift in labor demand gets smaller, and as a result, net increases in employment get bigger.[2]

[2] A higher degree of price stickiness will increase the multipliers if marginal cost and, by extension, labor demand respond positively to government spending. This only occurs when $\mu > \mu^*$.

The center panel considers changes in ϕ_π. Under the baseline calibration, Σ_c and Σ_y increase as the response coefficient rises and are nearly identical to Γ_c and Γ_y for any $\phi_\pi > 2$. The intuition here is simple. With sticky prices, a central bank can replicate the flexible price equilibrium by implementing a policy rule that stabilizes inflation.

The right panel shows changes in ρ. Notice that Σ_c and Σ_y get bigger as the persistence of government spending increases. Thus for any $\rho > 0.9$, spending shocks crowd-in aggregate consumption, resulting in an output multiplier greater than one. Should they become permanent ($\rho = 1$), the effects will be the same as those under flexible prices. The reason has mostly to do with monetary policy. As is clear from (B.12), a higher value of ρ translates into a more persistent adjustment of marginal cost. This strengthens the contemporaneous effect of spending shocks on inflation; an effect that will be *negative* given the countercyclical response of marginal cost. A larger disinflation, in turn, triggers a more aggressive interest rate cut by the central bank. This extra monetary accommodation further stimulates output and employment, bolstering aggregate consumption through the composition effect.[3]

B.3 The Case of Full Insurance

According to Figure B.1, the output multiplier under flexible prices is still relatively large (about 0.71) when $\mu = 1$ and is very close to the value produced by the sticky-price model (about 0.73). This result appears to contradict the theoretical research arguing that price rigidity can, under certain conditions, substantially enlarge the multiplier effects in neoclassical models of fiscal policy (e.g., Monacelli and Perotti, 2008; Hall, 2009).

To understand why the flexible-price model with full insurance is still capable of generating sizable multipliers, it helps to consider the labor market. Recall that the no-shirking condition becomes perfectly horizontal under full insurance. This makes the model observationally equivalent to a neoclassical structure with either indivisible labor or with divisible but infinitely elastic labor supply (e.g., Alexopoulos, 2004). As shown by Baxter and King (1993) and many others, the usual wealth effects of higher government purchases lead to bigger changes in employment when labor supply is elastic than when it is upward sloping.

A flat supply curve also explains why there isn't much daylight between flexible and sticky-price multipliers under full insurance. To be sure, sticky-price multipliers are a bit larger. The differences can be magnified though if one turns up the "Keynesian" elements of the model. Figure B.3 graphs Σ_y (solid lines) and Σ_c (dashed lines) as functions of χ, ϕ_π,

[3] When marginal cost is procyclical (i.e, when $\mu > \mu^*$), a higher value of ρ pushes up the response of inflation. The resultant increase in the interest rate reduces the stimulative effects of a shock.

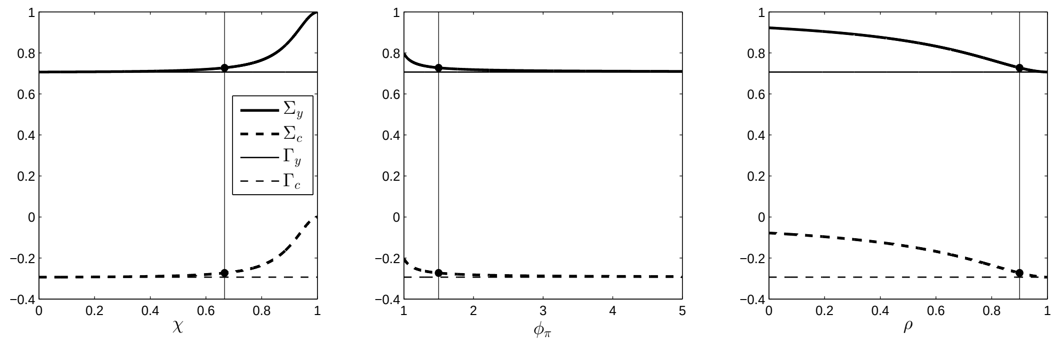

Fig. B.3. Impact multipliers

Notes: Impact multipliers for output (Σ_y) and consumption (Σ_c) under sticky prices are shown as functions of χ, ϕ_π, and ρ. Also shown are the multipliers for output (Γ_y) and consumption (Γ_c) under flexible prices. Computations are based on the following calibration: $\mu = 1$, $\beta = 0.99$, $g = 0.17$, $\rho = 0.90$, $N = 0.942$, $\alpha = 1/3$, $\chi = 2/3$, $\eta = 6$, $\phi_\pi = 1.50$.

and ρ while holding $\mu = 1$. Vertical lines mark the baseline values of 2/3, 1.5, and 0.9. As a reference, the figure also displays Γ_y and Γ_c for the case of $\mu = 1$.

Results show that higher values for the share of fixed-price firms χ and lower values for either the policy response to inflation ϕ_π or the persistence of government spending ρ tend to increase the sticky-price multipliers. The reason is that each of these variations makes real marginal cost more procyclical (i.e., markups more countercyclical) since $\mu > \mu^*$ in this case. And as explained in earlier, this increases labor demand and so strengthens the positive employment effects of a government spending shock. The larger the values of χ, or the smaller the values for ϕ_π and ρ, the bigger is the right shift in labor demand. Under flexible prices, by contrast, markups are zero and so labor demand is fixed.

B.4 Proof of Proposition 2

To obtain dY_t/dG_t and dC_t/dG_t, it suffices to find the reduced-form solutions of the log-linearized model. Here I conjecture that the solutions for $\hat{Y}_t$ and $\hat{C}_t$ implied by (B.1)-(B.11) take the form $\hat{Y}_t = \gamma_Y \hat{G}_t$ and $\hat{C}_t = \gamma_C \hat{G}_t$, where γ_Y and γ_C are undetermined coefficients. Since $\hat{X}_t \equiv \ln X_t - \ln X$ for any variable X_t with steady state X, I can rewrite the impact multipliers for output and consumption as $dY_t/dG_t = (1/g)\gamma_Y$ and $dC_t/dG_t = ((1-g)/g)\gamma_C$.

To find γ_Y and γ_C, substitute (B.8), (B.6), and (B.7) into (B.1) to obtain

$$\hat{\lambda}_t = -\hat{C}_t + f(\mu)\left(\frac{1}{1-\alpha}\right)\left((1-g)\hat{C}_t + g\hat{G}_t\right).$$

Substituting this expression along with the policy rule (B.10) into (B.2) gives

$$\left(1-\frac{1-g}{1-\alpha}f(\mu)\right)\left(\hat{C}_t-E_t\hat{C}_{t+1}\right)=-\left(\phi_\pi\hat{\pi}_t-E_t\hat{\pi}_{t+1}\right)+\left(\frac{g}{1-\alpha}\right)f(\mu)(1-\rho)\hat{G}_t.$$

Recalling the conjectured solution for $\hat{C}_t$ yields

$$\left(1-\frac{1-g}{1-\alpha}f(\mu)\right)(1-\rho)\gamma_C\hat{G}_t=-(\phi_\pi-\rho)\gamma_\pi\hat{G}_t+\left(\frac{g}{1-\alpha}\right)f(\mu)(1-\rho)\hat{G}_t,$$

where γ_π is the undetermined coefficient in the solution $\hat{\pi}_t=\gamma_\pi\hat{G}_t$. Matching coefficients gives the following parametric restriction between γ_C and γ_π

$$\left(1-\frac{1-g}{1-\alpha}f(\mu)\right)(1-\rho)\gamma_C=-(\phi_\pi-\rho)\gamma_\pi+\left(\frac{g}{1-\alpha}\right)f(\mu)(1-\rho).$$

A second restriction can be found by making use of the Phillips curve (B.9). But first, substitute into (B.3), (B.4), (B.8), and (B.6) to obtain an expression for real marginal cost

$$\hat{mc}_t=\Gamma_y^{-1}\hat{C}_t+\frac{g}{1-\alpha}\left(\alpha-\frac{(1-\mu)N}{(1-\mu)N+\mu}\right)\hat{G}_t,$$

where Γ_y is the impact multiplier for output in the flexible price model. Inserting $\hat{mc}_t$ into (B.9) along with the conjectured solutions for $\hat{C}_t$ and $\hat{\pi}_t$ yields

$$\gamma_\pi\hat{G}_t=\beta\rho\gamma_\pi\hat{G}_t+\kappa\Gamma_y^{-1}\gamma_C\hat{G}_t+\kappa\left(\frac{g}{1-\alpha}\right)\left(\alpha-\frac{(1-\mu)N}{(1-\mu)N+\mu}\right)\hat{G}_t$$

and implies the following restriction between γ_C and γ_π

$$(1-\beta\rho)\gamma_\pi=\left(\frac{\kappa}{\Gamma_y}\right)\gamma_C+\kappa\left(\frac{g}{1-g}\right)\left(\frac{1}{\Gamma_y}-1\right).$$

With two linear restrictions, the solution for γ_C can easily be found as

$$\gamma_C=\frac{-\kappa\left(\frac{\phi_\pi-\rho}{1-\beta\rho}\right)(1-\Gamma_y)+(1-\rho)\Gamma_y f(\mu)\left(\frac{1-g}{1-\alpha}\right)}{(1-\rho)\left[1-\left(\frac{1-g}{1-\alpha}\right)f(\mu)\right]\Gamma_y+\kappa\left(\frac{\phi_\pi-\rho}{1-\beta\rho}\right)}\cdot\frac{g}{1-g}.$$

Finally, substituting γ_C into (B.7) and collecting terms yields the solution for γ_Y as

$$\gamma_Y = \frac{(1-\rho) + \kappa\left(\frac{\phi_\pi - \rho}{1-\beta\rho}\right)}{(1-\rho)\left[1 - \left(\frac{1-g}{1-\alpha}\right) f(\mu)\right] + \kappa\left(\frac{\phi_\pi-\rho}{1-\beta\rho}\right)\Gamma_y^{-1}} \cdot g.$$

Part (*ii*) of Proposition 2 establishes conditions on μ consistent with $dY_t/dG_t > 1$ and $dC_t/dG_t > 0$. To derive these conditions, set the multiplier expression γ_Y/g greater than one. With $g \in (0,1)$, $\alpha \in (0,1)$, $\rho \in (0,1)$, $\beta \in (0,1)$, $\phi_\pi > 1$ and $\kappa \in [0,\infty)$, this requires

$$(1-\rho) + \kappa\left(\frac{\phi_\pi - \rho}{1-\beta\rho}\right) > (1-\rho) - (1-\rho)\left(\frac{1-g}{1-\alpha}\right) f(\mu) + \kappa\left(\frac{\phi_\pi - \rho}{1-\beta\rho}\right)\Gamma_y^{-1}.$$

Simplifying this inequality through substitutions and canceling redundant terms gives

$$\alpha - f(\mu)\left(\frac{(1-\rho)(1-\beta\rho)}{\kappa(\phi_\pi - \rho)}\right) < \frac{(1-\mu)N}{(1-\mu)N + \mu}.$$

Part (*iii*) establishes conditions on μ consistent with sticky-price multipliers being larger than flexible-price multipliers. To derive these conditions, set the multiplier expression γ_Y/g greater than Γ_y, that is,

$$\frac{(1-\rho) + \kappa\left(\frac{\phi_\pi - \rho}{1-\beta\rho}\right)}{(1-\rho)\left[1 - \left(\frac{1-g}{1-\alpha}\right) f(\mu)\right] + \kappa\left(\frac{\phi_\pi-\rho}{1-\beta\rho}\right)\Gamma_y^{-1}} > \Gamma_y.$$

After cross-multiplying, substituting for $f(\mu)$, and canceling redundant terms, the inequality expression simplifies to

$$\alpha > \frac{(1-\mu)N}{1-(1-\mu)N}. \tag{B.13}$$

Moving μ to the left-hand-side yields

$$\mu > 1 - \frac{\alpha}{1+\alpha}\frac{1}{N},$$

which identifies the critical value of unemployment insurance μ^* defined in the proposition.[4] And since $dC_t/dG_t = dY_t/dG_t - 1$, the values of μ that deliver $dY_t/dG_t > \Gamma_y$ are the same values that deliver $dC_t/dG_t > \Gamma_c$.

[4]The value μ^* corresponds to the insurance level that equalizes the slopes of the labor demand curve and the "Frisch" no-shirking condition (e.g., Nakajima, 2006).

Table C.1
An Indivisible Labor Model with Employment Lotteries

Average marginal utility	$\hat{\lambda}_t = -\frac{\mu N}{1-(1-\mu)N}\hat{C}_t^e - \frac{1-N}{1-(1-\mu)N}\hat{C}_t^u - \frac{(1-\mu)N}{1-(1-\mu)N}\hat{N}_t$	(C.1)
Euler equation	$\hat{\lambda}_t = E_t\hat{\lambda}_{t+1} + \hat{r}_r$	(C.2)
Marginal product of labor	$\hat{w}_t = -\alpha\hat{N}_t$	(C.3)
Labor supply	$\frac{\sigma(1-\alpha)(1/N)}{(1-g)-(1-\sigma)(1-\alpha)}(\hat{\lambda}_t + \hat{w}_t) = \frac{1}{1-(1-\mu)N}(\hat{C}_t^u - \hat{C}_t^e)$	(C.4)
Risk-sharing condition	$(1/\mu)\hat{C}_t^e - \hat{C}_t^u = \frac{(1-\sigma)(1-\alpha)(1/N)}{(1-g)-(1-\sigma)(1-\alpha)}\hat{w}_t$	(C.5)
Production function	$\hat{Y}_t = (1-\alpha)\hat{N}_t$	(C.6)
Resource constraint	$\hat{Y}_t = (1-g)\hat{C}_t + g\hat{G}_t$	(C.7)
Aggregate consumption	$\frac{\mu}{(1-g)-(1-\sigma)(1-\alpha)}\Big((1-g)\hat{C}_t - (1-\sigma)(1-\alpha)\hat{N}_t\Big) = N\hat{C}_t^e + (1-N)\mu\hat{C}_t^u$	(C.8)
Government spending	$\hat{G}_t = \rho\hat{G}_{t-1} + \hat{\varepsilon}_t$	(C.9)

Notes: All variables are expressed as log deviations from the nonstochastic steady state and are denoted with the ˆ symbol.

C Alternative Models of Unemployment

In this section I report the set of log-linearized equilibrium conditions for the two alternative models of unemployment discussed in the text. The first is an indivisible labor model with employment lotteries, and the second is a labor search model. For each one, I adopt the same family structure and insurance arrangement used in the shirking model.

C.1 Employment Lotteries

Table C.1 contains the linearized equilibrium equations of the lottery model. All variables and parameters have the same interpretation as the shirking model. All preferences and technologies are also the same. The only real difference between the two is that labor supply is chosen optimally in the lottery model but is taken as given in the shirking model. This means that families now internalize their choice of N_t on the insurance premium F_t when determining labor supply. The first-order condition with respect to N_t, which equates the real wage to the average marginal rate of substitution, replaces the no-shirking condition as the relevant labor supply concept in the model. The affected equations include average marginal utility (C.1), the labor supply condition (C.4), the risk-sharing equation (C.5), and the aggregate consumption identity (C.8).

An important implication of the lottery model is that C_t^u/C_t^e is no longer constant outside the steady state. In equilibrium this ratio is given by $C_t^u/C_t^e = 1-(1-\sigma)hw_t/C_t^e$. To facilitate the comparisons illustrated in Figure 4 from the text, I define the degree of risk-sharing μ as the steady-state value of C_t^u/C_t^e. One can show that μ depends on the primitive insurance

Table C.2
A Search and Matching Model

Average marginal utility	$\hat{\lambda}_t = -\frac{\mu N}{1-(1-\mu)N}\hat{C}^e_t - \frac{1-N}{1-(1-\mu)N}\hat{C}^u_t - \frac{(1-\mu)N}{1-(1-\mu)N}\hat{N}_t$	(C.10)
Euler equation	$\hat{\lambda}_t = E_t\hat{\lambda}_{t+1} + \hat{r}_r$	(C.11)
Employment flows	$\hat{N}_t = \left(\frac{\lambda_p - N}{1-N}\right)\hat{N}_{t-1} + (1-\lambda_p)\hat{p}_t$	(C.12)
Production function	$\hat{Y}_t = (1-\alpha)\hat{N}_t$	(C.13)
Aggregate consumption	$(N + (1-N)\mu)\,\hat{C}_t = N\hat{C}^e_t + (1-N)\mu\hat{C}^u_t + (1-\mu)N\hat{N}_t$	(C.14)
Risk-sharing condition	$\hat{C}^e_t - \mu\hat{C}^u_t = (1-\sigma)\left(\frac{hw/Y}{C^e/Y}\right)\hat{w}_t$	(C.15)
Joint surplus	$(S_n/Y)(\hat{\lambda}_t + \hat{S}_{n,t}) = ((1-\alpha)/N)(\hat{\lambda}_t - \alpha\hat{N}_t) + \ldots$	
	$\frac{(C^e/Y)-(1-\sigma)(hw/Y)}{\sigma(1-(1-\mu)N)}\left(\hat{C}^e_t - \hat{C}^u_t\right) + \ldots$	
	$\beta(S_n/Y)E_t\left((\lambda_p - \eta_p p)(\hat{\lambda}_{t+1} + \hat{S}_{n,t+1}) - \eta_p p\hat{p}_{t+1}\right)$	(C.16)
Hiring condition	$\hat{S}_{n,t} = \gamma\hat{\varrho}_t$	(C.17)
Job-finding rate	$\hat{p}_t = (1-\gamma)\hat{\varrho}_t$	(C.18)
Wage bargaining	$\hat{w}_t = \eta_p\,(1 + (1-\eta_p)(S_n/hw))\,\hat{\overline{w}}_t + (1-\eta_p)\,(1-\eta_p(S_n/hw))\,\underline{\hat{w}}_t$	(C.19)
Firms' reservation wage	$(hw + (1-\eta_p)S_n)\hat{\overline{w}}_t = -\alpha(1-\alpha)(Y/N)\hat{N}_t + \ldots$	
	$\beta\lambda_p(1-\eta_p)S_n\left(E_t\hat{S}_{n,t+1} - \hat{r}_t\right)$	(C.20)
Workers' reservation wage	$(hw - \eta_p S_n)\underline{\hat{w}}_t = (hw + (1-\eta_p)S_n)\hat{\overline{w}}_t - S_n\hat{S}_{n,t}$	(C.21)
Labor market tightness	$\hat{v}_t = \hat{\varrho}_t - (N/(1-N))\hat{N}_{t-1}$	(C.22)
Resource constraint	$\hat{Y}_t = (C^e/Y)\,(N + (1-N)\mu)\,\hat{C}_t + g\,(1 - c_p(v/Y))\,\hat{G}_t + c_p(v/Y)\hat{v}_t$	(C.23)
Government spending	$\hat{G}_t = \rho\hat{G}_{t-1} + \hat{\varepsilon}_t$	(C.24)

Notes: All variables are expressed as log deviations from the nonstochastic steady state and are denoted with the ˆ symbol.

coefficient σ and other parameters according to

$$\mu(\sigma) \equiv C^u/C^e = \frac{(1-g)-(1-\sigma)(1-\alpha)}{(1-g)+(1-\sigma)(1-\alpha)((1-N)/N)} \leq 1.$$

C.2 Search and Matching

Table C.2 contains the linearized equilibrium conditions of the search model. The family structure, utility function, production technology, and insurance arrangement are identical to the ones in the shirking model. The rest of the structure follows Monacelli *et al.* (2010) except that the capital stock is assumed fixed in the aggregate. Most of the variables in the search model have the same interpretation as those in the shirking model. There are, however, some variables that don't appear in the latter. These include vacancies v_t, the job-finding probability p_t, the joint surplus of a marginal match $S_{n,t}$, the degree of market tightness ϱ_t, firms' reservation wage $\overline{w}_t$, and workers' reservation wage $\underline{w}_t$.

Table C.3 lists the calibrated values of the structural parameters along with key steady-

Table C.3
Search model calibration

β	Discount factor	$0.99^{1/3}$
α	Share of capital in production	1/3
g	Share of government spending in GDP	0.17
ρ	Persistence of government spending	$0.90^{1/3}$
N	Steady-state employment	0.942
h	Work hours	173
λ_p	Job survival rate	0.965
γ	Elasticity of matches to unemployment	0.50
ϱ	Labor market tightness	0.50
η_p	Workers' bargaining power	0.75
Ω_p	Relative value of nonwork activity	0.955
p	Job-finding rate	$(1-\lambda_p)N/(1-N)$
v	Vacancies	$\varrho(1-N)$
Y	Output	$((1-\beta)/\alpha\beta)^{\alpha/(\alpha-1)}Nh$
S_n	Joint surplus	$(1-\alpha)(Y/N)(1-\Omega_p)\left(1-\beta(\lambda_p-\eta_p p)\right)^{-1}$
hw	Real wage	$(1-\alpha)(Y/N)-(1-\beta\lambda_p)(1-\eta_p)S_n$
c_p	Vacancy costs	$(p/\varrho)(1-\eta_p)S_n$
C^e/Y	Employed consumption	$1-g(1-c_p(v/Y))-((1-N)/Y)\left(c_p\varrho-(1-\sigma)hw\right)$
$\mu(\sigma)$	Degree of unemployment insurance	$1-(1-\sigma)(hw/Y)/(C^e/Y)$

Notes: The calibration mostly follows Monacelli *et al.* (2010). There are two exceptions. The first is η_p, which governs workers' relative bargaining power, and is set close to the value in Shimer (2005). The other is Ω_p, which determines the relative (average) value of nonwork to work activity in the model, and is set to the value suggested by Hagedorn and Manovskii (2008).

state objects that appear in the linearized model. Because the job finding rate in the U.S. is fairy high, Monacelli *et al.* (2010) calibrate their model at a monthly frequency. As such, the discount factor β, the persistence of government spending ρ, and hours of work h are set to values that would be consistent with the same concepts in a quarterly model. The rest of the parameters are unaffected by this modeling choice. Of course the frequency does affect how one interprets the multipliers. In the search model, the *impact* multiplier measures the change in output or consumption from a spending increase over the course of one month. This quantity must be scaled up to a three-month period in order to make valid comparisons to the shirking and lottery models. So to generate quarterly figures in the search model, I compute *present-value* multipliers over a three-month horizon using the formula presented in section 4 of the main text. These are the quantities that appear in Figure 4.

Finally, it should be pointed out that the consumption ratio C_t^u/C_t^e is again no longer constant outside the steady state. In equilibrium it is given by $C_t^u/C_t^e = 1-(1-\sigma)hw_t/C_t^e$.

Table D.1
The Shirking Model with Capital Accumulation

Average marginal utility	$\hat{\lambda}_t = -\hat{C}^e_t - \frac{(1-\mu)N}{1-(1-\mu)N}\hat{N}_t$	(D.1)
Euler equation	$\hat{\lambda}_t = E_t\hat{\lambda}_{t+1} + \hat{R}_t - E_t\hat{\pi}_{t+1}$	(D.2)
Investment demand	$\hat{I}_t - \hat{K}_t = -\frac{1}{\phi''(\delta)\delta}\hat{q}_t$	(D.3)
Capital accumulation	$\hat{K}_{t+1} = (1-\delta)\hat{K}_t + \delta\hat{I}_t$	(D.4)
Arbitrage equation	$\hat{\lambda}_t + \hat{q}_t = E_t\hat{\lambda}_{t+1} + \beta E_t\hat{q}_{t+1} + (1-\beta(1-\delta))\, E_t\hat{r}^k_{t+1}$	(D.5)
Marginal product of capital	$\hat{r}^k_t = \hat{mc}_t + (\alpha-1)\left(\hat{K}_t - \hat{N}_t\right)$	(D.6)
Marginal product of labor	$\hat{w}_t = \hat{mc}_t + \alpha\left(\hat{K}_t - \hat{N}_t\right)$	(D.7)
No-shirking condition	$\hat{C}^e_t = \hat{w}_t$	(D.8)
Risk-sharing condition	$\hat{C}^u_t = \hat{C}^e_t$	(D.9)
Production function	$\hat{Y}_t = \alpha\hat{K}_t + (1-\alpha)\hat{N}_t$	(D.10)
Resource constraint	$\hat{Y}_t = \left(1 - g - \frac{\alpha\delta\beta}{1-\beta(1-\delta)}\left(\frac{\eta-1}{\eta}\right)\right)\hat{C}_t + \frac{\alpha\delta\beta}{1-\beta(1-\delta)}\left(\frac{\eta-1}{\eta}\right)\hat{I}_t + g\hat{G}_t$	(D.11)
Aggregate consumption	$\hat{C}_t = \hat{C}^e_t + \frac{(1-\mu)N}{(1-\mu)N+\mu}\hat{N}_t$	(D.12)
Phillips curve	$\hat{\pi}_t = \beta E_t\hat{\pi}_{t+1} + \frac{(1-\chi)(1-\chi\beta)}{\chi}\hat{mc}_t$	(D.13)
Monetary policy	$\hat{R}_t = \phi_\pi\hat{\pi}_t$	(D.14)
Government spending	$\hat{G}_t = \rho\hat{G}_{t-1} + \hat{\varepsilon}_t$	(D.15)

Notes: All variables are expressed as log deviations from the nonstochastic steady state and are denoted with the ˆ symbol.

So for the purposes of constructing Figure 4 in the text, I define the degree of risk-sharing μ as the steady-state value of C^u_t/C^e_t. One can show that μ depends on the underlying insurance coefficient σ and is displayed in Table C.3. For any given choice of C^u/C^e, the function $\mu(\sigma)$ can be inverted to find the implied value of σ.

D The Model with Capital Accumulation

In this section I report the log-linearized general equilibrium conditions for the shirking model with capital accumulation. The full system is mapped into companion form, and standard methods are used to check the (local) determinacy conditions (e.g., Klein, 2000).

D.1 Companion Form

Define $\mathbf{x}_t = [\hat{G}_t\ \hat{K}_t]'$ the (2×1) vector of date-t predetermined variables and $\boldsymbol{\varepsilon}_t = [\hat{\varepsilon}_t\ 0]'$ the corresponding vector of i.i.d. exogenous shocks. In a similar way, group all 14 of the date-t expectational variables in the vector $\mathbf{X}_t = [\hat{\lambda}_t\ \hat{C}^e_t\ \hat{C}^u_t\ \hat{N}_t\ \hat{I}_t\ \hat{K}_{t+1}\ \hat{q}_t\ \hat{r}^k_t\ \hat{w}_t\ \hat{mc}_t\ \hat{Y}_t\ \hat{C}_t\ \hat{\pi}_t\ \hat{R}_t]'$.

Stacking (D.1)-(D.15) in companion form produces the vector difference equation

$$A\begin{bmatrix}\mathbf{x}_{t+1}\\ E_t\mathbf{X}_{t+1}\end{bmatrix}=B\begin{bmatrix}\mathbf{x}_t\\ \mathbf{X}_t\end{bmatrix}+\begin{bmatrix}\boldsymbol{\varepsilon}_{t+1}\\ \mathbf{0}_{14\times 1}\end{bmatrix}, \tag{D.16}$$

where A and B are (16×16) matrices containing the structural parameters of the model.

Taking conditional expectations of (D.16) gives

$$AE_t\begin{bmatrix}\mathbf{x}_{t+1}\\ \mathbf{X}_{t+1}\end{bmatrix}=B\begin{bmatrix}\mathbf{x}_t\\ \mathbf{X}_t\end{bmatrix}.$$

As is common in business cycle applications, A is not a full rank matrix. Assessing the determinacy properties of this system therefore requires computation of the generalized eigenvalues of the matrix pair (A,B). In this example, there will be a locally unique (bounded) rational expectations equilibrium if the number of generalized eigenvalues of modulus greater than one is exactly equal to the number of expectational variables. Here that number is 14. Should the number of explosive roots be less than 14, the model would exhibit a multiplicity of stable equilibria. But shoud that number be greater than 14, the model would have no stable equilibria. In either case the equilibrium of the model would be indeterminate.

In Figure 5 of the text, the eigenvalue condition is evaluated for a grid of points (μ,χ) in the space $[\mu(0),1]\times[0,1]$. At each point, while holding all other parameters fixed at baseline values, the number of explosive roots is recorded. If that number equals 14, the equilibrium is (locally) unique. If it is not equal to 14, the equilibrium is indeterminate.

E The Extended Model

In this section I report the log-linearized equilibrium conditions for the extended model with capital utilization and public goods. I also report results from a few miscellaneous policy exercises concerning the unemployment rate, consumption inequality, the robustness of the fiscal multipliers, and the effects of the ARRA legislation under a nominal interest rate peg.

E.1 Unemployment and Consumption Inequality

The left panel of Figure E.1 shows the response of the unemployment rate to a one-percent increase in government purchases in the extended model with partial insurance. The size of the shock is same as the orthogonalized innovation considered in the VAR models. Recall that the U.S. unemployment rate falls anywhere from 0.1 to 0.3 percentage points in the

Table E.1
The Extended Shirking Model with Capital Utilization and Public Goods

Average marginal utility	$\left(\frac{N}{(C^e/Y)+bg}+\frac{1-N}{(C^u/Y)+bg}\right)\hat{\lambda}_t=\left(\frac{N}{(C^e/Y)+bg}-\frac{N}{(C^u/Y)+bg}\right)\hat{N}_t-\ldots$	
	$\left(\frac{N}{((C^e/Y)+bg)^2}+\frac{1-N}{((C^u/Y)+bg)^2}\right)bg\hat{G}_t-\ldots$	
	$N\frac{C^e/Y}{((C^e/Y)+bg)^2}\hat{C}^e_t-(1-N)\frac{C^u/Y}{((C^u/Y)+bg)^2}\hat{C}^u_t$	(E.1)
Euler equation	$\hat{\lambda}_t=E_t\hat{\lambda}_{t+1}+\hat{R}_t-E_t\hat{\pi}_{t+1}$	(E.2)
Capital utilization	$\hat{z}_t=\psi\hat{r}^k_t$	(E.3)
Investment demand	$\hat{I}_t-\hat{K}_t=-\frac{1}{\phi''(\delta)\delta}\hat{q}_t$	(E.4)
Capital accumulation	$\hat{K}_{t+1}=(1-\delta)\hat{K}_t+\delta\hat{I}_t$	(E.5)
Arbitrage equation	$\hat{\lambda}_t+\hat{q}_t=E_t\hat{\lambda}_{t+1}+\beta E_t\hat{q}_{t+1}+(1-\beta(1-\delta))\,E_t\hat{r}^k_{t+1}$	(E.6)
Marginal product of capital	$\hat{r}^k_t=\hat{mc}_t+(\alpha-1)\left(\hat{z}_t+\hat{K}_t-\hat{N}_t\right)$	(E.7)
Marginal product of labor	$\hat{w}_t=\hat{mc}_t+\alpha\left(\hat{z}_t+\hat{K}_t-\hat{N}_t\right)$	(E.8)
No-shirking condition	$((C^e/Y)+bg)\,\hat{w}_t=(C^e/Y)\hat{C}^e_t+bg\hat{G}_t$	(E.9)
Risk-sharing condition	$(C^u/Y)\hat{C}^u_t=\mu(C^e/Y)\hat{C}^e_t-(1-\mu)bg\hat{G}_t$	(E.10)
Production function	$\hat{Y}_t=\alpha(\hat{z}_t+\hat{K}_t)+(1-\alpha)\hat{N}_t$	(E.11)
Resource constraint	$\hat{Y}_t=\left(1-g-\frac{\alpha\delta\beta}{1-\beta(1-\delta)}\left(\frac{\eta-1}{\eta}\right)\right)\hat{C}_t+\frac{\alpha\delta\beta}{1-\beta(1-\delta)}\left(\frac{\eta-1}{\eta}\right)\hat{I}_t+\ldots$	
	$g\hat{G}_t+\frac{\alpha(\eta-1)}{\eta}\hat{z}_t$	(E.12)
Aggregate consumption	$\left(1-g-\frac{\alpha\delta\beta}{1-\beta(1-\delta)}\left(\frac{\eta-1}{\eta}\right)\right)\hat{C}_t=N\left((C^e/Y)-(C^u/Y)\right)\hat{N}_t+\ldots$	
	$N(C^e/Y)\hat{C}^e_t+(1-N)(C^u/Y)\hat{C}^u_t$	(E.13)
Phillips curve	$\hat{\pi}_t=\beta E_t\hat{\pi}_{t+1}+\frac{(1-\chi)(1-\chi\beta)}{\chi}\hat{mc}_t$	(E.14)
Monetary policy	$\hat{R}_t=\phi_\pi\hat{\pi}_t$	(E.15)
Government spending	$\hat{G}_t=\rho\hat{G}_{t-1}+\hat{\varepsilon}_t$	(E.16)

Notes: All variables are expressed as log deviations from the nonstochastic steady state and are denoted with the ˆ symbol. The consumption ratios are given by $C^e/Y=((C/Y)+(1-N)(1-\mu)bg)\,[N+(1-N)\mu]^{-1}$ and $C^u/Y=\mu(C^e/Y)-(1-\mu)bg$, where $C/Y=\left(1-g-\frac{\alpha\delta\beta}{1-\beta(1-\delta)}\left(\frac{\eta-1}{\eta}\right)\right)$.

first few years after a one-percent increase in government consumption (see Fig. 1 in the text). The extended model produces a similar-sized drop of about 0.25 percentage points. A key difference of course is that the effects are concentrated in the impact period with a gradual return to the mean of 5.8 percent. By contrast, VARs point to a smoother, more hump-shaped response over the cycle. To be sure, the shirking model does produce a hump-shaped decline in unemployment when government spending follows the profile specified by the ARRA (see Fig. 8 in the text). But this reflects the gradual adjustment of government spending during this episode and the fact that the stimulus is 5 percent instead of 1 percent.

In the extended model with public goods, the risk-sharing constant $\mu(\sigma)$ takes the form $\mu=(C^u_t+bG_t)/(C^e_t+b_t)$. The ratio C^u_t/C^e_t, which identifies the consumption drop at unemployment, is therefore no longer constant outside the steady state. Instead it varies according to $C^u_t/C^e_t=\mu-(1-\mu)b(G_t/C^e_t)$. In the paper I calibrated μ to deliver a steady-

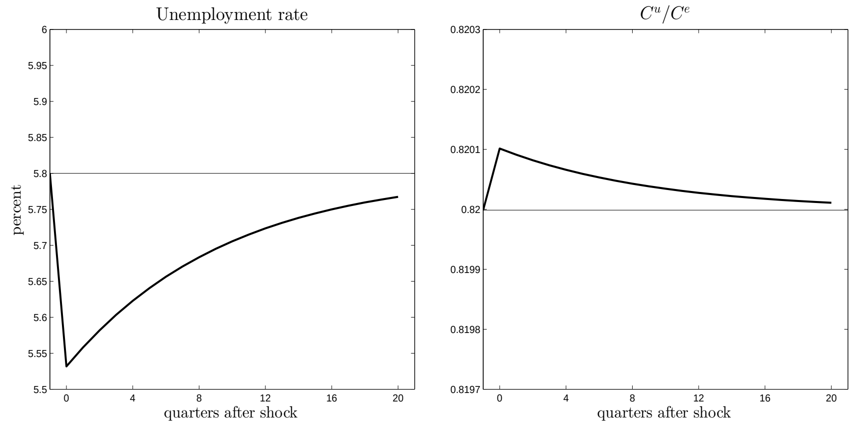

Fig. E.1. Impulse response functions

Notes: Impulse response functions for the unemployment rate, $100(1-N_t)$, and the consumption ratio, C_t^u/C_t^e, to a one-percent increase in government spending are shown for the extended shirking model with partial unemployment insurance, capital utilization, and public goods. Simulations are based on the following calibration: $\beta = 0.99$, $g = 0.17$, $N = 0.942$, $\alpha = 1/3$, $\chi = 2/3$, $\eta = 6$, $\phi_\pi = 1.50$, $\delta = 0.025$, $\phi''(\delta) = -40$, $\psi = 0.5$, $b = -0.2$, $C^u/C^e = 0.82$.

state value of C^u/C^e equal to 0.82, the midpoint of the estimates suggested by the micro literature on the cost of unemployment. Although this value (i.e., $\mu = 0.8099$) is kept constant across all experiments, C_t^u/C_t^e can fluctuate around 0.82 following a spending shock.

The right panel of Figure E.1 graphs the response of C_t^u/C_t^e to a one-percent increase in government spending. Results show that consumption inequality is mildly countercyclical contingent on a spending increase. To be clear, consumption of both unemployed and employed members fall due to the negative wealth effect. But the percentage drop for unemployed members is somewhat smaller, implying an increase in the consumption ratio (see also Fig. 8 in the text). These results are qualitatively consistent with estimates in Anderson, Inoue, and Rossi (2016) and Ma (2019). Both studies estimate the heterogeneous response of consumption to government spending across the income distribution. They find that the consumption of low-income relative to high-income earners increases after a positive innovation to government purchases. While their results focus on inequality across the income distribution, mine focus on inequality with respect to job status.

E.2 Parameter Variations

Table E.2 reports *impact* multipliers in the extended model for GDP, consumption, and investment. The first column corresponds to the baseline calibration and essentially restates results that can be gleaned from Figure 7 in the text. The next two columns rerun the

Table E.2
Impact Multipliers in the Extended Shirking Model

	Baseline	$N = 0.915$	$N = 0.965$	$\mu = 0.9303$
GDP	1.1672	1.1620	1.1715	1.0483
Consumption	0.1336	0.1303	0.1364	0.0483
Investment	0.0336	0.0317	0.0352	0.0000

Notes: Impact multipliers for GDP, consumption, and investment are reported for the extended shirking model with capital utilization and public goods. The first column reports values under the baseline calibration. The next three columns report multipliers for different values of N and μ. Computations are based on the calibration: $\beta = 0.99$, $g = 0.17$, $\rho = 0.90$, $N = \{0.942, 0.915, 0.965\}$, $\alpha = 1/3$, $\chi = 2/3$, $\eta = 6$, $\phi_\pi = 1.50$, $\delta = 0.025$, $\phi''(\delta) = -40$, $\psi = 0.5$, $b = -0.2$, $\mu = \{0.8099, 0.9303\}$.

experiment for two different values of steady-state employment N. The last column considers an alternative value of the risk-sharing coefficient μ. For each variation, all other structural parameters are held fixed at their baseline values.

One potential criticism of the model is that extensive margin for consumption is limited by the fact that steady-state employment is 0.942. Put differently, the maximal change in the unemployment rate is only 5.8 percentage points. I examine this issue by recomputing the multipliers for average employment rates below (0.915) and above (0.965) the baseline. It turns out that impact multipliers for all three variables are not very sensitive to changes in employment. And in fact, the multipliers get somewhat smaller as N declines. By contrast, a recent empirical literature has argued that multipliers are larger when there is slack in the economy, or when unemployment is high (e.g., Auerbach and Gorodnichenko, 2012). Explaining any state-dependent effects of government consumption may therefore be difficult to accomplish in the shirking model unless other mechanisms capable of producing an asymmetric response are added to the mix. Possible candidates include incomplete markets, borrowing constraints, and downward nominal wage rigidity.

Although there is no consensus, several studies document a decrease in private investment after a positive government spending shock (e.g., Blanchard and Perotti, 2002). In the extended model with partial insurance, investment multipliers are slightly positive (see also Fig. 7), which could be viewed as inconsistent with the data. The final column of Table E.2 identifies the critical value of μ such that the investment multiplier is exactly equal to zero. At this point ($\mu = 0.9303$), consumption is about 0.05 and the GDP 1.05. This shows that multipliers above zero and one do not require a level of insurance that also renders the investment multiplier positive. Indeed there is a range of values for μ such that consumption and GDP are above zero and one while investment is negative ($0.9303 < \mu < 0.9892$).

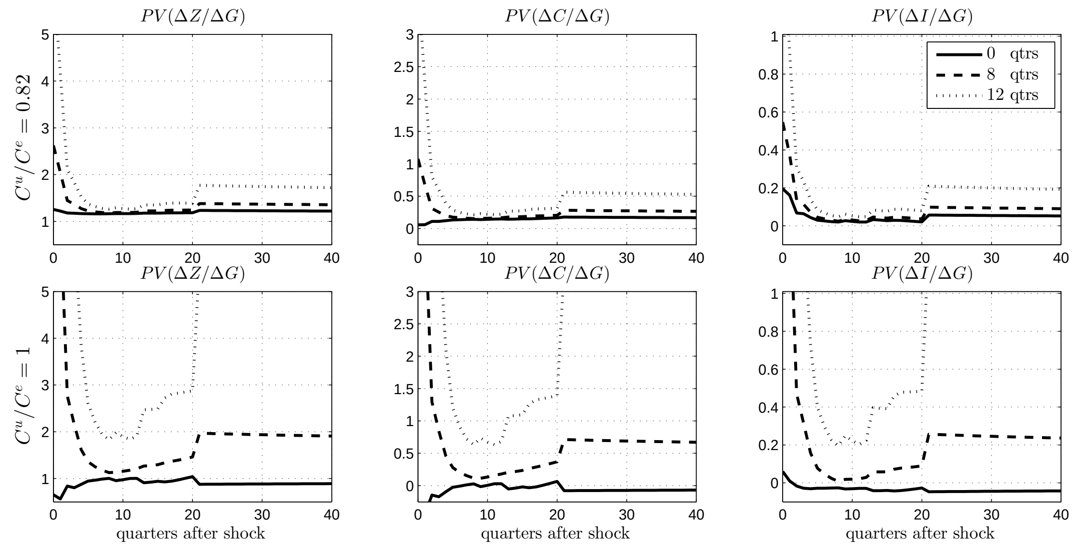

Fig. E.2. Interest rate peg: present-value multipliers

Notes: Present-value multipliers for GDP, consumption, and investment implied by the path of the economy under both the ARRA and a nominal interest rate peg of zero (solid lines), eight (dashed lines), or twelve-quarter (dotted lines) durations are shown for versions of the extended shirking model with capital utilization and public goods. One version corresponds to partial insurance (top row) and the other to full insurance (bottom row). Simulations are based on the following calibration: $\beta = 0.99$, $g = 0.17$, $N = 0.942$, $\alpha = 1/3$, $\chi = 2/3$, $\eta = 6$, $\phi_\pi = 1.50$, $\delta = 0.025$, $\phi''(\delta) = -40$, $\psi = 0.5$, $b = -0.2$, $C^u/C^e = \{0.82, 1\}$.

E.3 The ARRA with an Interest Rate Peg

Section 4 of the manuscript considers the effects of the ARRA and a nominal interest rate peg separately. Yet during the entirety of the ARRA episode from 2009 to 2015, the federal funds rate was held fixed at near zero. A natural question then is whether or to what extent the impact of this legislation was influenced by accommodative monetary policy. To answer this question, I rerun the peg simulations but with government consumption following the profile under the ARRA. In other words, what do the multipliers look like when the ARRA and the interest rate peg are run simultaneously?

Figure E.2 graphs present-value multipliers implied by interest rate pegs of zero (solid lines), eight (dashed lines), and twelve (dotted lines) quarters. The first row is for the extended model with partial insurance ($\mu = 0.8099$), and the second row is for full insurance ($\mu = 1$). The results are qualitatively similar to the example used in the text. The size of the multipliers, however, are bigger given the unusually large and persistent increase in government spending under the ARRA. In the partial insurance case, multipliers are once again largest in the impact period and increasing in the duration of the peg. For a two-year peg, the impact multiplier for GDP is 2.6. For a three-year peg, it is 6.25. Both quantities fall rapidly to more plausible levels after just one or two quarters.

Under full insurance, the multipliers are substantially larger for reasons discussed in the text. Switching from partial to full insurance reduces the amount of endogenous price rigidity in the model. So when given the chance, firms increase their reset prices by more under full insurance. This raises the inflation response to higher government spending and, in turn, pushes down the real rate (because the nominal rate is pegged) to an even larger extent. The result is a huge increase in private spending that yields implausibly large multipliers.

F A Model with Rule-of-Thumb Families

In this section I augment the extended model to include a fraction of so-called "rule-of-thumb" agents. This feature has been shown to reduce the negative wealth effects of fiscal policy and thus increase the size of government spending multipliers. Table F.1 contains the full set of log-linearized equilibrium equations, and Table F.2 defines the steady-state consumption ratios that appear as coefficients.

F.1 Rule-of-Thumb Families

In the baseline model all families participate in asset markets where they buy and sell bonds and accumulate capital. I consider an alternative setup here that assumes a fraction $\omega \in [0, 1]$ never participate in these markets. They own no assets (or liabilities) and so consume only their after-tax labor income. In the spirit of Campbell and Mankiw (1989) and Galí *et al.* (2007), I refer to this population as "rule-of-thumb" families. The other $1-\omega$ have full access to capital markets and behave according to the same intertemporal optimization problem described in the text.

Preferences of a rule-of-thumb (ROT) family are the same as those of an optimizing one. And like the latter, the effort of its members is imperfectly observable. To simplify the analysis, I assume firms cannot tell which family type workers come from. The best they can do then, in terms of preventing shirking at the lowest cost, is to design a blanket contract, but one that makes the incentive compatibility constraint hold with equality only for those who happen to be members of an optimizing family. The constraint for ROT workers, to be sure, will also hold (as a slackness condition) but will never bind in equilibrium.[5] If instead firms lowered wages to make ROT workers indifferent between effort and shirking, workers

[5] I verify ex post that the equilibrium wage-effort pair satisfies the incentive compatibility constraint of ROT workers both in the steady state and along the transition path.

Table F.1
The Extended Model with Rule-of-Thumb Families

Average marginal utility	$\left(\frac{N}{(C_o^e/Y)+bg}+\frac{1-N}{(C_o^u/Y)+bg}\right)\hat{\lambda}_{o,t}=\left(\frac{N}{(C_o^e/Y)+bg}-\frac{N}{(C_o^u/Y)+bg}\right)\hat{N}_t-\ldots$ $\left(\frac{N}{((C_o^e/Y)+bg)^2}+\frac{1-N}{((C_o^u/Y)+bg)^2}\right)bg\hat{G}_t-\ldots$ $N\frac{C_o^e/Y}{((C_o^e/Y)+bg)^2}\hat{C}_{o,t}^e-(1-N)\frac{C_o^u/Y}{((C_o^u/Y)+bg)^2}\hat{C}_{o,t}^u$	(F.1)
Euler equation	$\hat{\lambda}_{o,t}=E_t\hat{\lambda}_{o,t+1}+\hat{R}_t-E_t\hat{\pi}_{t+1}$	(F.2)
Capital utilization	$\hat{z}_t=\psi\hat{r}_t^k$	(F.3)
Investment demand	$\hat{I}_t-\hat{K}_{o,t}=-\frac{1}{\phi''(\delta)\delta}\hat{q}_{o,t}$	(F.4)
Capital accumulation	$\hat{K}_{o,t+1}=(1-\delta)\hat{K}_{o,t}+\delta\hat{I}_t$	(F.5)
Arbitrage equation	$\hat{\lambda}_{o,t}+\hat{q}_{o,t}=E_t\hat{\lambda}_{o,t+1}+\beta E_t\hat{q}_{o,t+1}+(1-\beta(1-\delta))\,E_t\hat{r}_{t+1}^k$	(F.6)
Marginal product of capital	$\hat{r}_t^k=\hat{mc}_t+(\alpha-1)\left(\hat{K}_t-\hat{N}_t\right)$	(F.7)
Marginal product of labor	$\hat{w}_t=\hat{mc}_t+\alpha\left(\hat{K}_t-\hat{N}_t\right)$	(F.8)
No-shirking condition	$((C_o^e/Y)+bg)\,\hat{w}_t=(C_o^e/Y)\hat{C}_{o,t}^e+bg\hat{G}_t$	(F.9)
Risk-sharing condition	$(C_o^u/Y)\hat{C}_{o,t}^u=\mu(C_o^e/Y)\hat{C}_{o,t}^e-(1-\mu)bg\hat{G}_t$	(F.10)
Employed ROT consumers	$(C_r^e/Y)\hat{C}_{r,t}^e=-g\hat{T}_t+(1-\mu)(1-N)\left((C_o^e/Y)\hat{C}_{o,t}^e+bg\hat{G}_t\right)+\ldots$ $(1-\alpha)((\eta-1)/\eta)\left(\hat{w}_t+\hat{N}_t\right)-(1-\mu)N\,((C_o^e/Y)+bg)\,\hat{N}_t$	(F.11)
Unemployed ROT consumers	$(C_r^u/Y)\hat{C}_{r,t}^u=(C_r^e/Y)\hat{C}_{r,t}^e-(1-\mu)\left((C_o^e/Y)\hat{C}_{o,t}^e+bg\hat{G}_t\right)$	(F.12)
Optimizing consumption	$(C_o/Y)\hat{C}_{o,t}=N(C_o^e/Y)\hat{C}_{o,t}^e+(1-N)(C_o^u/Y)\hat{C}_{o,t}^u+\ldots$ $N\,((C_o^e/Y)-(C_o^u/Y))\,\hat{N}_t$	(F.13)
ROT consumption	$(C_r/Y)\hat{C}_{r,t}=N(C_r^e/Y)\hat{C}_{r,t}^e+(1-N)(C_r^u/Y)\hat{C}_{r,t}^u+\ldots$ $N\,((C_r^e/Y)-(C_r^u/Y))\,\hat{N}_t$	(F.14)
Aggregate consumption	$(C/Y)\hat{C}_t=(1-\omega)(C_o/Y)\hat{C}_{o,t}+\omega(C_r/Y)\hat{C}_{r,t}$	(F.15)
Production function	$\hat{Y}_t=\alpha\hat{K}_t+(1-\alpha)\hat{N}_t$	(F.16)
Resource constraint	$\hat{Y}_t=(C/Y)\hat{C}_t+(1-(C/Y)-g)\,\hat{I}_t+g\hat{G}_t+\alpha((\eta-1)/\eta)\hat{z}_t$	(F.17)
Capital services	$\hat{K}_t=\hat{z}_t+\hat{K}_{o,t}$	(F.18)
Gov't budget constraint	$\hat{b}_t=(1/\beta)\hat{b}_{t-1}+g(\hat{G}_t-\hat{T}_t)$	(F.19)
Phillips curve	$\hat{\pi}_t=\beta E_t\hat{\pi}_{t+1}+\frac{(1-\chi)(1-\chi\beta)}{\chi}\hat{mc}_t$	(F.20)
Monetary policy	$\hat{R}_t=\phi_\pi\hat{\pi}_t$	(F.21)
Fiscal policy	$g\hat{T}_t=\phi_b\hat{b}_{t-1}+\phi_g g\hat{G}_t$	(F.22)
Gov't spending	$\hat{G}_t=\rho\hat{G}_{t-1}+\hat{\varepsilon}_t$	(F.23)

Notes: All variables are expressed as log deviations from the nonstochastic (zero debt/zero inflation) steady state and are denoted with the ˆ symbol. The only exception is real government debt, which is defined as $\hat{b}_t \equiv b_t/Y$.

from optimizing families would always prefer to shirk. Setting the wage just high enough to satisfy incentive compatibility for optimizing workers therefore ensures that all employees supply effort in the least costliest way possible for firms. This arrangement, together with the assumption that firms allocate labor demand uniformly, implies that wages and employment probabilities will be the same for everyone.

Let $C_{r,t}^e$ and $C_{r,t}^u$ denote the consumption of employed and unemployed ROT workers.

Table F.2
Steady-State Ratios with Rule-of-Thumb Families

C/Y	$1 - g - \frac{\alpha\delta\beta}{1-\beta(1-\delta)}\left(\frac{\eta-1}{\eta}\right)$
C_o^e/Y	$\frac{C/Y+(1-\omega)(1-N)(1-\mu)bg-\omega(1-\alpha)((\eta-1)/\eta)+\omega g}{(1-\omega)((1-\mu)N+\mu)}$
C_o^u/Y	$\mu(C_o^e/Y) - (1-\mu)bg$
C_o/Y	$((1-\mu)N+\mu)(C_o^e/Y) - (1-N)(1-\mu)bg$
C_r^e/Y	$(1-\alpha)\left(\frac{\eta-1}{\eta}\right) - g + (1-N)(1-\mu)\left((C_o^e/Y)+bg\right)$
C_r^u/Y	$(1-\alpha)\left(\frac{\eta-1}{\eta}\right) - g - N(1-\mu)\left((C_o^e/Y)+bg\right)$
C_r/Y	$(1-\alpha)\left(\frac{\eta-1}{\eta}\right) - g$

With no equity stake in firms, equations (2) and (4) require that these quantities satisfy

$$\begin{aligned} C_{r,t}^e &= -T_t + \left[1-\sigma(1-N_t)\right] hw_t, \\ C_{r,t}^u &= -T_t + \sigma N_t hw_t. \end{aligned}$$

From this point it is easy to rewrite $C_{r,t}^e$ and $C_{r,t}^u$ as functions of μ. Just apply the definition from (20) along with the no-shirking condition to obtain

$$\begin{aligned} C_{r,t}^e &= -T_t + N_t hw_t + (1-N_t)(1-\mu)(C_{o,t}^e + bG_t), \\ C_{r,t}^u &= C_{r,t}^e - (1-\mu)(C_{o,t}^e + bG_t). \end{aligned}$$

Summing the activity of all workers produces the aggregate consumption identity

$$C_t = N_t\left[(1-\omega)C_{o,t}^e + \omega C_{r,t}^e\right] + (1-N_t)\left[(1-\omega)C_{o,t}^u + \omega C_{r,t}^u\right],$$

where $C_{o,t}^e$ and $C_{o,t}^u$ are the consumption of workers who belong to an optimizing family.

In models with ROT agents, Ricardian equivalence no longer holds like it does in the previous models. As a result, the method of government finance can now have significant effects on fiscal multipliers. I follow Galí *et al.* (2007) in assuming that the government pursues a mix of lump-sum taxes and borrowing by implementing

$$T_t = T + \phi_g(G_t - G) + \phi_b\left(\frac{B_{t-1}}{P_{t-1}} - \frac{B}{P}\right).$$

For suitable values of ϕ_g and ϕ_b, this rule permits substantial deficit financing (increased borrowing) in the short run while preserving stable debt dynamics in the long run. A lower tax burden, even if only temporary, boosts the consumption response of ROT workers since this group is more sensitive to disposable income. Such "non-Ricardian" behavior helps cushion aggregate demand from the wealth consequences of higher government spending. The effect gets bigger the greater the fraction ω of ROT families.

Before running any policy simulations, one must select values for (ω, ϕ_g, ϕ_b). Informed by estimates in Coenen and Straub (2005), Bilbiie, Meier, and Müller (2008), and Forni, Monteforte, and Sessa (2009), I initially fix the share of ROT families ω at 0.25. Estimates on the fraction of (wealthy and poor) hand-to-mouth U.S. households from Kaplan, Violante, and Weidner (2014), however, suggest that ω could be as high as 0.35 or as low as 0.15. So I also report multipliers using these alternative values. Turning to the fiscal rule, I follow Galí *et al.* (2007) by setting $\phi_b = 0.33$ and $\phi_g = 0.1$. As shown by the authors, these values are consistent with VAR-based estimates of deficit and spending dynamics. But since the financing regime now matters for fiscal policy, I also consider two other values of ϕ_b that allow for either more or less short-run deficit financing of government spending.

F.2 Present-Value Multipliers

Figure F.1 graphs present-value multipliers for GDP, consumption, and investment out to a ten-year horizon. The first row corresponds to the partial insurance model, which includes capital utilization, public goods, and now ROT families as well. The second row considers the same model but with full insurance instead. Solid lines indicate the benchmark case in which $\omega = 0.25$. Dashed lines correspond to $\omega = 0.15$ and dotted lines to $\omega = 0.35$.

Take the partial insurance model first. Impact multipliers for GDP and consumption are a bit larger with ROT families. For $\omega = 0.25$, these two quantities jump to 1.29 and 0.26, up from 1.16 and 0.13 when $\omega = 0$ (see Fig. 7 in the text). Moreover, the impact effects increase with the share of ROT families. Since government spending is now financed in part by a rise in public debt, taxes are smaller on impact. The resultant increase in disposable income boosts the consumption spending of ROT families. The bigger this group, the bigger is the effect on total consumption in the economy. Nevertheless, the tax bill eventually comes due as the government reverses debt over time. And when this happens, spending by ROT consumers in particular declines rapidly. Should ω be sufficiently large, the cumulative effects on aggregate consumption and GDP will fall below zero and one in just a few quarters. This sharp drop in the persistence of the multipliers is why my preferred version of the extended model in the manuscript excludes ROT families altogether.[6]

[6] In a model with ROT agents but Calvo-type sticky wages, Leeper, Traum, and Walker (2017) find that

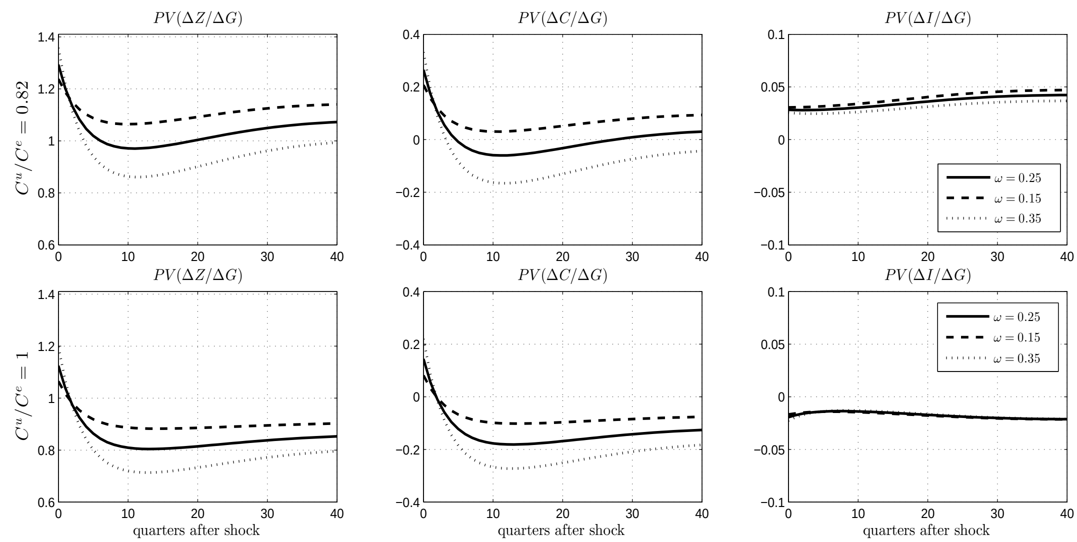

Fig. F.1. Present-value multipliers

Notes: Present-value multipliers for GDP, consumption, and investment are shown for the extended model with rule-of-thumb families under partial (row one) and full insurance (row two). Three different values for the fraction of rule-of-thumb families ω are considered: 0.25 (solid lines), 0.15 (dashed lines), and 0.35 (dotted lines). Computations are based on the following calibration: $\beta = 0.99$, $g = 0.17$, $\rho = 0.90$, $N = 0.942$, $\alpha = 1/3$, $\chi = 2/3$, $\eta = 6$, $\phi_\pi = 1.50$, $\delta = 0.025$, $\phi''(\delta) = -40$, $\psi = 0.5$, $b = -0.2$, $\omega = \{0.15, 0.25, 0.35\}$, $\phi_b = 0.33$, $\phi_g = 0.10$, $\mu = \{0.8099, 1\}$.

The second row demonstrates once again how important partial insurance is for the transmission of government spending. Under full insurance, present-value multipliers become significantly lower (compared to row one) regardless of the share of ROT families. Only in the impact period are GDP and consumption somewhat greater than one and zero.

In Figure F.2 I reset the ROT share $\omega = 0.25$ and compute multipliers under partial (top row) and full insurance (bottom row) for different values of ϕ_b. Solid lines correspond to the benchmark case of $\phi_b = 0.33$. Dashed lines ($\phi_b = 0.05$) illustrate what happens when fiscal policy permits much greater debt accumulation in the short run. Dotted lines ($\phi_b = 0.75$) show the opposite, or what happens when taxes adjust quickly to stabilize debt.

Allowing for greater deficit financing ($\phi_b = 0.05$) increases the multipliers for GDP and consumption in the near term. As taxes get pushed into the future, current disposable income of ROT consumers goes up, driving aggregate spending higher. At the same time, rising deficits increase future taxes for optimizers and ROT agents alike. The inevitable drop in disposable income–for the latter group in particular–forces consumption and GDP

most of the increases in output and consumption go away after two years.

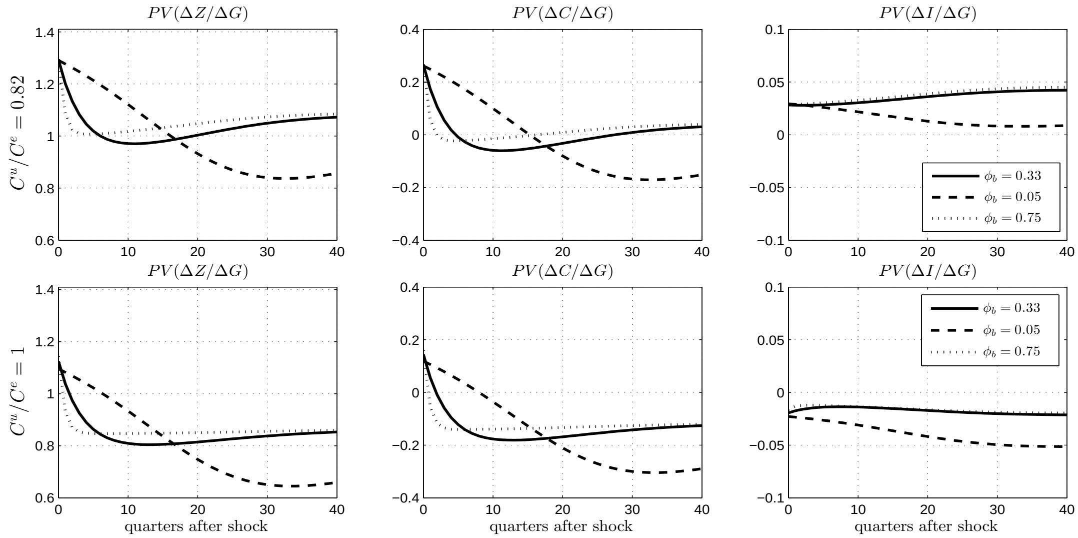

Fig. F.2. Present-value multipliers

Notes: Present-value multipliers for GDP, consumption, and investment are shown for the extended model with rule-of-thumb families under partial (row one) and full insurance (row two). Three different values for the coefficient on real debt ϕ_b in the fiscal rule are considered: 0.33 (solid lines), 0.05 (dashed lines), and 0.75 (dotted lines). Computations are based on the following calibration: $\beta = 0.99$, $g = 0.17$, $\rho = 0.90$, $N = 0.942$, $\alpha = 1/3$, $\chi = 2/3$, $\eta = 6$, $\phi_\pi = 1.50$, $\delta = 0.025$, $\phi''(\delta) = -40$, $\psi = 0.5$, $b = -0.2$, $\omega = 0.25$, $\phi_b = \{0.05, 0.33, 0.75\}$, $\phi_g = 0.10$, $\mu = \{0.8099, 1\}$.

well below zero and one after a period of around four years. So while deficits may strengthen the multipliers in the short run, they tend to weaken the effects of fiscal policy in the long run. By contrast, a tax regime that responds aggressively to debt ($\phi_b = 0.75$) avoids the large costs of government spending at longer horizons, but any benefits in terms of higher multipliers are short-lived. Notice the same dynamics also play out under full insurance, but with multipliers that are lower across the board due to the absence of composition effects.

G Extensive-Margin Effects of Government Spending

In this section I discuss details of the impulse response estimates summarized in the introduction. In accordance with the literature, response functions are obtained using vector autoregression (VAR) models estimated on quarterly U.S. data. Four specifications are considered. One identifies government spending shocks using contemporaneous restrictions along the lines of Blanchard and Perotti (2002). Another identifies spending shocks as orthogonalized innovations to the Ramey (2011) narrative measure of defense news. A third specification uses innovations to the accumulated excess stock returns of major U.S. military contractors as constructed by Fisher and Peters (2010). The last model employs historical shocks extracted by Ben Zeev and Pappa (2017) that maximize contributions to the forecast error variance of defense spending over a five-year horizon.

The basic covariance-stationary VAR is given by

$$X_t = F_c + b_1 t + b_2 t^2 + F_1 X_{t-1} + F_2 X_{t-2} + \ldots + F_p X_{t-p} + A\epsilon_t,$$

where X_t is a $k \times 1$ vector of observable variables, F_i are $k \times k$ coefficient matrices, p denotes the lag length, F_c is a $k \times 1$ vector of intercepts, and b_1 and b_2 are linear and quadratic time-trend coefficients. The $k \times 1$ vector ϵ_t is a zero mean, serially uncorrelated vector of fundamental shocks with $E(\epsilon_t \epsilon_t') = I$. The $k \times k$ matrix A is an impact matrix.

Impulse response functions are obtained from the moving average representation

$$X_t = (I - F(L))^{-1}(F_c + b_1 t + b_2 t^2 + A\epsilon_t),$$

where $(I - F(L))^{-1}$ is a convergent infinite-order lag polynomial. For each specification, the trend-stationary responses of X_t to a spending shock are summarized by appropriate columns of the matrix polynomial $(I - F(L))^{-1}A$.

Most of the data used for these exercises comes from Valerie Ramey's website.[7] Data on civilian employment, unemployment, and the labor force comes from the U.S. Bureau of Labor Statistics Current Population Survey. Data on real government consumption expenditures comes from the U.S. Bureau of Economic Analysis.

I obtain confidence bands using the following procedure. First, I take the joint distribution of the VAR coefficients $(F_c, b_1, b_2, F_1, ..., F_p)$ and residual covariance matrix (AA') to be asymptotically normal with mean equal to the sample estimates and covariance equal to the sample covariance matrix of those estimates. I then draw $10,000$ random vectors from this distribution and, preserving identification restrictions, recompute impulse response functions for each draw. Ninety-percent confidence bands correspond to the 5th and 95th percentage bounds of the simulated distribution of responses over all $10,000$ trials.

G.1 Contemporaneous Restrictions

The first VAR identifies government spending shocks using an approach akin to Blanchard and Perotti (2002). This strategy assumes there is a one-quarter implementation lag in which government consumption does not react to innovations in the other variables. This makes it

[7] https://econweb.ucsd.edu/∼vramey/research.html.

predetermined, in which case innovations can be recovered via a Choleski decomposition of the reduced-form error covariance matrix with government consumption ordered first.

Variables included in the VAR in order are: the log of real per capita government consumption expenditures, the log of real per capita GDP, the log of real per capita consumption of nondurables and services, the 3-month Treasury bill rate (annualized percentage points), the Barro and Redlick (2010) average marginal tax rate, and the logs total unemployment and the civilian labor force both divided by the total population (including armed forces overseas). The sample period runs from 1957Q3 to 2007Q4. Four lags are included as well as a constant and a linear time trend ($b_2 = 0$). To estimate the response of employment, I swap out the last two variables for the logs of civilian employment and total hours (household-based measure), and rerun the estimation over the same sample period. Both variables are again normalized by the total population. This procedure helps preserve degrees of freedom and sharpens estimates of the impulse response functions.

To estimate the response of the real wage, I again drop the last two variables (civilian employment and total hours) and replace them with the log of nominal compensation in the business sector divided by the deflator for nondurable plus services consumption.[8] Notice here that I use a measure of the *consumption* real wage rather than the *product* wage. Although the latter is more common in VAR studies of fiscal policy, I use data on the former because the relevant efficiency-wage concept in the shirking model is a consumption wage rather than a product wage.

G.2 Defense News

The second VAR identifies shocks to government purchases with orthogonalized (Choleski) innovations to the narrative measure of U.S. defense spending developed by Ramey (2011). In particular, the "defense news" variable corresponds to the present discounted value of the expected change in government spending due to foreign political events divided by nominal GDP from the previous quarter. This series is arguably more immune to the well-known problem of anticipation effects that are thought to plague spending shocks estimated with contemporaneous restrictions on government consumption.

Variables included in this VAR in order are: the Ramey (2011) defense news series, the log of real per capita government consumption expenditures, the log of real per capita GDP, the log of real per capita consumption of nondurables and services, the 3-month Treasury

[8] This series is constructed using chained nondurable and services consumption aggregated by methods described in Whelan (2000).

bill rate, the Barro and Redlick (2010) average marginal tax rate, and the logs total unemployment and the civilian labor force both divided by the population. To obtain estimates of the response function for employment, I again replace the last two variables with the logs of civilian employment and total hours (both divided by the population). And to obtain estimates of the real wage, I swap the previous two with the log of nominal compensation in the business sector divided by the consumption deflator (nondurables plus services). In contrast to the first case, the sample period runs from $1948Q1$ to $2007Q4$. The reason for this change is that defense news turns out to have low predictive power if the Korean War episode is excluded from the sample. Four lags are included as well as a constant and a quadratic time trend ($b_1 = 0$). The choice to use a quadratic instead of a linear trend in addition to backing up the start date makes the specification more consistent with the one used in Ramey (2011).

G.3 Top 3 Excess Returns

The third VAR identifies spending shocks with innovations to the accumulated excess stock returns of "Top 3" military contractors from Fisher and Peters (2010). Like the narrative approach, it is based on the idea that periodic disturbances to current and expected future U.S. military spending can be viewed as exogenous. If such a disturbance was to occur, the flow of earnings of businesses who specialize in the production of military goods and services would be expected to change.

Variables included in order are: the log of real per capita defense spending, the log of real per capita government consumption expenditures, the log of real per capita GDP, the log of real per capita consumption of nondurables and services, the 3-month Treasury bill rate, the log of the unemployment-population ratio, the log of the labor force-population ratio, and finally, the log of the "Top 3" excess returns variable from Fisher and Peters (2010). Consistent with the authors, government spending shocks are identified with a Choleski innovation to the excess returns series. It is ordered last in the VAR under the assumption that innovations to this series are orthogonal to the current state of the economy.

The sample period again runs from $1957Q3$ to $2007Q4$. But this time, six lags are used as well as a constant and a linear time trend ($b_2 = 0$). These two modeling choices along with the sample period and the fact that the VAR includes defense spending but excludes any measure of tax changes also makes the specification as close as possible to the one used by Fisher and Peters (2010). Finally, estimates of the response function for employment are obtained by rerunning the analysis with logs of employment and total hours (normalized by the population) replacing the unemployment and labor force variables. Estimates of the real wage are obtained by rerunning the regression a third time with the log of nominal business compensation divided by the consumption deflator for services and nondurables.

G.4 Maximum Forecast Error Variance Method

The fourth VAR identifies spending shocks with innovations to the historical series recovered by Ben Zeev and Pappa (2017). They define shocks to news about real defense spending as the ones that maximize contributions to the forecast error variance of defense spending over a five-year horizon. Moreover, these shocks are also assumed to be orthogonal to current defense spending. This implies that exogenous shocks to government spending correspond to Choleski innovations of defense news provided it is ordered second in the VAR, right after the military spending variable.

Variables included in this VAR in order are: the log of real per capita defense spending, the Ben Zeev and Pappa (2017) defense news series, the log of real per capita government consumption expenditures, the log of real per capita GDP, the log of real per capita consumption of nondurables and services, the 3-month Treasury bill rate, the Romer and Romer (2010) narrative series of tax changes (endogenous plus exogenous), the log of total unemployment divided by the population and the log of the labor force divided by the population. The inclusion of the Romer and Romer (2010) tax measure instead of the Barro and Redlick (2010) measure is done to make the VAR as consistent as possible with the specification presented in Ben Zeev and Pappa (2017).

The sample period is $1957Q3$ to $2007Q4$. Four lags are included in the VAR as well as a constant and a linear time trend ($b_2 = 0$). To estimate the responses of employment, I once again replace the last two variables with the logs of civilian employment and total hours, and rerun the estimation over the same sample period. In the same way, the wage response is obtained by using the log of nominal business compensation divided by the deflator for nondurables and services consumption.

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