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Entry, Unemployment, and the Transmission of Government Spending Shocks

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Abstract

Postwar data reveals significant co-movement between net firm entry and private consumption conditional on a government spending shock. We construct and estimate an equilibrium model that matches this observation both in a qualitative sense and with an eye towards replicating the quantitative effects over time. Our model combines endogenous entry subject to sunk costs with unemployment arising from unobservable effort. Key to its success is an insurance design that partially protects workers against job risk. This feature allows aggregate consumption to increase through compositional changes in the labor force while amplifying the procyclical response of firm entry.

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1 Introduction

Since the mid 2000s, academics and policy experts alike have made great strides in the development of business cycle models capable of explaining the stimulative effects of government purchases on private economic activity (e.g., Linnemann, 2006; Galí, López-Salido, and Vallés, 2007; Hall, 2009; Bilbiie, 2011). A dynamic that until recently has been almost universally overlooked in this literature is variation in the number or range of producers (and products) through entry and exit. Those with neoclassical characteristics imply zero profits in all periods and an indeterminate number of producing firms. New Keynesian models, by contrast, leave room for positive profits but typically assume a fixed and exogenous mass of producers from the outset. That entry dynamics are missing from discussions of the fiscal transmission mechanism, however, makes little sense empirically. The best evidence we have to the contrary comes from US manufacturers, where net product creation (from new and existing firms) reportedly makes up a large share of overall production and is highly correlated with the business cycle (e.g., Bernard, Redding, and Schott, 2010; Broda and Weinstein, 2010). These facts alone are reason enough to incorporate endogenous entry into models of fiscal policy and to assess its role in propagating government spending shocks.

The only study we know of that takes up this task is Lewis and Winkler (2017). They employ a general framework for analyzing the effects of government spending centered around the variety-based entry model of Bilbiie, Ghironi, and Melitz (2012). To this core the authors add a mix of behavioral features that transmit policy (*i*) by inducing countercyclical price markups and (*ii*) by cutting off the wealth effects (of higher taxes) on labor supply. The key takeaway from their analysis is that models of this sort, no matter the details, cannot deliver joint procyclical responses of firm entry and private consumption. And the inability to do so, they argue, is a major concern seeing as it differs so dramatically from the data. Estimates provided by the authors indeed show that a positive shock to government spending leads to a period of increased consumption and a sustained rise in business formation.

Figure 1 presents evidence of our own that tells the same story as Lewis and Winkler (2017). Pictured are impulse responses for personal consumption expenditures and for the BEA's index of net business formation. Both derive from a VAR(4) estimated on quarterly US data and identified by imposing contemporaneous restrictions along the lines of Blanchard and Perotti (2002). Our estimates confirm that an unexpected increase in government purchases stimulates private consumption and business entry over a horizon of around one-to-four years. The full conditional correlation between these two variables, which embeds all of the impulse response coefficients, is also positive and significant at ordinary levels.

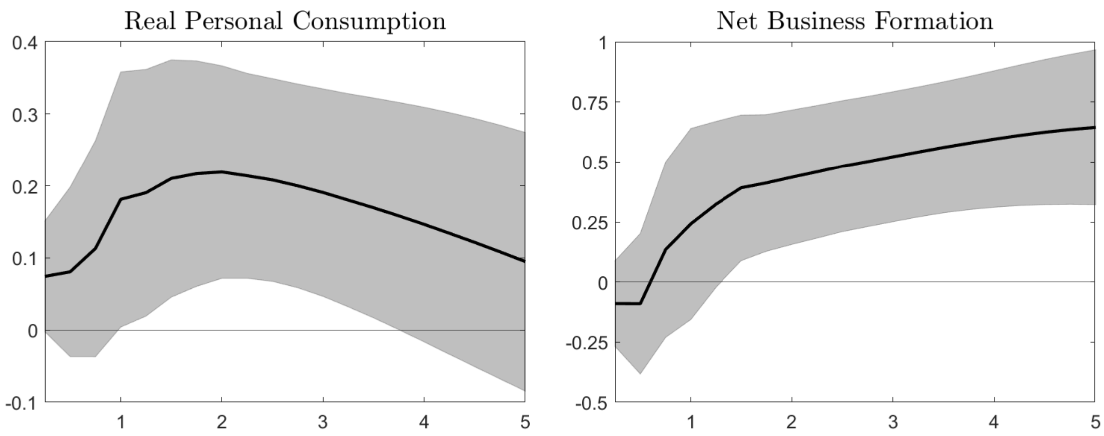

Fig. 1. Estimated Impulses Responses

Notes: Impulse responses to a one-percent innovation in government spending are shown for a structural VAR(4) model estimated on quarterly US data. Quantities are expressed in percent deviation form. Time on the horizontal axis is in years. Shaded regions are bootstrapped 90-percent confidence bands. Section 4 contains a detailed discussion of the empirical methodology.

Models that rely on conventional mechanisms like those examined by Lewis and Winkler (2017) cannot explain the pattern of co-movement described above. Put simply, our objective in this paper is to build one that can. Before we get into specifics, though, it is important to reiterate why the mismatch between theory and data happens in the first place. As the authors point out, this is a consequence of the way consumption and entry decisions interact with the usual wealth effects of government spending. Where consumption gets crowded-out, entry rises as conditions in the labor market (lower wages) boost the value of investing in new firms. Model features that block the wealth effect can reverse the crowding-out anomaly but at the expense of higher wages and a counterfactual drop in firm entry.[1] The apparent trade-off here implies that any effort to negotiate the wealth effect head-on, as conventional models do, will at best yield one positive and one negative response. Matching both sides of the data therefore requires a different approach. What we propose instead is a framework whose main transmission channel actually bypasses the wealth effect altogether, thereby making it possible to increase consumption without flipping the sign of the entry response.

Our solution to the co-movement puzzle borrows from Givens (2022) the idea that aggregate outcomes depend on the composition of total spending between workers and nonworkers. Imagine for a moment that government demand for goods and services suddenly goes up, job creation rises and unemployment falls as a result. If the transition from nonwork to work

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[1] Common features used to suppress the wealth effect include consumption-labor complementarity modeled after Greenwood, Hercowitz, and Huffman (1988) and "rule-of-thumb" households as in Galí *et al.* (2007).

in this scenario carries with it a step-up in *individual* consumption, *aggregate* consumption will increase right away due to composition effects alone. So in theory, procyclical consumption can be achieved without having to introduce features that sever the bond between the wealth effect and labor supply. Keep in mind those same features are also responsible for the wage hikes that occur in conventional models. Without them, labor costs may remain low enough–and profits high enough–to increase rather than decrease producer entry.

To articulate this view of the transmission mechanism, we put together a business cycle model in section 2 of this paper that combines labor market frictions with endogenous firm entry and product variety à la Bilbiie *et al.* (2012). The frictions we have in mind take the form of unobservable effort and worker moral hazard as in Alexopoulos (2004). Producers in our model elicit effort (prevent shirking) by means of an efficiency wage that exceeds the market-clearing rate, causing unemployment to emerge in equilibrium. To facilitate composition effects, we pair these frictions with an unemployment insurance program that nests a continuum of risk-sharing options from partial to full insurance. In the limiting case of full insurance, these effects disappear from the model completely. But with partial insurance, all the preconditions necessary for them to take effect are present, namely, a reservoir of unemployed workers who consume fewer goods and services than do the employed.

In section 3 we simulate a baseline version of our model in which labor is the only factor used in the production of existing goods and in the creation of new ones. For these exercises we fix the amount of insurance so that the spending gap (on the composite good) between workers and nonworkers averages 14 percent, a figure we argue is consistent with micro evidence on the consumption cost of unemployment. Results show that private consumption and firm entry (or product creation more generally) both respond procyclically in the aggregate to an unexpected but persistent rise in government purchases. The consumption response in particular is mostly due to the net migration of people from low- to high-consumption status through increases in employment. In our discussion below we refer to changes of this type as the *extensive* margin and demonstrate that it more than offsets the drag on individual consumption (i.e., the *intensive* margin) caused by the negative wealth effect. The entry response, meanwhile, follows naturally from this upswing in consumer demand coupled with overall sluggishness in the real wage. Together they generate an expectation of higher profits, which jump-starts investment in new firms and expands the range of varieties in the market.

While useful for building intuition, our baseline model lacks certain features that would make it suitable for explaining the quantitative effects of government spending over time. That being the case, in section 4 we install the efficiency-wage hardware into a “medium-scale" entry model that contains physical capital along with various real and nominal frictions designed to fit aggregate time-series data. We then estimate its structural parameters using the two-step Bayesian impulse response matching technique of Christiano, Trabandt, and Walentin (2010). Our application involves minimizing a weighted distance between the model and empirical responses of eight objects in total, entry and consumption included. The latter we obtain in the first step from an identified VAR for postwar US data.

The results of our empirical exercise are summarized as follows. First, the estimated model captures most of the co-movement between entry and consumption and other prominent aspects of the data as well. Second, posterior estimates of the degree of unemployment insurance align closely with values taken from panel studies on the household-level spending effects of involuntary job loss. Third, restricted models that have full insurance by assumption are at odds with the data, and when juxtaposed with the unrestricted model, tell us exactly where composition effects play a decisive role. Not surprisingly, the biggest discrepancy is in consumption, where the response under full insurance ends up negative at every point over the cycle. The differences for firm entry are significant too. Here our estimates indicate that partial insurance amplifies the cumulative effects of government spending (compared to full insurance) by 40 to 50 percent in accordance with the data.

We conclude our paper in section 5 with a few summary remarks followed by a short discussion of Lewis and Winkler's (2017) own answer to the consumption-entry puzzle. Theirs centers around the familiar idea that government spending may be valued as a public good.

2 An Entry Model with Unemployment

We modify the endogenous entry model of Bilbiie *et al.* (2012) by (*i*) adding shocks to government spending and (*ii*) replacing the neoclassical labor supply assumption with a shirking, efficiency-wage structure similar to Alexopoulos (2004). In our baseline setup, labor is the only input for producing existing goods and for expanding the range of available goods. The latter is subject to a sunk entry cost and a time-to-build lag of one period.

A. *Preferences*

The economy is inhabited by a unit mass of identical families, each with a $[0, 1]$ continuum of members. A fraction N_t receive wage offers every period. The other $1 - N_t$ are unemployed.

Partial consumption insurance between these groups implies that family members are ex-post heterogenous. To avoid distributional complications, we centralize ownership of family assets along the lines of Andolfatto (1996) and Merz (1995).

A representative family maximizes the expected present value of the average utility of its members, weighted by the employment probability of each type. Anticipating that wage earners will not shirk in equilibrium, average utility can be written as

$$E_0 \sum_{t=0}^{\infty} \beta^t \{N_t U(C_t^e, e_t) + (1 - N_t) U(C_t^u, 0)\},$$

where $\beta \in (0, 1)$ is the discount factor and C_t^j for $j = \{e, u\}$ denotes consumption of an employed or unemployed worker at date t. The utility function $U(C_t^j, e_t) = \log C_t^j + \theta \log(H - \nu_t[he_t + \xi])$, with $\theta > 0$, and where H is a time endowment, h is a constant number of work hours, and ξ are fixed time costs of supplying effort e_t. The function ν_t is an indicator that equals one if employed and exerting effort.

All family members consume a composite good C_t^j defined over a continuum of differentiated goods Ω. Only a subset $\Omega_t \subset \Omega$ is available in a given period t. Here we assume that the consumption aggregator features constant elasticity of substitution (CES) between goods and takes the form $C_t^j = [\int_{i \in \Omega_t} c_t^j(i)^{\eta - 1/\eta} di]^{\eta/(\eta-1)}$, where $\eta > 1$ is the substitution elasticity across varieties $i \in \Omega_t$. The consumption-based price index, or unit expenditure function, is $P_t = [\int_{i \in \Omega_t} p_t(i)^{1-\eta} di]^{1/(1-\eta)}$, where $p_t(i)$ is the nominal price of $c_t^j(i)$.

B. *Budget Constraints*

The family enters period t with share holdings x_t of a mutual fund that distributes income equal to the profit of all firms in operation. Let $d_t(i)$ be the date-t profit of firm i and define $n_t = \int_{i \in \Omega_t} di$ as the number of firms. Anticipating a symmetric equilibrium, $d_t(i) = d_t$ for all $i \in \Omega_t$, and the total profit of firms is $d_t n_t$. During period t, the family reinvests in holdings x_{t+1} of $n_t + n_{E,t}$ firms (incumbent firms plus new entrants) at a share price v_t equal to the present value of post-entry future profits. After paying taxes T_t, any remaining resources are spent on consumption benefits C_t^f for each member. The family allocates these goods before it sees who is employed, making C_t^f a lower bound on the consumption available to members.[2] The period budget constraint is

$$C_t^f + v_t(n_t + n_{E,t})x_{t+1} = (d_t + v_t)n_t x_t - T_t.$$

Family members can consume more than C_t^f by working. Firms offer one-period job contracts that stipulate hours h and effort e_t in exchange for an hourly wage w_t. The inability to monitor effort, however, means that workers have an incentive to shirk. Following Alexopoulos (2004), we assume firms pay a portion shw_t of the wage bill up front. The last installment $(1-s)hw_t$ is paid at the end of the contract period on the condition that shirking goes undetected. Detection occurs with probability m.

In addition to managing assets, the family runs an insurance program where each working member contributes F_t units of consumption into a pool for the unemployed. Having defined $\{C_t^e, C_t^u\}$ and letting C_t^s be the (notional) consumption of a detected shirker, it follows that

$$\begin{aligned} C_t^e &= C_t^f + hw_t - F_t, && (1) \\ C_t^s &= C_t^f + shw_t - F_t, && (2) \\ C_t^u &= C_t^f + N_t F_t/(1-N_t). && (3) \end{aligned}$$

As in Givens (2022), intra-family transfers take the form $F_t = \sigma(1-N_t)hw_t$. The coefficient $\sigma \in [0,1]$ governs the scope of unemployment insurance and nests a continuum of possible risk-sharing arrangements. Full insurance corresponds to $\sigma = 1$ since $C_t^e = C_t^u$ in this case. Values of $\sigma < 1$ imply partial insurance with $C_t^u < C_t^e$ in equilibrium.[3]

C. *Production*

There is a continuum of monopolistically competitive firms, each capable of producing a unique variety $i \in \Omega$. The mass of firms operating at any point in time is endogenous. Prior to entry, stakeholders must pay a sunk cost denominated in units of consumption. Once established, firms produce without disruption until they encounter an exit shock, which occurs randomly with probability δ_E every period.

Labor is the only factor of production (we introduce physical capital in section 4). Goods supplied by firm i are described by a linear technology $z[l_t(i) - l_t^s(i)]he_t(i)$, where inputs

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[2] If benefits were distributed after the fact, families would contrive to fully insure members by allocating fewer goods to workers and more goods to the unemployed. Effort would never be individually rational under such conditions as it would only result in less leisure with no gain in consumption.

[3] The temptation to lie about not having received a wage offer rises with σ. To deter such behavior, we assume families see which members receive them and denies access to the insurance pool to all who do.

$\{l_t(i), l_t^s(i), e_t(i)\}$ represent the demand for workers, shirkers, and unobservable effort. Labor productivity is fixed and exogenous and indexed by z. Since it is not profitable to hire shirkers, firms offer job contracts that elicit effort, ensuring $l_t^s(i) = 0$ in equilibrium. This requires that the terms of employment satisfy workers' *incentive compatibility* constraint

$$U(C_t^e, e_t(i)) \geq mU(C_t^s, 0) + (1-m)U(C_t^e, 0). \tag{4}$$

The right-hand-side of (4) is the expected utility from shirking given the monitoring technology m. We assume that firms understand the incentive problem faced by workers and set wages strategically to eliminate any moral hazard.

The objective of firm i is to select $\{p_t(i),\ l_t(i),\ w_t(i),\ e_t(i)\}$ so as to maximize shareholder dividends $d_t(i)$. Constraining its choices are the incentive compatibility condition and the derived demand for good i, which we denote $y_t(i)$, and obtain as $y_t(i) = [\partial P_t / \partial p_t(i)] Y_t^F = [p_t(i)/P_t]^{-\eta} Y_t^F$. The quantity Y_t^F measures aggregate absorption of the composite good and is taken as given by the firm. A formal expression of the profit-maximization problem is

$$\max_{\{p_t(i), l_t(i), w_t(i), e_t(i)\}} \quad \left(\frac{p_t(i)}{P_t}\right)^{1-\eta} Y_t^F - w_t(i) l_t(i) h + mc_t(i) \left[z l_t(i) h e_t(i) - \left(\frac{p_t(i)}{P_t}\right)^{-\eta} Y_t^F \right],$$

subject to (4). In equilibrium, the incentive compatibility constraint holds with equality and implies the following relationship between wages and effort:

$$e_t(i) = \frac{H-\xi}{h} - \frac{H}{h}\left(\frac{C_t^f + h w_t(i) - F_t}{C_t^f + s h w_t(i) - F_t}\right)^{-m/\theta} \equiv e(w_t(i); C_t^f, F_t). \tag{5}$$

Using (5) and taking $\{P_t, Y_t^F, C_t^f, F_t\}$ as given, the first-order conditions simplify to

$$\begin{aligned} \frac{p_t(i)}{P_t} &= \frac{\eta}{\eta - 1}\left(\frac{w_t(i)/e(w_t(i))}{z}\right), \\ \frac{e'(w_t(i)) w_t(i)}{e(w_t(i))} &= 1. \end{aligned} \tag{6}$$

The first equation instructs the firm to set its relative price $\rho_t(i) \equiv p_t(i)/P_t$ as a constant markup over real marginal cost.[4] The second is the classic Solow condition, establishing the

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[4] Marginal cost $mc_t(i)$ can be obtained as the shadow value (Lagrange multiplier) of relaxing the firm's supply constraint, and in units of the consumption basket, is equal to $(w_t(i)/e(w_t(i)))/z$.

optimal wage as one that minimizes labor costs per unit of effort.[5]

A key implication of (5) and (6) is that the consumption ratio between a worker and a notional shirker is constant and determined implicitly by

$$H\left(\frac{m}{\theta}\right)(1-s\tilde{C})(\tilde{C}-1)=(1-s)\left[(H-\xi)\tilde{C}^{1+m/\theta}-H\tilde{C}\right],$$

where $\tilde{C}\equiv C_t^e/C_t^s$. Substituting this ratio back into (5) shows that effort is also constant and valued at $\bar{e}=(H/h)(1-\tilde{C}^{-m/\theta})-(\xi/h)$. Fixed effort implies that real wages are the same across firms, so $w_t(i)=w_t$ for all $i\in\Omega_t$.

D. *Labor Supply*

In models of unobservable effort, labor supply is characterized by a "no-shirking condition" originating from workers' incentive compatibility constraint. Plugging (2) into (1) and using $C_t^e/C_t^s=\tilde{C}$, the no-shirking condition (NSC) takes the form

$$hw_t=\frac{1}{1-s}\left(\frac{\tilde{C}-1}{\tilde{C}}\right)C_t^e. \tag{7}$$

The NSC also plays a key role in determining how consumption gets allocated across the family. Plugging (3) into (1) and substituting out w_t using (7) gives

$$\frac{C_t^u}{C_t^e}=1-\frac{1-\sigma}{1-s}\left(\frac{\tilde{C}-1}{\tilde{C}}\right)\equiv\mu(\sigma), \tag{8}$$

implying a fixed consumption ratio between employed and unemployed members. Given s and $\tilde{C}$, the value of μ identifies σ. With full insurance, $\mu(1)=1$, and (8) becomes $C_t^u=C_t^e$. With partial insurance, $\mu(\sigma)<1$, and we write (8) as $C_t^u=\mu C_t^e$.

E. *Entry and Exit*

Alongside the mass of firms in this economy lives an even bigger mass of prospective entrants. Each one is forward-looking and capable of forecasting expected future profits $d_s(i)$ for

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[5] Wages are also subject to an *individual rationality* constraint, $U(C_t^e,e_t(i))\geq U(C_t^u,0)$, that ensures workers voluntarily accept job offers. But this constraint never binds in equilibrium for the simple reason that workers who reject offers are automatically denied unemployment benefits.

$s \geq t+1$. Following Bilbiie *et al.* (2012), entrants at date t do not begin operations until $t+1$, thereby introducing a one-period time-to-build lag akin to physical capital in the textbook real business cycle model. Like incumbent firms, entrants face a random exit shock at the end of the period, meaning a fraction δ_E will never produce. Before exits occur, however, new firms compute their expected post-entry value $v_t(i) = E_t \sum_{s=t+1}^{\infty} Q_{t,s} d_s(i)$, where $Q_{t,s}$ is the stochastic discount factor.[6]

Entry decisions in our model are coordinated by a specialized (mass-zero) investor whose objectives align with those of the family. We call this agent the *venture capitalist* (VC) for lack of a better term. The VC performs two tasks. First, it uses resources acquired through the sale of mutual fund shares x_{t+1} to finance the startup costs of new firms. It then "produces" those firms (i.e., creates new products) by means of an aggregate technology that takes the form $n_{E,t} = z l_{E,t} h e_{E,t}/f_E$, where $\{l_{E,t}, e_{E,t}\}$ represent the sectoral demand for workers and unobservable effort. To simplify the analysis, we assume the VC hires labor from the same pool as existing firms, apportions wages by the same fraction s, and detects shirkers at the same rate m. Under these conditions, the wage-effort pair that satisfies the incentive compatibility constraint is the same in both sectors of the economy. This symmetry implies that the real unit cost of producing new goods $n_{E,t}$, interpreted here as the *sunk cost* of entry, can be expressed as $f_E(w_t/\bar{e})/z$.[7]

The VC's period-t objective is to seed new firms $n_{E,t}$ so as to maximize their total post-entry value minus the requisite entry costs, or

$$\max_{n_{E,t}} \quad -f_E\left(\frac{w_t/\bar{e}}{z}\right) n_{E,t} + F(n_{E,t}) \int_0^{n_{E,t}} v_t(i) di.$$

Following Beaudry, Collard, and Portier (2011), we assume that not all new firms are successful. Only a fraction $F(n_{E,t})$ survive the startup phase. The likelihood of success is given by $F(n_{E,t}) = 1 - \Phi_E(n_{E,t}/n_t)$, where $\Phi_E(\cdot)$ represents an endogenous hazard rate. We find it convenient to interpret $\Phi_E(\cdot)$ as a type of adjustment cost to the product space analogous to those rooted in q-theory models of investment. The steady-state properties of this function are $\Phi_E = \Phi'_E = 0$ and $\Phi''_E > 0$. The costs of raising or lowering the startup rate $n_{E,t}/n_t$ (relative to steady state) are thus positive and increasing at the margin.[8]

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[6] The value of $Q_{t,s}$ in equilibrium is determined by the optimal investment behavior of the family and correctly accounts for the current and future probability of firm exit.

[7] The constant f_E measures sunk costs in effective labor units while $f_E(w_t/\bar{e})/z$ measures the same concept in units of the consumption basket.

[8] We depart from the usual assumption whereby prospective firms make entry decisions in a decentralized manner (e.g., Ghironi and Melitz, 2005). Instead, our centralized approach is closer to the setup used in

With symmetry across firms, the VC's first-order necessary condition becomes

$$f_E\left(\frac{w_t/\bar{e}}{z}\right)=\left[1-\Phi_E\left(\frac{n_{E,t}}{n_t}\right)\right]v_t-\Phi_E'\left(\frac{n_{E,t}}{n_t}\right)\left(\frac{n_{E,t}}{n_t}\right)v_t. \tag{9}$$

Equation (9) generalizes the standard free entry condition in Bilbiie *et al.* (2012). In our model, entry occurs until the sunk cost $f_E(w_t/\bar{e})/z$ equals the expected value of setting up a firm rather than the actual value. The former has two parts. The first part multiplies firm value v_t by the survival probability $F(n_{E,t})$. The second is an adjustment that captures the external effect of the marginal entrant on the success rate itself.[9]

Finally, protocols for entry, exit, and production imply the following law-of-motion for the number of goods producers:

$$n_{t+1}=(1-\delta_E)\left(n_t+n_{E,t}\left[1-\Phi_E\left(\frac{n_{E,t}}{n_t}\right)\right]\right). \tag{10}$$

Firms operating in $t+1$ are the surviving incumbents from period t plus any new firms that get past the startup phase while also avoiding the exit shock.[10]

F. *Symmetric Equilibrium*

All goods-producing firms face the same costs and make the same choices, so that $p_t(i)=p_t$, $\rho_t(i)=\rho_t$, $l_t(i)=l_t$, $y_t(i)=y_t$, $d_t(i)=d_t$, and $v_t(i)=v_t$ for $i\in\Omega_t$. With prices equal across firms, the relative price ρ_t and the number of producers n_t are linked through the familiar variety effect equation $\rho_t=n_t^{1/(\eta-1)}$.

Every period the government consumes G_t units of the composite good, which it fully finances by collecting taxes T_t. We assume G_t evolves exogenously by the law-of-motion $\log G_t=(1-\rho_g)\log G+\rho_g\log G_{t-1}+\varepsilon_t$, where $\rho_g\in(0,1)$ and $\varepsilon_t\sim(0,1)$.

Labor market clearing implies $N_t=l_tn_t+l_{E,t}$. Equilibrium in the goods market requires $y_tn_t=Y_t^F/\rho_t$. Both conditions along with $x_t=1$ and $T_t=G_t$, when imposed on the budget

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Lewis and Poilly (2012), Lewis and Stevens (2015), and Lewis and Winkler (2017) but with a designated agent coordinating $n_{E,t}$ rather than (or on behalf of) the household itself. This assumption is important because centralizing the problem ensures the hazard rate $\Phi_E(\cdot)$ is internalized in the course of optimization.

[9] The free entry condition (9) only applies in states where $n_{E,t}>0$. We assume government spending shocks are small enough for this inequality to hold in every period.

[10] Our use of the hazard function $\Phi_E(\cdot)$ is consistent with evidence from the industrial organization literature indicating that business startups experience higher rates of exit than incumbent firms (e.g., Haltiwanger, Jarmin, and Miranda, 2013; Mata and Portugal, 1994).

Table 1
Baseline Model Equations

Pricing	$\rho_t = \left(\frac{\eta}{\eta-1}\right)\left(\frac{w_t/\bar{e}}{z}\right)$	(2.1)
Variety effect	$\rho_t = n_t^{1/(\eta-1)}$	(2.2)
Profits	$d_t = \frac{1}{\eta}\left(\frac{Y_t^F}{n_t}\right)$	(2.3)
Free entry	$v_t = f_E\left(\frac{w_t/\bar{e}}{z}\right) + v_t\left[\Phi_E\left(\frac{n_{E,t}}{n_t}\right) + \Phi'_E\left(\frac{n_{E,t}}{n_t}\right)\frac{n_{E,t}}{n_t}\right]$	(2.4)
Number of firms	$n_{t+1} = (1-\delta_E)\left(n_t + n_{E,t}\left[1 - \Phi_E\left(\frac{n_{E,t}}{n_t}\right)\right]\right)$	(2.5)
Average marginal utility	$\lambda_t = N_t/C_t^e + (1-N_t)/C_t^u$	(2.6)
Euler equation (shares)	$v_t(n_t + n_{E,t}) = \beta E_t \frac{\lambda_{t+1}}{\lambda_t}(d_{t+1} + v_{t+1})n_{t+1}$	(2.7)
No-shirking condition	$hw_t = \frac{1}{1-s}\left(\frac{\tilde{C}-1}{\tilde{C}}\right)C_t^e$	(2.8)
Unemployment insurance	$C_t^u = \mu(\sigma)C_t^e$	(2.9)
Aggregate consumption	$C_t = N_t C_t^e + (1-N_t)C_t^u$	(2.10)
Resource constraint	$Y_t^F = C_t + G_t + n_{E,t}\left[v_t - f_E\left(\frac{w_t/\bar{e}}{z}\right)\right]$	(2.11)
Goods supply	$Y_t^F = \rho_t z l_t h \bar{e} n_t$	(2.12)
Labor market equilibrium	$N_t = l_t n_t + n_{E,t}\left(\frac{f_E}{z h \bar{e}}\right)$	(2.13)

constraint, yield the aggregate resource identity $Y_t^F = C_t + G_t + n_{E,t}\left[v_t - f_E(w_t/\bar{e})/z\right]$. Output of the composite good Y_t^F is the sum of private consumption C_t, government consumption G_t, and resources spent on changing the entry rate. Private consumption, in turn, equals the consumption of all employed and unemployed family members, so $C_t = N_t C_t^e + (1-N_t)C_t^u$.

Table 1 lists the equilibrium conditions. The system contains 13 equations that determine 13 endogenous variables: $\{\rho_t, w_t, n_t, d_t, v_t, n_{E,t}, l_t, \lambda_t, Y_t^F, N_t, C_t^e, C_t^u, C_t\}$. Only one, the number of firms n_t, is predetermined as of time t. The only exogenous state variable is G_t.

3 Equilibrium Dynamics

The purpose of this section is twofold. First is to demonstrate the ability of our model to explain the conditional dynamics of firm entry and private consumption described in the introduction. Second is to identify the role of unemployment insurance apart from other mechanisms in propagating government spending shocks throughout the economy.

A. *Calibration*

We interpret time periods as quarters and adopt parameter values that are taken from the literature or calibrated to match certain long-run properties of postwar US data. The results are summarized in Table 2. The discount factor β is consistent with an average real interest

Table 2
Baseline Model Calibration

Parameter	Value	Description
β	$1.04^{-1/4}$	Subjective discount factor
δ_E	$1.1^{1/4} - 1$	Firm exit rate
η	3.8	Substitution elasticity
ϕ_E	0.25	Entry adjustment costs
N	0.941	Steady-state employment
g	0.155	Share of government spending in GDP
μ	0.86	Unemployment insurance
ρ_g	0.95	AR(1) of log government spending

Notes: $\phi_E \equiv (\delta_E/(1-\delta_E))^2\Phi_E''$; $g \equiv G/(C + vn_E + G)$; $\mu \equiv C^u/C^e$

rate of 4 percent per annum. The exit probability δ_E implies an annual product destruction rate of 10 percent.[11] Following Bilbiie *et al.* (2012), we fix the substitution elasticity $\eta = 3.8$, leading to a fairly high steady-state markup of about 35 percent and a ratio of investment (in new productive units) to GDP of around 16 percent. Values of N and g are chosen to match the average civilian unemployment rate of 5.9 percent and the share of government consumption expenditures in GDP from 1954:Q1 to 2023:Q1. We set the auto-regressive coefficient $\rho_g = 0.95$, which is close to the estimate in Christiano and Eichenbaum (1992).

To calibrate μ, we look for empirical evidence on the household-level spending effects of involuntary job loss. As discussed in Givens (2022), much of the research in this area uses survey data to assess the average drop in food expenditures caused by an unemployment spell. Published estimates range anywhere from 6 to 19 percent (e.g., Gruber, 1997; Stephens, 2004; Aguiar and Hurst, 2005). Studies that use a broader measure of consumption (not just food) report spending cuts between 14 and 28 percent (e.g., Browning and Crossley, 2001; Chodorow-Reich and Karabarbounis, 2016). As a baseline value, we set $\mu = 0.86$. The implied consumption drop of 14 percent is near the midpoint of the available estimates we know of but at the low end of the subset that uses data on total spending.

We compute the equilibrium response to government spending shocks by log-linearizing the equations in Table 1 around the steady state. With just one (endogenous) predetermined variable, the usual Blanchard and Khan (1980) determinacy condition is that one and only one eigenvalue of the linearized system lie inside the unit circle. While this condition is always upheld by the standard model in Bilbiie *et al.* (2012), the same cannot be said of a version that incorporates unemployment and partial insurance. Obtaining a local solution

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[11] Evidence based on firm-level data in Bernard *et al.* (2010) points to a minimum product destruction rate of 8.8 percent per year.

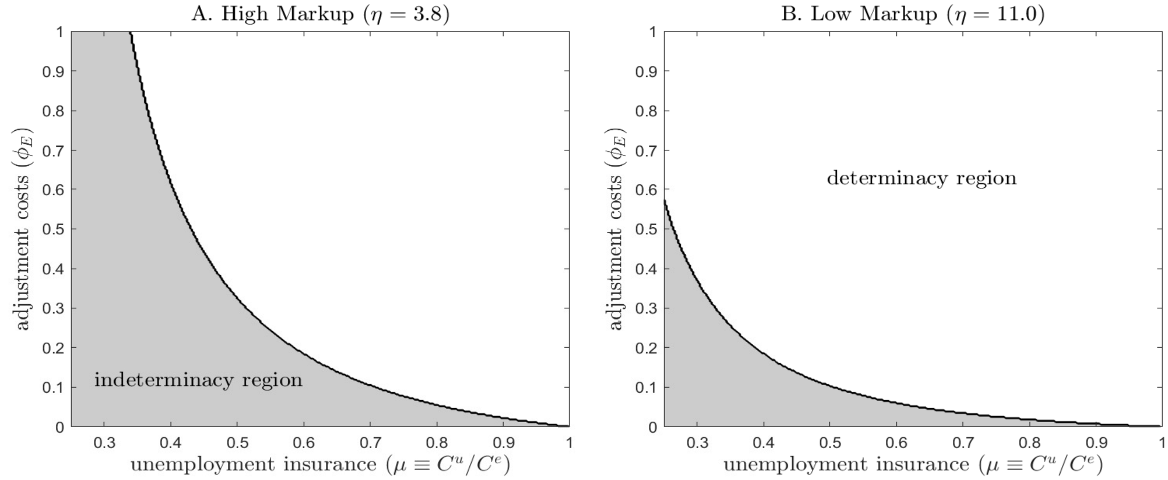

Fig. 2. Determinacy Analysis

Notes: Regions of the parameter space (μ, ϕ_E) consistent with a unique and stable equilibrium (light area) or indeterminacy (dark area) are shown for the entry model with a high markup of 35 percent (A) and a low markup of 10 percent (B).

that is both unique and nonexplosive requires certain restrictions on the parameter space, particularly over values of μ and the adjustment cost term ϕ_E. Characterizing the nature of these restrictions is the subject to which we now turn.

B. *Local Determinacy*

Figure 2 identifies regions of the parameter space (μ, ϕ_E) associated with (in)determinacy holding fixed the other parameters at values listed in Table 2. The exception is the substitution elasticity η. Panel A conditions on the high-markup baseline value and panel B on a lower markup of 10 percent. Results show that without adjustment costs ($\phi_E = 0$), the only version of the model that is locally determinate is one with full insurance. Anything less ($\mu < 1$) produces indeterminate dynamics regardless of the size of the markup.[12]

That the shirking model is vulnerable to indeterminacies was first pointed out by Nakajima (2006), who noticed similarities with previous work on this subject by Aiyagari (1995) and Bennett and Farmer (2000). The key insight is that the relevant labor supply concept or NSC can be both downward-sloping and steeper than labor demand for insurance levels

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[12] The log-linearized system reduces to a pair of equations in $\widehat{N}_t$ and $\widehat{n}_t$ whose characteristic polynomial has complex roots whenever $\phi_E = 0$ and $\mu < 1$. Since they always appear in conjugate pairs, both roots have modulus greater than one or both have modulus less than one.

below a certain threshold. Here that threshold is $\mu = 1$ since production (of goods and firms) in the baseline model is linear and the resulting labor demand curve perfectly horizontal.

To insulate the model from indeterminacies and allow scrutiny of a wider range of insurance options, we rely on adjustment costs to the startup rate of new firms as described earlier.[13] How effective this approach is can be seen in the figure. Moving right to left on the μ-axis, we find that the size of adjustment costs needed to prevent multiple equilibria increases slowly from zero at first but then accelerates quickly as insurance becomes scarce. Fortunately, this does not happen under either markup until μ is far below levels consistent with the micro evidence cited above. When $\mu = 0.86$, for example, the minimum value of ϕ_E is around 0.04 in the baseline case and 0.02 in the low-markup case.

For added context on values of ϕ_E inside the determinacy region, we examine the log-linearized free entry condition (9)

$$\widehat{v}_t - \widehat{w}_t = \underbrace{\left(\frac{\delta_E}{1-\delta_E}\right)^2 \Phi''_E}_{\phi_E} \left(\widehat{n}_{E,t} - \widehat{n}_t\right),$$

where hatted variables denote percent deviations from steady state. Note that ϕ_E is equivalent to the inverse elasticity of the entry rate $(n_{E,t}/n_t)$ with respect to the share price of new firms v_t. What's more, this quantity is isomorphic to the familiar elasticity coefficient appearing in q regressions derived from models where investment (in physical capital) is carried out by firms instead of embodied in the creation of new products. Instrumental variables estimates of such regressions often yield inverse elasticities between one and five (e.g., Cummins, Hassett, and Hubbard, 1996; Chirinko, Fazzari, and Meyer, 1999). For the simulations in this section, we set $\phi_E = 0.25$, implying much smaller adjustment costs by comparison. Even so, our results make clear that the shirking model is locally determinate, not only under the baseline calibration but also for plausible alternative values of μ.

C. *Impulse Responses*

We study the equilibrium response path of the economy to an unanticipated but persistent increase in government spending. While our main concern here is in qualitative aspects of the model, our eventual goal is to match the quantitative responses to corresponding moments in

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[13] The same strategy vis-à-vis physical capital in the one-sector growth model has been used to great success by Wen (1998) and Kim (2003), both of whom report that even small adjustment costs are sufficient to avert indeterminacies of the type made possible by increasing returns.

the data. Linking the model to data, however, is complicated by the presence of endogenous variety effects. As explained in Ghironi and Melitz (2005), real variables of interest to the researcher should net out the effects of changes in the number of available products to make them consistent with the data. To that end, we construct auxiliary variables that deflate nominal quantities not by the usual consumption-based price index P_t, but by the average price of individual goods p_t instead.[14] So for any X_t measured in units of the consumption basket, its data-consistent counterpart is $X_{R,t} \equiv P_t X_t / p_t = X_t / \rho_t$. In what follows, we focus on welfare-relevant concepts when discussing the transmission mechanism but pivot to empirical quantities when drawing comparisons to the data.

Figure 3 shows the responses (in percent deviations from steady state) of key variables to a one-percent positive innovation to G_t. Time on the horizontal axis is in years. Circles denote welfare-relevant variables and crosses their data-consistent counterparts. Consider first the effects on firm entry. Absorption of the composite good by the government boosts the demand for individual goods y_t. This raises firm-level profits d_t now and in the future since the spending shock is persistent. An expectation of higher profits translates into a higher (ex-ante) value v_t for each producer. Higher valuations, in turn, cause prospective firms to enter the market, which pushes the (ex-post) equilibrium value back down towards the level of the sunk cost. But because entry is moderated by adjustment costs, v_t remains elevated in the impact period and beyond. The increase in firm entry and firm value implies that investment $v_t n_{E,t}$ (in units of consumption) reacts positively to a spending shock.

Now consider what happens to private consumption. The increase in taxes T_t tightens the family's budget constraint, causing it to pull back on consumption benefits C_t^f. As explained in Alexopoulos (2004), this temporarily pushes up the ratio C_t^e / C_t^s, loosening the incentive compatibility constraint (4) in a way that makes employees strictly prefer effort to shirking. Naturally, employers in both sectors respond by lowering the (ex-ante) real wage w_t in an effort to re-balance this constraint. As labor costs decline, however, their appetite for hiring workers goes up. The result is an increase in the number of jobs available for producing goods $l_t n_t$ and for starting up new firms $l_{E,t}$.[15] Since families always satisfy labor demand, total employment N_t rises and reverts gradually to steady state over time.

This jump in the working population is the key to obtaining a positive consumption

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[14] Observed price indices like CPI are constructed on the basis of a fixed basket of goods whose composition adjusts slowly to changes in product variety. It follows that CPI data are actually closer to p_t than P_t.

[15] Bilbiie *et al.* (2012) argue that the rate of return on mutual fund shares $(v_{t+1} + d_{t+1})/v_t$ governs the allocation of labor across sectors. That growth in $l_{E,t}$ is higher than $l_t n_t$ in the years right after a spending shock reflects the above-average investment returns generated over this period (not shown in the figure).

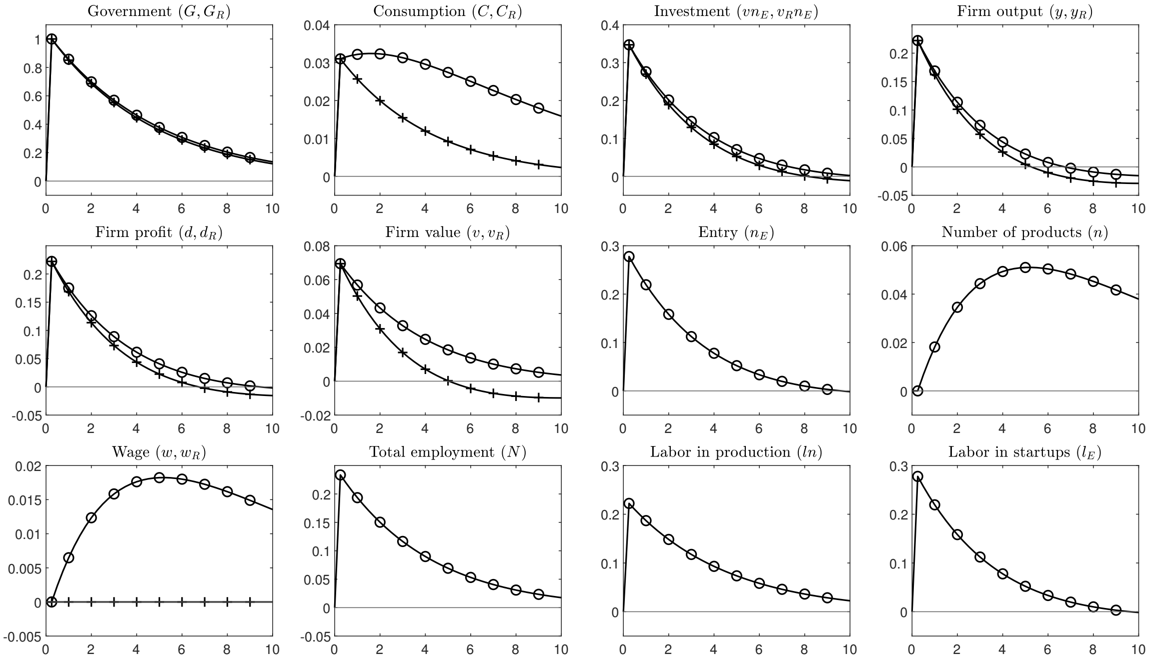

Fig. 3. Impulse Responses: Baseline Model

Notes: Impulse responses to a one-percent innovation in government spending are shown for the baseline model. Variables are in percent deviations from steady state. Circles denote welfare-relevant quantities and crosses their data-consistent counterparts. Time on the horizontal axis is in years.

response. As discussed in Givens (2022), changes in aggregate consumption C_t occur along two margins: an *intensive* margin reflecting movements in individual consumption (C_t^e and C_t^u) and an *extensive* margin coming from shifts in the composition of the workforce. The usual wealth effects of higher taxes tend to decrease C_t through the intensive margin by paring down the incentive-compatible wage as described above. Composition effects, on the other hand, tend to increase C_t through the extensive margin as long as unemployed workers are only partially insured. That way any employment growth N_t results in a larger share of the family consuming C_t^e and a smaller share consuming $C_t^u < C_t^e$. As it happens, composition effects are the dominate force in the baseline model and the reason why we observe aggregate consumption (C_t and $C_{R,t}$) going up after a spending shock.

Despite employers' efforts to lower the (ex-ante) real wage, the (ex-post) value of w_t in equilibrium is constant on impact and rises gently thereafter. Two equations dictate this outcome: the markup equation (2.1) and the variety effect (2.2). The former keeps w_t in lockstep with the relative price $\rho_t \equiv p_t/P_t$ at all times, while the latter ensures ρ_t depends

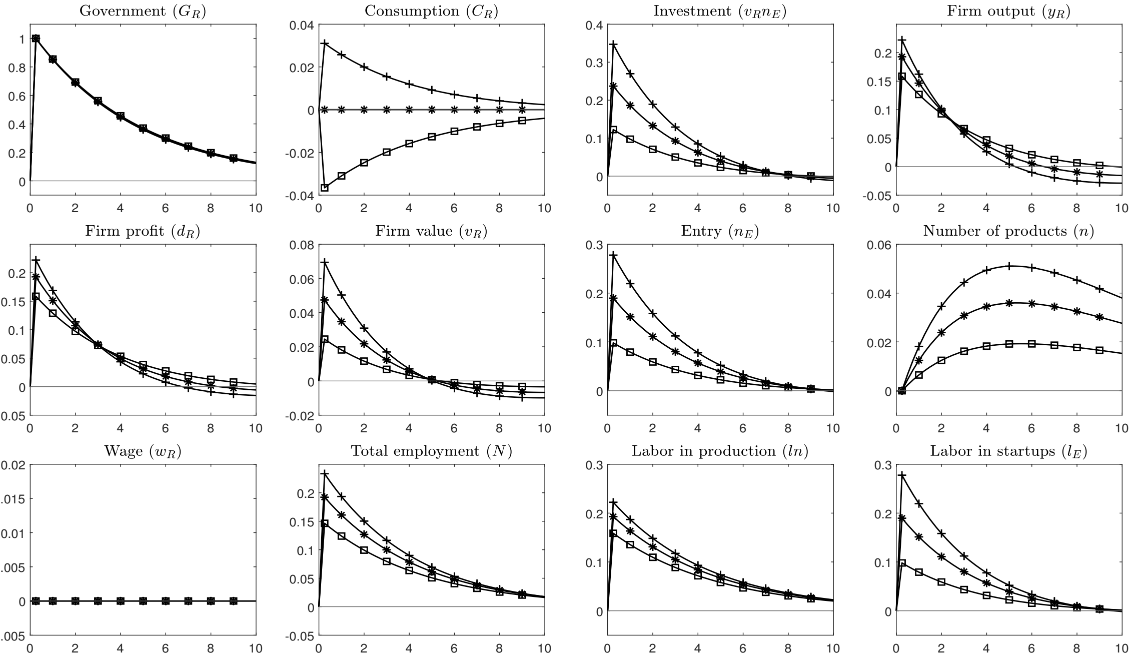

Fig. 4. Impulse Responses: Model Comparisons

Notes: Impulse responses to a one-percent innovation in government spending are shown for the partial insurance model (crosses), a full insurance model (stars), and a neoclassical model (squares). Variables are in percent deviations from steady state, and where relevant, correspond to data-consistent quantities only. Time on the horizontal axis is in years.

only on the predetermined number of products n_t. After the initial period, entry of new firms leads to an expansion in product variety whose positive welfare effects show up as an increase in the relative price and an identical increase in the wage. As for the data-consistent wage, however, symmetry between w_t and ρ_t implies that $w_{R,t}$ stays fixed the whole time.[16]

Simulations of our model appear broadly consistent with the empirical evidence on entry and consumption reported in Lewis and Winkler (2017) and verified independently in this study. But how much of this success is due to unemployment as opposed to unemployment insurance per se? For insight, we run the previous experiment on three separate models and compare outcomes in Figure 4. First is the baseline model with partial insurance (crosses). Second is a full insurance version (stars) obtained by resetting $\mu = 1$. The third model (squares) swaps out the shirking, efficiency-wage apparatus for a neoclassical structure in

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[16] Conditional on the number of goods n_t, aggregate labor demand in the baseline model is infinitely elastic. It follows that outward shifts in the NSC (from an increase in G_t) affect employment N_t but leave the equilibrium wage w_t unchanged on impact. As n_t rises over time, labor demand shifts up and with it w_t.

which labor is divisible and chosen optimally by households.[17] In each case, we display only the data-consistent real quantities plus any welfare-relevant variables not measured in consumption units (i.e., new and existing firms, labor supply).

Comparing the models side-by-side demonstrates very clearly the different implications each one has for consumption dynamics. In the baseline case, $C_{R,t}$ rises on impact and remains above steady state for some time. Meanwhile, $C_{R,t}$ is unresponsive in the case of full insurance and significantly negative (below steady state) in the neoclassical setup. These last two findings tell us that unemployment is necessary but not sufficient for generating a procyclical response of consumption. Capturing this aspect of the data, it seems, requires that partial insurance be added to the mix. Why the full insurance model fails in this regard is easy to see. Recall that the extensive margin of consumption is operative if and only if workers are partially insured. Full insurance shuts off this margin completely by equalizing consumption across the family, so that $C^e_{R,t} = C^u_{R,t} = C_{R,t}$. Obviously changes in employment N_t no longer affect $C_{R,t}$ in this case. All that matters is individual consumption, which according to the NSC (2.8), should not deviate from the constant wage $w_{R,t}$.

Partial insurance apart from unemployment more generally also has a big influence on the behavior of entry $n_{E,t}$ and investment $v_{R,t}n_{E,t}$. By a wide margin, the increase in both variables is highest in the baseline model during the first few years after a spending shock. This "amplification effect" is of course the upshot of stronger profit incentives for prospective firms. Note that all three models experience the same increase in government consumption, but only under partial insurance does private consumption go up too. Higher total spending on the composite good reinforces the demand for individual goods $y_{R,t}$ and, in turn, strengthens firm-level profits $d_{R,t}$ and value $v_{R,t}$. Efforts to exploit oversize profit opportunities are visible in the labor market as well, where employment growth in the startup sector $l_{E,t}$ is relatively high at first. By contrast, the sectoral balance of the labor market is about even under full insurance but shifted more towards goods production $l_t n_t$ in the neoclassical model. Over time, the run-up in product variety n_t in the baseline model erodes the demand for individual goods, which undermines the profit incentives of prospective firms ($d_{R,t}$ and $v_{R,t}$) and hastens the decline of entry and investment back to steady state.

D. *Discussion*

We view the preceding results as a major achievement of the baseline model. Recent evidence on this subject, as laid out carefully in Lewis and Winkler (2017), shows that conventional

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[17] We set the inverse Frisch elasticity to one-fourth, the same value used in Bilbiie *et al.* (2012).

models of the fiscal transmission mechanism fail to capture the observed co-movement between entry and consumption after a government spending shock. The common thread among these models is their reliance on features that weaken or even eliminate the wealth effects of higher taxes (e.g., countercyclical markups, GHH preferences, rule-of-thumb consumers). Such features are capable of producing a rise in private consumption, to be sure; but when grafted into a model like Bilbiie *et al.* (2012), they tend to squeeze profits to such a degree that firm entry goes down, not up as the data suggests.

Our model succeeds in restoring procyclical responses of both variables. Key to that success is the recognition that wealth effects operate at the level of individual consumption and may be offset in the aggregate by changes in the composition of the labor force. This approach has two clear advantages. Not only does it make conventional mechanisms of the sort referenced above unnecessary, it avoids the very thing responsible for the co-movement puzzle to begin with. In fact, we believe that our model shows great promise for resolving this puzzle altogether. A potential concern though is whether the complementary effects on entry and consumption induced by partial insurance hold up to further empirical scrutiny.

4 An Empirical Application

Results from the previous section demonstrated our model's consistency with some important qualitative aspects of the data. In this section, we investigate its quantitative properties by estimating structural parameters using a Bayesian variant of the two-step impulse response matching approach of Christiano, Eichenbaum, and Evans (2005). In a first step, we obtain empirical responses of relevant aggregate variables from an identified VAR estimated on postwar US data. We then evaluate the posterior in a second step using a criterion that minimizes the distance between impulse responses produced by the model and their empirical counterparts acquired in step one. The Bayesian procedure we use follows closely the one developed by Christiano *et al.* (2010) and applied more recently in Christiano, Eichenbaum, and Tranbandt (2015, 2016).

A. *A Medium-Scale Entry Model*

The entry model used thus far is too stylized to be taken to the data in a serious manner. Such a task often requires that one incorporate certain frictions–real and nominal–which have proved useful for explaining aggregate time-series data (e.g., Smets and Wouters, 2007). We take a page from this literature by extending the baseline setup along the same lines. The result is a "medium-scale" entry model that we believe is more suitable for estimation. In what follows, we describe each new component not in any great detail, but just enough to understand and interpret the empirical findings. A full derivation of the equilibrium conditions can be found in the appendix.

Translog Preferences. Assembly of the composite good Y_t^F is consistent with the translog cost structure proposed by Feenstra (2003). This specification introduces demand-side pricing complementarities in which the elasticity of substitution, $-[\partial y_t(i)/\partial p_t(i)][p_t(i)/y_t(i)]$, is given by $1 + \gamma n_t$, with $\gamma > 0$ for any symmetric variety $i \in \Omega$. Unlike CES preferences, the substitution elasticity here is increasing in the number of goods n_t. Under such conditions, firms' desired markups and the consumption value of additional varieties–both constant in the baseline model–get smaller as n_t increases and goods become closer substitutes.[18]

Consumption Habits. The utility function takes the form $U(C_t^j - bC_{t-1}, e_t) = \log(C_t^j - bC_{t-1}) + \theta \log(H - \nu_t[he_t + \xi])$, where $b \in [0, 1]$ governs the degree of habit formation.[19] Often used as a means of generating consumption persistence, allowing $b > 0$ in the shirking model also changes the incentive compatibility constraint (4), and by extension, the allocation rule (8) between employed and unemployed workers. In this case, the equilibrium ratio linking C_t^u to C_t^e generalizes to $(C_t^u - bC_{t-1})/(C_t^e - bC_{t-1}) = \mu(\sigma)$. What matters for interpretation though is C_t^u/C_t^e, still the relevant measure of insurance in the model and the same concept used in applied research on the spending effects of unemployment. Instead of being constant, this ratio now varies according to $C_t^u/C_t^e = \mu + (1 - \mu)b(C_{t-1}/C_t^e)$.

Physical Capital. We extend the baseline model to include physical capital alongside the capital embodied in the stock of available product lines. So what we now call "total investment" encompasses additions to physical capital I_t plus resources used to expand the range of products $v_t n_{E,t}$. Investment in physical capital requires assembly of the same (translog) composite of varieties used in the consumption basket, and once installed, depreciates at a constant rate $\delta_K \in (0, 1)$ per period. Following Lewis and Stevens (2015), we assume physical capital is an input for producing existing goods and for creating new ones. The technology for exist-

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[18] Lewis and Poilly (2012) show that translog preferences induce a "competition effect" among producers that gives rise to countercyclical markups in equilibrium. Many have argued that countercyclical markups themselves may be an important propagation mechanism of government spending shocks (e.g., Hall, 2009).

[19] Although family members view C_{t-1} as given, we assume the head-of-household internalizes this quantity when forming intertemporal decisions. This makes our model closer to the internal habit setup as suggested by Fuhrer (2000) and Boldrin, Christiano, and Fisher (2001).

ing goods is described by a Cobb-Douglas production function $y_t(i) = zk_t(i)^\alpha[l_t(i)he_t(i)]^{1-\alpha}$, where $\alpha \in (0,1)$ and $k_t(i)$ denotes capital services employed by firm i. The VC's technology belongs to the same class and takes the form $n_{E,t} = (1/f_E)zk_{E,t}^{\alpha_E}[l_{E,t}he_{E,t}]^{1-\alpha_E}$. To simplify matters, we assume the capital share is the same in both sectors, so that $\alpha = \alpha_E$.

Capital Accumulation. The family owns the stock of physical capital K_t and rents its services in competitive markets. The accumulation technology is given by $K_{t+1} = (1-\delta_K)K_t + [1 - \Phi_K(I_t/I_{t-1})]\, I_t$, where $\Phi_K(I_t/I_{t-1})\, I_t$ represents investment adjustment costs. The function $\Phi_K(\cdot)$ is increasing and convex and satisfies $\Phi_K = \Phi_K' = 0$ and $\Phi_K'' \equiv \phi_K > 0$ in steady state. A similar adjustment cost specification applies to firm entry. Following Lewis (2009), we modify the hazard function $\Phi_E(\cdot)$ to depend on the growth rate of new startups. With this change, the law-of-motion (10) looks the same but with the survival probability replaced by $1 - \Phi_E(n_{E,t}/n_{E,t-1})$, where $\Phi_E = \Phi_E' = 0$ and $\Phi_E'' \equiv \phi_E > 0$ in steady state. Values of $\{\phi_K, \phi_E\}$ together affect the speed at which both types of investment respond to shocks.

Variable Utilization. Every period the family chooses the rate u_t at which physical capital is utilized in production. Leasing K_t brings in $r_t^k u_t K_t$ units of rental income, but it also entails maintenance costs in terms of the composite good equal to $a(u_t)K_t$. The cost function $a(\cdot)$ is increasing and convex and has the following steady-state properties: $u_t = 1$, $a(1) = 0$, and $a''(1)/a'(1) \equiv \chi \geq 0$. The value of χ plays an important role, as it determines the (inverse) elasticity of the utilization rate with respect to the rental price r_t^k.

Sticky Prices. Following Bilbiie, Ghironi, and Meltiz (2008), we assume that firms face price adjustment costs modeled in the style of Rotemberg (1982). The period-t cost for firm i is given by $\Psi_t(i) \equiv (\kappa/2)\left[(p_t(i)/p_{t-1}(i)) - \pi_{t-1}\right]^2 (p_t(i)/P_t)y_t(i)$, with $\kappa \geq 0$ and $\pi_t \equiv p_t/p_{t-1}$. The quantity $\Psi_t(i)$ denotes real costs in units of the composite good of implementing an inflation rate for product i different from the average inflation rate across firms in the previous quarter.[20] The magnitude of these costs are scaled by κ and are proportional to the real value of total sales $(p_t(i)/P_t)\, y_t(i)$. As $\kappa \to \infty$, costs become so large that firms never deviate from the path implied by π_{t-1}. But as $\kappa \to 0$, adjustment costs vanish and the problem collapses to the flexible-price scenario depicted in the baseline model.

Monetary Policy. A central bank conducts monetary policy by setting the one-period nom-

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[20] The decision to model price adjustment costs as a function of lagged rather than steady-state inflation is motivated on empirical grounds. Fuhrer (2006) argues that the presence of backward-looking terms imparts persistence to inflation that cannot easily be explained by sluggishness in marginal cost alone.

inal interest rate r_t according to the following Taylor-type rule:

$$\log\left(\frac{r_t}{r}\right) = \theta_r \log\left(\frac{r_{t-1}}{r}\right) + (1-\theta_r)\left[\theta_\pi \log\left(\frac{\pi_t}{\pi}\right) + \theta_{\Delta Y} \log\left(\frac{Y_{R,t}}{Y_{R,t-1}}\right)\right].$$

Coefficients $\{\theta_r, \theta_\pi, \theta_{\Delta Y}\}$ capture the policy response to steady-state deviations in the lagged interest rate, producer inflation, and the growth rate of GDP. Here we use the data-consistent measure of GDP defined in the model as $Y_{R,t} = C_{R,t} + I_{R,t} + v_{R,t} n_{E,t} + G_{R,t}$.

Fiscal Policy. To produce the kind of fiscal dynamic seen in the data, we model G_t as an AR(2) process: $\log(G_t/G) = \rho_{g1} \log(G_{t-1}/G) + \rho_{g2} \log(G_{t-2}/G) + \varepsilon_t$, with $\varepsilon_t \sim (0, \sigma_g^2)$.

B. *Data and Econometric Strategy*

This section describes procedural details of the two-step estimation. Notable examples of this approach to the study of government spending shocks include Bilbiie, Meier, and Müller (2008), Ravn, Schmitt-Grohé, and Uribe (2012), and Lewis and Winkler (2017). Our usage differs from theirs mostly in the Bayesian implementation of step two.

VAR Step. We estimate the effects of government spending using a VAR of the form

$$A\mathbf{x}_t = B(L)\mathbf{x}_{t-1} + C(L)\mathbf{z}_t + \epsilon_t,$$

where $\mathbf{x}_t$ contains observable variables from the model, $\mathbf{z}_t$ is a vector of exogenous controls, and ϵ_t are mean-zero, serially uncorrelated shocks with diagonal covariance matrix Σ_ϵ. The square matrix A imposes contemporaneous relationships between variables in $\mathbf{x}_t$; $B(L)$ and $C(L)$ are conformable lag polynomials of order four. Ordinary least squares yields estimates of $A^{-1}B(L)$ and $A^{-1}C(L)$ as well as the residual covariance matrix $A^{-1}\Sigma_\epsilon\,(A^{-1})'$.

The VAR contains six variables, $\mathbf{x}_t = [\widehat{G}_{R,t}, \widehat{C}_{R,t}, \widehat{TI}_{R,t}, \widehat{n}_{E,t}, \widehat{r}_t - \widehat{\pi}_t, \mathbf{v}_{j,t}]'$, a fixed group of five variables and a sixth (ordered last) that we rotate into the system one at a time from the set $\mathbf{v}_t = \{\widehat{D}_{R,t}, \widehat{N}_t, \widehat{w}_{R,t}\}$. This strategy allows us to estimate the model on an expanded number of impulse responses without forcing too many variables into one large unconstrained VAR.[21] Our measure for $\widehat{G}_{R,t}$ is the log of government consumption spending deflated by the GDP price index. Private consumption and total investment ($TI_{R,t} \equiv I_{R,t} + v_{R,t} n_{E,t}$) are the logs of real personal consumption expenditures and real gross domestic investment.

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[21] Burnside, Eichenbaum, and Fisher (2004) justify this approach as a way to balance the trade-off between preserving degrees of freedom and minimizing the potential harm of omitted variable bias.

All three are in per capita terms. We measure firm entry $\widehat{n}_{E,t}$ using the (log) index of net business formation published in the Survey of Current Business. The real interest rate $\widehat{r}_t - \widehat{\pi}_t$ is the three-month Treasury Bill rate minus the annualized growth rate of the GDP price index.[22] We include it as a conditioning variable to help control for the simultaneous effects of monetary policy (e.g., Rossi and Zubairy, 2011). Total profit ($D_{R,t} \equiv d_{R,t} n_t$) is assembled from data on real per capita corporate profits and proprietors' income less the profit of Federal Reserve banks. The employment rate $\widehat{N}_t$ is the log ratio of nonfarm payrolls to the civilian labor force. We measure the wage $\widehat{w}_{R,t}$ by the log of real compensation per hour in the nonfarm business sector. Details on the data sources, transformations, and detrending procedures are provided in the appendix.

Following Blanchard and Perotti (2002), we identify innovations to government spending (i.e., the first element of ϵ_t) by assuming that $\widehat{G}_{R,t}$ is unresponsive to all other innovations within the quarter. The rest of the variables in $\mathbf{x}_t$, however, may respond contemporaneously to $\widehat{G}_{R,t}$ as they do in the model. To implement these restrictions, we set the top row of A to $[1\ 0_{1\times 5}]$ and obtain its lower triangular values from a Cholesky decomposition of $A^{-1}\Sigma_\epsilon \left(A^{-1}\right)'$.

When identifying shocks in this manner, one must be careful to avoid problems of fiscal foresight. Many researchers have indeed cautioned that VAR-based residuals may not recover structural shocks if government spending is anticipated by agents in advance (e.g., Ramey, 2016). One way to cleanse the residuals from anticipatory effects is to augment the VAR with variables that control for expected changes in $\widehat{G}_{R,t}$. To that end, we include in the vector of controls $\mathbf{z}_t$ the "narrative" measure of future defense outlays proposed by Ramey (2011). Critics of this series, however, point out that it has limited predictive power for government spending in post-Korean War data. For that reason, we also include in $\mathbf{z}_t$ the fiscal news shock of Fisher and Peters (2010). This series, based on the excess stock returns of military contractors, has more explanatory power in later samples.

The estimation period is the same as Lewis and Winkler (2017) and runs from 1954:Q1 through 1995:Q3. As explained by the authors, source data for the index of net business formation was discontinued in September 1995, which is why our sample ends when it does. To be sure, more recent information about firm entry is available from data on establishment births and deaths in the BLS's Business Employment Dynamics. Lewis and Winkler (2017) even go so far as to splice these two datasets into a single "net entry index" that covers the full period from 1954:Q1 to the present. A major concern though is that businesses and

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[22] In preliminary data analysis, standard ADF tests failed to reject the null of a unit root in $\widehat{r}_t$ and $\widehat{\pi}_t$ at a 5-percent level. However, the same test did reject a unit root in $\widehat{r}_t - \widehat{\pi}_t$, suggesting that the two series may be cointegrated. Specifying the VAR in terms of the real interest rate imposes this cointegrating relationship.

establishments are defined differently by the relevant statistical agencies, and as a result, exhibit very different time-series properties. Ultimately, the authors recommend using the business formation data by itself as the benchmark. We do the same in the next section.

Impulse Response Matching Step. Given an estimate of the VAR, we compute impulse responses for $\mathbf{x}_t$ to an identified spending shock. Let $\widehat{\varphi}$ be a vector that stacks the first 17 quarterly responses of government consumption, private consumption, total investment, firm entry, the real interest rate, aggregate profits, employment, and the real wage. Similarly, define $\varphi(\vartheta)$ as the mapping from a set of parameters ϑ to the corresponding model impulse responses. The idea underlying the two-step approach is to regard $\widehat{\varphi}$ as "data" and to search over values of ϑ that make $\varphi(\vartheta)$ as close to $\widehat{\varphi}$ as possible. Following Christiano *et al.* (2010), we specify priors for ϑ and apply Bayes' rule to evaluate its posterior distribution conditional on $\widehat{\varphi}$. One can show that the Bayesian log posterior for ϑ is proportional to

$$\log f(\vartheta|\widehat{\varphi}, W) \propto -\frac{1}{2}\left(\widehat{\varphi} - \varphi(\vartheta)\right)' W \left(\widehat{\varphi} - \varphi(\vartheta)\right) + \log p(\vartheta), \tag{11}$$

where $p(\vartheta)$ are the priors and W is a weight matrix. Motivated by small sample concerns, our estimator of W is a diagonal matrix whose nonzero entries are the inverse of the asymptotic variances of the ordered elements of $\widehat{\varphi}$. We compute each variance estimate across a sample of 50,000 bootstrap realizations of the VAR impulse response functions.[23]

In evaluating the posterior distribution of ϑ, we first locate the mode by maximizing the proportionality factor (11). We then explore the full Bayesian posterior using a conventional random walk Metropolis-Hastings (RWM) algorithm initialized at the mode. Results are based on a single chain of length ten million with a burn-in of two million draws and an acceptance rate of 25 percent. We verified that the chain length was sufficient to ensure convergence of all parameter estimates reported in the paper.[24]

C. *Empirical Results*

In this section we discuss the main findings of our two-step estimation. First we describe the various parameter restrictions imposed on the model prior to estimation. We then report

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[23] To obtain a given realization (indexed by τ), we construct an artificial sample $\{\mathbf{x}_t^{(\tau)}\}_{t=1}^{T}$ using our estimated VAR along with random draws from the fitted residuals. We then re-estimate the VAR on $\{\mathbf{x}_t^{(\tau)}\}_{t=1}^{T}$, imposing the same identifying restrictions as before and correcting for small sample bias using the method of Kilian (1998). The resulting impulse responses are stored in a vector $\widehat{\varphi}^{(\tau)}$.

[24] Details on convergence statistics and traceplots of individual parameters are provided in the appendix.

Table 3
Medium-Scale Model Calibration

Parameter	Value	Description
	Panel A: Parameters	
β	$1.04^{-1/4}$	Subjective discount factor
δ_E	$1.1^{1/4} - 1$	Firm exit rate
δ_K	$1.1^{1/4} - 1$	Depreciation rate
α	0.218	Capital share in production
	Panel B: Steady-state targets	
$(1 + \gamma n)/\gamma n$	1.145	Producer markup
$1 - N$	0.059	Unemployment rate
π	$1.02^{1/4}$	Quarterly inflation
G/Y	0.155	Share of government consumption in GDP
C/Y	0.626	Share of private consumption in GDP
$(I + vn_E)/Y$	0.219	Share of total investment in GDP
dn/Y	0.116	Share of profit income in GDP

estimates of the unrestricted parameters and compare the fit of the model under competing assumptions about the degree of unemployment insurance.

Parameter Restrictions. Certain parameters are difficult to estimate and so must be fixed a priori. For some, namely the discount factor β, the exit probability δ_E, average employment N, and the spending share g, we adopt the same values used in the baseline examples. The rest $(\delta_K, \pi, \alpha, \gamma)$ are specific to the medium-scale model and are reported next to the others in Table 3. The value for δ_K implies an annual depreciation rate of physical capital of 10 percent. Steady-state inflation π is 2 percent per year. As for α and γ, we pick values for each so that, conditional on the other parameters, the model jointly satisfies two steady-state criteria. One is the expenditure share of total investment in GDP and the other is the corresponding share of profits. Here we set both quantities equal to their long-run sample means.[25] These restrictions imply a value for α of 0.218, which is close to published estimates of the capital share in Smets and Wouters (2007). Imposing the same restrictions on γ yields a steady-state markup under translog preferences of around 15 percent.

Parameter Estimates. Table 4 reports means and 95-percent probability bounds for the prior and posterior distributions of $\vartheta \equiv (\mu, b, \chi, \phi_K, \phi_E, \kappa, \theta_r, \theta_\pi, \theta_{\Delta Y}, \rho_{g1}, \rho_{g2})$. The priors are broadly consistent with previous studies and relatively uninformative in most cases (e.g., Del Negro, Schorfheide, Smets, and Wouters, 2007). For parameters that live on the unit interval, we select a fairly loose beta distribution. For the adjustment cost terms, we use

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[25] Using measurement concepts consistent with the model, we construct quarterly time series for the GDP shares listed in Table 3 (panel B) over the period 1954 to 2023. Details are provided in the appendix.

Table 4
Priors and Posteriors of Model Parameters

		Prior			Posterior			
Description	Parameter	Distribution	Mean	[2.5-97.5%]	Mode	Median	**Mean**	[2.5-97.5%]
Frictions								
Unemployment insurance	μ	Beta	0.60	[0.29-0.87]	0.56	0.58	**0.58**	[0.47-0.67]
Consumption habit	b	Beta	0.50	[0.31-0.69]	0.63	0.60	**0.59**	[0.41-0.74]
Inverse utilization elasticity	χ	Gamma	2.00	[1.14-3.09]	0.86	0.99	**1.04**	[0.55-1.80]
Investment adjustment cost	ϕ_K	Gamma	4.00	[2.29-6.19]	3.93	4.19	**4.28**	[2.46-6.58]
Entry hazard function	ϕ_E	Gamma	4.00	[2.29-6.19]	2.97	3.16	**3.23**	[1.84-5.03]
Price stickiness	κ	Gamma	200	[81-372]	285	283	**292**	[138-491]
Monetary Policy								
Interest rate smoothing	θ_r	Beta	0.75	[0.53-0.92]	0.71	0.70	**0.69**	[0.49-0.86]
Inflation	θ_π	Normal	1.60	[1.21-1.99]	1.37	1.44	**1.46**	[1.15-1.86]
GDP growth	$\theta_{\Delta Y}$	Normal	0.10	[-0.10-0.30]	0.06	0.07	**0.07**	[-0.07-0.21]
Fiscal Policy								
AR(2) first lag	ρ_{g1}	Beta	0.75	[0.53-0.92]	0.73	0.72	**0.72**	[0.63-0.81]
AR(2) second lag	ρ_{g2}	Normal	0.10	[-0.10-0.30]	0.23	0.23	**0.23**	[0.14-0.33]

gamma distributions that encompass a wide range of estimates from the literature. The one exception is χ, whose prior concentrates around values that imply relatively mild costs of varying the utilization of capital.[26] As for monetary policy, feedback coefficients on inflation and output follow normal distributions centered on values typical of estimated Taylor rules (e.g., Coibion and Gorodnichenko, 2011). Lastly, priors for fiscal policy have means that are close to the estimates one obtains by fitting the response of $\widehat{G}_{R,t}$ from the first step to an AR(2) process. Consulting this subset of the data in advance, to some extent, helps condition our second-stage estimates on the "correct" dynamic for government spending.[27]

On the whole, posteriors for the common behavioral parameters of our model are in line with existing research. When it comes to non-policy parameters, the posterior means are also not too far away from the prior means. The consumption habit b, for example, is somewhat higher (0.59) but still close to the benchmark value in Christiano *et al.* (2005). The estimate of χ, on the other hand, is below the prior (1.04) and implies a near-unit elasticity of the capital utilization rate. The adjustment cost parameter ϕ_K has a posterior mean (4.28) just above the prior. It is similar to estimates in Del Negro *et al.* (2007), and in our model, returns an investment elasticity with respect to the price of installed capital of about one-fourth.[28] Meanwhile, the hazard function ϕ_E is smaller (3.23) but in the vicinity

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[26] A loose prior for χ is at odds with the sample information. In pre-estimation trials, we found that it leads to multimodality of the posterior and poor convergence of the RWM chain.

[27] We expect impulse responses for G_t and $G_{R,t}$ to be similar since fluctuations in the relative price ρ_t are small by comparison (see Fig. 3).

[28] The Euler equation for investment can be solved forward as $\widehat{I}_t = \widehat{I}_{t-1} + (1/\phi_K)\sum_{j=0}^{\infty}\beta^j E_t\widehat{q}_{t+j}$, where q_t is the family's date-t shadow value of an extra unit of installed capital K_{t+1}. It follows that $1/\phi_K$ is the

of estimates reported by Lewis and Stevens (2015) and Offick and Winkler (2019). As for the price stickiness term κ, the estimated mean (292) is large but not inconsistent with reduced-form evidence contained in the Phillips curve. This equation, which traces to the optimal pricing decision of firms (e.g., Bilbiie *et al.*, 2008), features a slope coefficient on the (log) markup equal to $\gamma n/\kappa\pi^2$. The posterior mean of this coefficient is 0.023 and within the range of slope estimates one gets from the Calvo framework with strategic complementarities and average price contracts of 2-3 quarters (e.g., Eichenbaum and Fisher, 2007).

Turning to the policy equations, estimates of the Taylor rule coefficients on inflation and GDP growth are $\theta_\pi = 1.46$ and $\theta_{\Delta Y} = 0.07$, and there is ample interest rate inertia with $\theta_r = 0.69$. The mean of $\theta_{\Delta Y}$, in particular, suggests that monetary policy has largely accommodated the stimulative effects of government spending over the sample. Estimates of the fiscal rule indicate that public consumption is highly persistent. The sum of the AR(2) coefficients is $\rho_{g1} + \rho_{g2} = 0.96$ and close to the value obtained by Lewis and Winkler (2017).

Of course the main parameter of interest in this study is μ, which governs the insurance arrangement between workers and is central to the transmission of government spending shocks. The posterior mean of this parameter is 0.58 and the associated probability interval 0.47 to 0.67. On its own, this result is difficult to interpret since μ does not identify the consumption drop in the medium-scale model. As explained earlier, C_t^u/C_t^e is both time-varying and jointly dependant on μ and b. Still one can show that absent shocks, this ratio converges to a steady state whose value at the posterior mean is given by

$$\frac{C^u}{C^e} = \frac{\mu(1-b) + [N + (1-N)\mu]b}{(1-b) + [N + (1-N)\mu]b} = 0.826.$$

Thus our estimates of μ and b along with the fixed value of N imply that consumption is about 17 percent less for unemployed workers in steady state.

Figure 5 displays the prior (dotted) and posterior (solid) distributions for μ and C^u/C^e. The data are clearly informative about μ, which in turn, helps update our beliefs on the size of the consumption drop. Note that draws from the prior distribution of C^u/C^e fall within 0.60 and 0.94 almost 95 percent of the time, whereas draws from the posterior stay between 0.75 and 0.88. This range of values under the posterior is significant for two reasons. First, it suggests that imposing full insurance would be rejected by the data. Second, it aligns remarkably well with estimates from the micro literature on the household spending effects of unemployment.[29] So not only is identification of C^u/C^e possible from macroeconomic

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elasticity of I_t with respect to a one-percent increase in q_t.

[29] Published estimates of the consumption drop based on survey data range anywhere from 14 to 28 percent

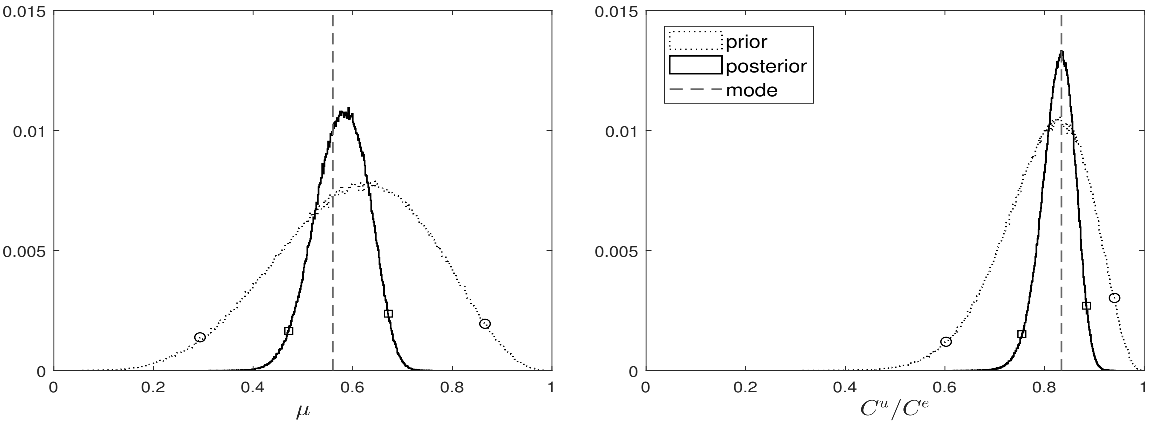

Fig. 5. Prior and Posterior Distributions

Notes: Histograms of the prior and posterior distributions are shown for μ and C^u/C^e. The posteriors are approximated by sampling every tenth draw from the RWM chain and grouping the results into 300 uniform bins. Dashed lines are positioned at the posterior mode. Squares (circles) mark the 2.5 and 97.5-percent density intervals for the posteriors (priors).

data alone, macro and micro estimates of this quantity appear broadly consistent.

Impulse Responses. Solid black lines in Figure 6 are impulse response functions produced by the VAR. Shaded regions are (symmetric) bootstrapped 90-percent confidence bands. Thick dashed lines are the model responses evaluated at the posterior mode and the thin lines their highest 95-percent probability density intervals.

The estimated model does reasonably well at matching key aspects of the data. Most (but not all) of the responses lie comfortably inside the empirical confidence bands out to a four-year horizon. Looking closely at consumption and investment, we see that both are positive on impact and rise gradually thereafter. Although neither have distinct hump-shaped profiles, their short-run effects are consistent with the data. Consider the changes one year after a shock for example. The cumulative increase in consumption (investment) is about 0.4 (0.9) percent in the model compared to 0.5 (1.3) percent in the VAR.[30] These gaps increase somewhat over the next year but narrow considerably by the end of year three.

The fit of the model is better when it comes to firm entry. Like the VAR, it produces a sluggish initial response followed by a longer period of incremental gains. The observed and

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when measured by total expenditures rather than just food. Prominent among the studies we know of are Burgess, Kingston, St. Louis, and Sloane (1981), Dynarski, Gruber, Moffitt, and Burtless (1997), Browning and Crossley (2001), Low, Meghir, and Pistaferri (2010), and Chodorow-Reich and Karabarbounis (2016).

[30] These values imply cumulative *multipliers* for consumption (investment) totaling 0.09 (0.22) in the model and 0.14 (0.36) in the VAR. Ramey (2016) gives a definition of this concept with examples from the literature.

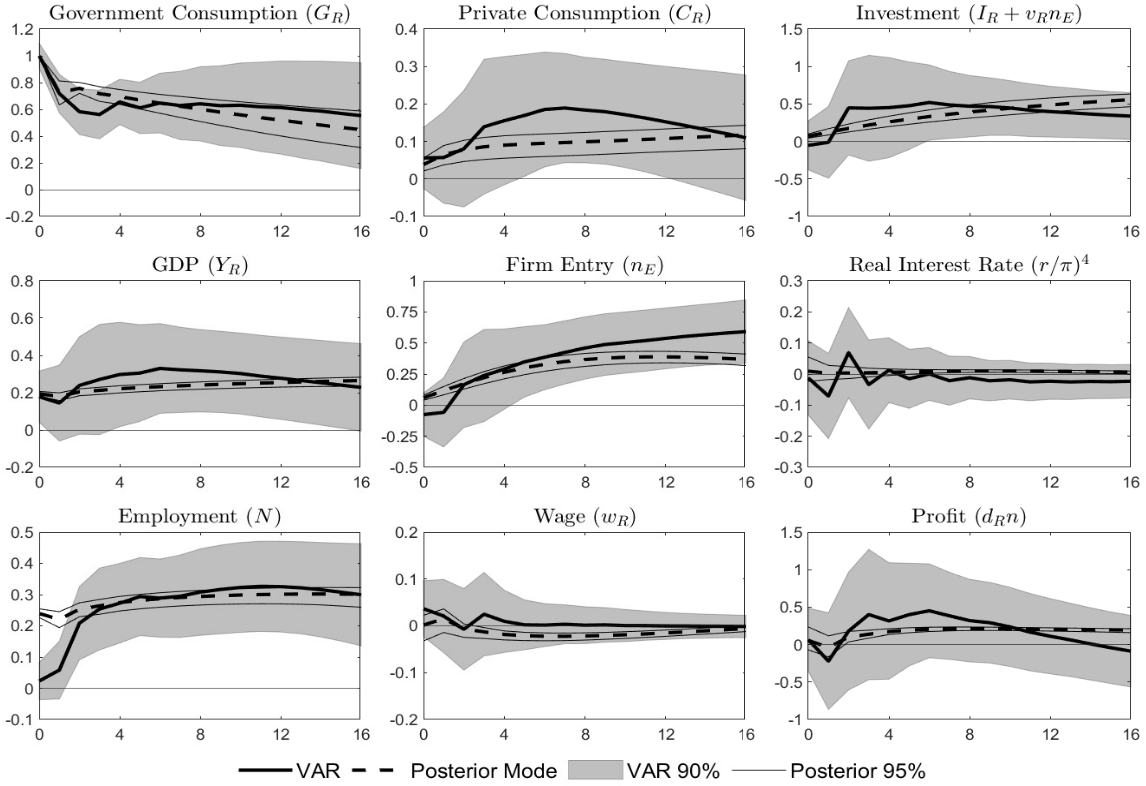

Fig. 6. Impulse Responses to a Government Spending Shock

Notes: Impulse responses to a one-percent innovation in government spending are shown for the VAR and the estimated model. Variables are in percent deviations from steady state. Time on the horizontal axis is in quarters. The VAR response of GDP satisfies $\widehat{Y}_{R,t} = (C/Y)\widehat{C}_{R,t} + (G/Y)\widehat{G}_{R,t} + ((I + vn_E)/Y)\widehat{TI}_{R,t}$ using values for the steady-state ratios in Table 3.

predicted responses are in fact so alike that two years out, the cumulative increase is basically the same in both (2.2 percent). Not only that, the peak effects appear to lag changes in consumption by a few quarters. This pattern of co-movement in which consumption growth leads entry over the cycle is also visible in the data.

Our analysis of the baseline model established that positive co-movement between entry and consumption may result from shifts in the composition of the labor force conditional on partial insurance. We bring this up because empirical evidence of these effects can also be seen through the lens of the medium-scale model. After a unit shock to government spending, the model predicts an immediate and sustained increase in total employment of around 0.25 percent. In the VAR, by comparison, the initial response is not as swift but the level effects six months and beyond are nearly the same. Matching this observation is central to the model's interpretation of the data. With more jobs comes more movement of individuals from low- to high-consumption status, lifting aggregate consumption along the way via the extensive margin. How important this mechanism is for delivering procyclical consumption and for reconciling the co-movement puzzle more generally will become apparent when we estimate a restricted model that imposes full insurance a priori.

The transmission of government spending shocks also depends, to a degree, on the cyclical properties of the real wage. Estimates from our model indicate that real wages are mostly unresponsive to a spending increase. This finding is significant not just because it matches the data, but for what it implies about the behavior of profits and entry as well. By keeping a lid on wages (i.e., by tightening the incentive compatibility constraint), firms retain more profits after an upswing in demand. Bigger profit margins attract new startups, in turn, causing aggregate profits to respond procyclically as they do in the data. While the dynamics are less volatile, to be sure, the overall effects are quantitatively similar. Four years out, accrued profits are 2.9 percent in the model and 3.0 percent in the VAR.

One last variable worth mentioning is the (ex-post) real interest rate. In both the model and the data, real rates are essentially unaffected by a spending shock. The intuition here is straightforward. An increase in the demand for goods has little effect on inflation due to rigidities in marginal cost imparted by sluggish wages and capital utilization. The corresponding rise in the policy rate is greater but not by much, resulting in slightly higher real rates that return to average as soon as the inflationary impulse of the shock wears off.

Discussion. Our model's account of the effects of government spending should be viewed as an improvement over the conventional models surveyed in Lewis and Winkler (2017). Recall those models work by pairing countercyclical markups with features that reduce the wealth effect on labor supply. This combination can, under certain conditions, crowd-in private consumption, but at the cost of higher wages, lower margins, and a decline in firm entry that runs counter to the data. The shirking model, on the other hand, embraces the wealth effect, and in doing so, limits any growth in wages from countercyclical fluctuations in the markup.[31] As a result, profit margins stay elevated and entry goes up in accordance with the data. What's more, these outcomes occur alongside an increase in consumption instead of a decrease as is often the case in conventional models. This is achieved not by suppressing the wealth effect, but through compositional changes to the mass of high- and low-income individuals brought on by the job gains that come with increased investment in new firms.

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[31] Both sticky prices and translog preferences render markups countercyclical in the medium-scale model.

Table 5
Priors and Posteriors for Model Comparisons

		Prior Distribution			Posterior Distribution Mode **Mean** [2.5-97.5%]					
					Unrestricted: Partial UI			Restricted: Full UI		
Description	Parameter	$\mathcal{D}$	Mean	[2.5-97.5%]	Mode	**Mean**	[2.5-97.5%]	Mode	**Mean**	[2.5-97.5%]
Frictions										
Unemployment insurance	μ	$\mathcal{B}$	0.60	[0.29-0.87]	0.56	**0.58**	[0.47-0.67]	*1.00*		
Consumption habit	b	$\mathcal{B}$	0.50	[0.31-0.69]	0.63	**0.59**	[0.41-0.74]	0.44	**0.45**	[0.27-0.64]
Inverse utilization elasticity	χ	$\mathcal{G}$	2.00	[1.14-3.09]	0.86	**1.04**	[0.55-1.80]	0.70	**0.87**	[0.43-1.60]
Investment adjustment cost	ϕ_K	$\mathcal{G}$	4.00	[2.29-6.19]	3.93	**4.28**	[2.46-6.58]	3.24	**3.45**	[1.96-5.40]
Entry hazard function	ϕ_E	$\mathcal{G}$	4.00	[2.29-6.19]	2.97	**3.23**	[1.84-5.03]	2.94	**3.12**	[1.87-4.75]
Price stickiness	κ	$\mathcal{G}$	200	[81-372]	285	**292**	[138-491]	209	**258**	[103-477]
Monetary Policy										
Interest rate smoothing	θ_r	$\mathcal{B}$	0.75	[0.53-0.92]	0.71	**0.69**	[0.49-0.86]	0.80	**0.75**	[0.53-0.92]
Inflation	θ_π	$\mathcal{N}$	1.60	[1.21-1.99]	1.37	**1.46**	[1.15-1.86]	1.51	**1.42**	[1.00-1.91]
GDP growth	$\theta_{\Delta Y}$	$\mathcal{N}$	0.10	[-0.10-0.30]	0.06	**0.07**	[-0.07-0.21]	0.06	**0.07**	[-0.11-0.25]
Fiscal Policy										
AR(2) first lag	ρ_{g1}	$\mathcal{B}$	0.75	[0.53-0.92]	0.73	**0.72**	[0.63-0.81]	0.73	**0.73**	[0.65-0.80]
AR(2) second lag	ρ_{g2}	$\mathcal{N}$	0.10	[-0.10-0.30]	0.23	**0.23**	[0.14-0.33]	0.27	**0.27**	[0.20-0.35]
Memo Items										
Consumption drop	C^u/C^e		0.80	[0.60-0.94]	0.83	**0.83**	[0.75-0.88]	*1.00*		
Log posterior density	$f(\widehat{\varphi}\|\vartheta^*)p(\vartheta^*)$				238.8			193.7		
Log marginal data density	$f(\widehat{\varphi})$				231.7			187.0		

Notes: $\mathcal{B}$, $\mathcal{G}$, and $\mathcal{N}$ denote beta, gamma, and normal distributions ($\mathcal{D}$). *Italics* – imposed; ϑ^*– posterior mode.

Model Comparisons. Unemployment insurance plays a decisive role in the way government spending shocks are transmitted by the model. We first saw this in the baseline examples, but it turns out to be just as true in a medium-scale context as well. To demonstrate this point, we compare the fit of the unrestricted model with partial insurance against two restricted versions, both of which deliver full insurance by assumption. One version reruns the Bayesian estimation step subject to the constraint $\mu = C^u/C^e = 1$. The resulting posteriors are reported alongside the unrestricted estimates in Table 5. The second performs the simpler task of resetting $\mu = 1$ in the unrestricted model while keeping the remaining parameters fixed. By changing only μ, we get a better sense of its precise contribution in matching the data. Figure 7 displays impulse responses associated with the restricted models (Full UI) evaluated at their respective modes. Circles denote the re-estimated model and crosses the alternative. Also included are responses from the unrestricted model (Partial UI) and empirical responses from the VAR. These are once again depicted as dashed and solid lines, with shaded regions marking the 90-percent confidence intervals.

Consider first the Full UI model that recalibrates μ from 0.56 to 1. Changing this one parameter undermines the performance of the model in several areas, the most obvious being private consumption. Here aggregate dynamics are driven entirely by individual consump-

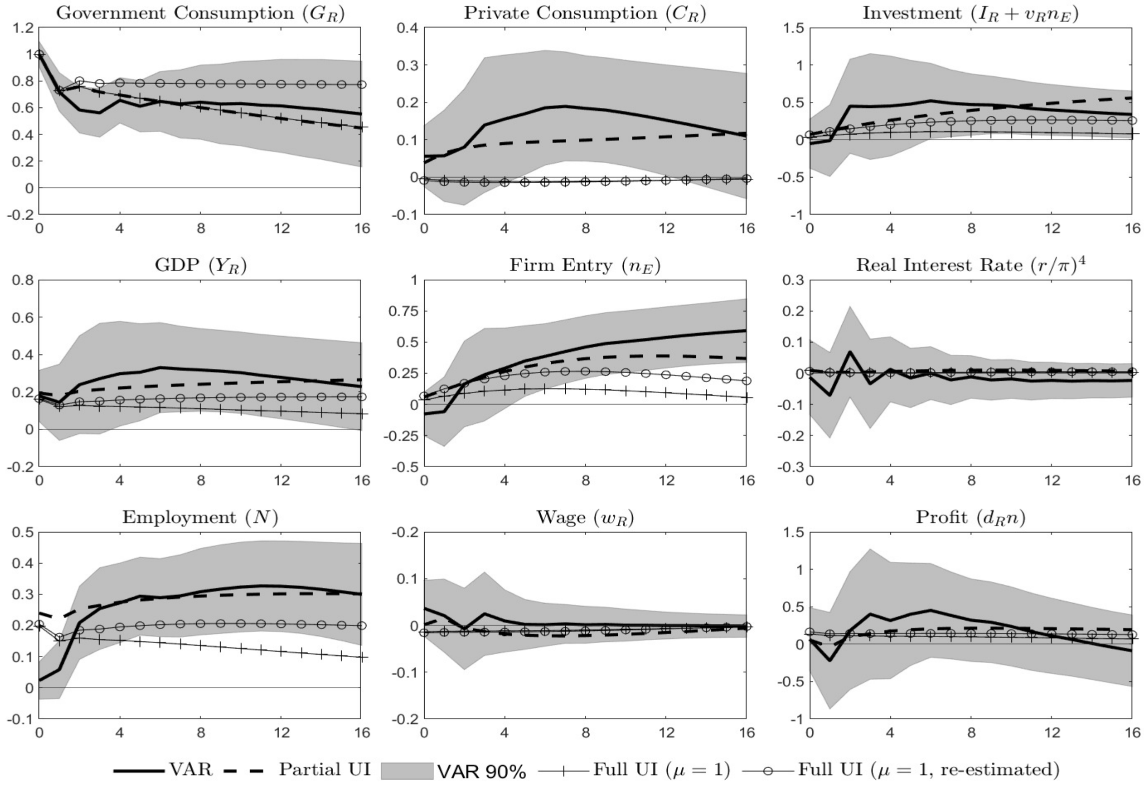

Fig. 7. Impulse Responses: Model Comparisons

Notes: Impulse responses to a one-percent innovation in government spending are shown for the VAR, the unrestricted model (Partial UI), the restricted model (Full UI) re-parameterized with $\mu = 1$, and the restricted model (Full UI) re-estimated subject to $\mu = 1$. Variables are in percent deviations from steady state. Time on the horizontal axis is in quarters.

tion, which owing to wealth effects, falls slightly after a spending shock. The failure to induce procyclical consumption also means that the model is unable to capture any part of the observed co-movement with firm entry, and on that score, is no better than conventional models. Note also that while the response of entry is still positive, the cumulative effects are much weaker than what we see in the Partial UI model, let alone the data. Under full insurance, firms' profit opportunities are smaller since private spending on consumption goods is basically flat. The result is fewer entrants and a lower demand for capital and labor in both sectors of the economy. It follows that aggregate quantities like total investment, GDP, and employment become much less responsive to government spending.

Another way to evaluate the insurance mechanism is by re-estimating the model subject to $\mu = 1$. Results show that this version of the Full UI model exhibits the same pathologies as the last one. A key difference though is that procyclical quantities–entry, investment, GDP, profit, and employment–are somewhat more responsive to a spending shock. What gives the model that extra lift in these cases is the behavior of fiscal policy itself. Notice that the posterior estimates of $\rho_{g1} + \rho_{g2}$ get arbitrarily close to unity under full insurance. A more persistent increase in government spending raises expected future profits, encourages greater firm entry, and strengthens labor demand, particularly in the startup sector. Since it cannot rely on lower values of μ to generate these dynamics, the Full UI model pushes government spending towards a unit root during the course of estimation. This trade-off, however, is costly in terms of model fit, as evidenced by the steep drop (45.1 log points) in the joint posterior density. A gap of this magnitude tells us that information from the sample and the prior strongly rejects the full insurance restriction.[32]

5 Concluding Remarks

Evidence based on postwar US data indicates that firm entry and private consumption respond positively to unanticipated increases in government spending. We construct and estimate an equilibrium business cycle model that explains this feature of the data, not just in a qualitative sense, but also with an eye towards matching the quantitative responses over time. Our model builds on the endogenous entry framework of Bilbiie *et al.* (2012) by incorporating a shirking, efficiency-wage structure of the labor market in the style of Alexopoulos (2004). In a simple version of the model where labor is the only factor of production, we find that positive co-movement between entry and consumption is possible if workers are partially insured against the risk of job loss. The same dynamic also appears in an estimated medium-scale version that includes physical capital and an assortment of frictions designed to fit aggregate time-series data. We attribute the success of our model to the way partial insurance interacts with the composition of the labor force. Conditional on the former, changes in the latter enable government spending to stimulate consumption along the extensive margin while amplifying the procyclical effects on firm entry. Tests show that this mechanism is powerful enough to generate sufficient co-movement at insurance levels consistent with microeconomic estimates of the consumption cost of unemployment.

Our paper is not the first to interpret the joint response of entry and consumption to a government spending shock. Lewis and Winkler (2017) themselves perform the same task

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[32] As an alternative measure of fit, we computed the marginal data densities for each model using the modified harmonic mean estimator of Geweke (1999). The density values reported in Table 5 imply a Bayes factor of approximately e^{45} in favor of the Partial UI model.

by estimating models in which public spending is useful, either as a direct source of utility to households or as an external factor of production for firms. Although the fit of both models is on par with our own, we believe that the mechanisms central to the public goods approach hinge on questionable assumptions.

Consider the utility angle first. Such models typically require significant complementarity between public and private consumption.[33] Unfortunately, studies that look for empirical evidence of this relationship often come up empty, with some even reporting estimates that favor substitutability instead (e.g., Aschauer, 1985; Ni, 1995; Amano and Wirjanto, 1998). A similar criticism applies to the production channel.[34] This mechanism only works to the extent that government spending has sizable effects on productivity, an assumption for which empirical support is limited at best (e.g., Evans and Karras, 1994; Holtz-Eakin, 1994).

A more fundamental challenge to the public goods interpretation has recently been put forward by Dupor, Li and Li (2019). They argue that government spending behaves less like a permanent income shock in these models and more like a preference or technology shock that exogenously shifts the marginal utility of private consumption or the marginal product of labor. It is easy to see here why this type of story might not be very convincing. By fastening a preference or technology effect to the deadweight loss of taxation, one's model will produce a rise in consumption and labor supply practically by assumption.

Our model provides an interpretation of the data that is less vulnerable to the issues described above. As a strictly empirical matter, the mechanism itself rests on two assumptions for which there is ample evidence: (*i*) government spending results in more workers and fewer nonworkers and (*ii*) consumption is lower for nonworkers.[35] It is also more resistant to the Dupor *et al.* (2019) critique given that compositional changes in the labor force are endogenous and not simply a reaction to exogenous preference or technology stimuli.

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[33] Examples of public-private complementarity include Linnemann and Schabert (2004), Boukez and Rebei (2007), Fève, Matheron, and Sahuc (2013), and Leeper, Traum, and Walker (2017).

[34] Applications of the public capital approach include Linnemann and Schabert (2006), Leeper, Walker, and Yang (2010), Leduc and Wilson (2013), and Sims and Wolff (2018).

[35] Ravn and Simonelli (2007), Monacelli, Perotti, and Trigari (2010), and Brückner and Pappa (2012) all report estimates that point to a reduction in US unemployment after a government spending increase.

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