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Government spending, consumption, and the extensive investment margin

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Government Spending, Consumption, and the Extensive Investment Margin*

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Abstract

We find VAR evidence that a rise in US government spending boosts consumption and firm entry. The joint dynamics observed in the data poses a puzzle for business cycle models with endogenous entry (extensive-margin investment). Persistent spending expansions generate entry but crowd out consumption through a negative wealth effect. Model features that dampen the wealth effect, such as credit-constrained consumers or non-separable preferences, reduce entry. This leads to weaker competition in oligopolistic markets, such that markups rise and consumption falls. The model captures the joint dynamics if labor supply is very elastic or public and private consumption are complements.

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1 Introduction

Policy makers have enacted sizable fiscal expansions to help the economy out of the Great Recession, the severe economic downturn that began at the end of 2007. The effectiveness of such policies depends on whether an increase in government spending stimulates private economic activity. In this paper, we investigate the effects of government spending on two forms of private economic activity, firm entry and consumption, both empirically and theoretically. The reasons are twofold.

The first motivation to study the dynamics of firm entry, which represents investment at the extensive margin, is that firm turnover is associated with a substantial amount of job creation and destruction. Davis and Haltiwanger (1990) attribute 25 percent of US annual job destruction to firm exit and 20 percent of annual job creation to entry, while Spletzer (1998) reports over one third for these two measures. For a government wishing to fight unemployment through a fiscal stimulus package, it is therefore useful to understand, in a first step, the effects of government spending on firm creation.[1]

Second, our model features countercyclical markups through endogenous firm entry. More precisely, markups drop - and thus real wages rise - as firm entry raises the degree of competition in an oligopolistic market.[2] The resulting upward shift of the labor demand curve allows for consumption to rise in the wake of a government spending expansion. The 'competition effect' offers a way to resolve the tension between empirical studies on the one hand, which typically find evidence for a rise in consumption following a positive government spending shock, and standard business cycle models on the other hand, which instead predict a crowding-out of consumption. In those models, the negative wealth effect of higher future taxes induces households to consume less and to work more, such that the labor supply curve shifts out and real wages and consumption decline.[3]

While empirical studies using vector autoregressions (VARs) overwhelmingly suggest that private consumption responds positively after an expansionary government spending shock, many find that capital investment (*intensive*-margin investment) falls, see Table 1.

[insert Table 1 here]

Evidence on the effect of fiscal expansions on *extensive*-margin investment, i.e. firm and product entry, is so far missing in the literature. Lewis (2009) finds that net business formation rises

[1]Colciago and Rossi (2012) show that job creation due to firm entry amplifies the response of labor market variables to technology shocks in a model with endogenous entry and unemployment.

[2]Notice that the mechanism is distinct from the 'specialization' of 'variety effect' discussed in Devereux, Head, and Lapham (1996).

[3]See e.g. Baxter and King (1993).

significantly after an expansionary aggregate demand shock; here, we want to isolate government spending shocks in particular and therefore apply the identification method of Blanchard and Perotti (2002). Our empirical results indicate that government spending expansions lead to higher private consumption and a delayed rise in business formation. We show that this finding is robust to two alternative identification methods using, respectively, an expectations-augmented VAR and sign restrictions.

Analyzing different variants and calibrations of the endogenous-entry model, we show that it is difficult to capture the joint dynamics observed in the data. The first ('frictionless') model assumes that firms must pay a fixed per-period cost to be able to produce. The second ('dynamic') model builds on Bilbiie, Ghironi and Melitz (2012): investment takes place at the extensive margin, entry costs are sunk costs incurred once at the time of entry, and there is a time-to-build lag in firm startups. We allow for a more general entry cost specification that combines materials and labor. This enables us to nest two cases that have been considered in the literature: one where entry costs are in terms of final output and one where entry requires labor services. Regarding the determination of the markup, we consider two alternative setups in both models: monopolistic competition and Bertrand competition. Markups are constant in the first case, but countercyclical in the second.

In the two models, shocks to government spending have potentially different effects on extensive-margin investment. In the *frictionless* model, entry rises unambiguously, while consumption falls in a typical calibration. The sign of the consumption response can be turned around only if the competition effect is present. In this case, the rise in real wages due to the drop in markups may overturn the negative wealth effect. For this to happen, the substitution effect away from leisure towards consumption needs to be sufficiently large. This is the case if either the competition effect is large so that real wages rise strongly or if labor supply is very elastic. Our results reveal that the competition effect is not strong enough to generate a consumption crowding-in for empirically supported values of the labor supply elasticity.

In the *dynamic* model, firm entry reacts positively if the government spending increase is sufficiently persistent. As in the frictionless model, consumption is crowded out if labor supply is not highly elastic. Regarding the consumption response, we consider two alternatives to the elastic-labor-assumption that have been proposed in the literature. First, we allow for credit-constrained or 'rule-of-thumb' households that neither save nor borrow, as in Galí, López-Salido and Vallés (2007). Second, we consider a preference specification with complementarity between consumption and labor, as in Bilbiie (2011) and Monacelli and Perotti (2008). Both modelling devices reduce the intertemporal wealth effect. We demonstrate that neither of them is successful in generating a rise in consumption in the presence of the competition effect. The reason is that a reduced wealth effect leads to a reduction in extensive-margin investment, which pushes up the markup through weaker competition and thereby generates a drop in consumption. This finding does not hinge on whether entry costs are specified in labor units or in terms of final output. Introducing price stickiness, either by itself or in combination with a wealth-effect reducing feature, does not alter our main finding. In contrast, a promising way to replicate the observed crowding-in of both consumption and extensive-margin investment is to assume complementarity between private and public consumption as in Linnemann and Schabert (2004).

The paper that is closest to ours is Devereux, Head and Lapham (1996), who analyze government spending shocks in the presence of increasing returns to specialization. They demonstrate the potential of endogenous entry to generate consumption crowding-in through increasing returns.[4] However, as Bilbiie (2011) points out, the degree of increasing returns is too small to generate a consumption crowding-in without relying on an extremely elastic labor supply. This paper differs from the aforementioned contributions in two dimensions. First, it ignores specialization or variety effects and instead focuses on markup countercyclicality coming from changes in competition. Monacelli and Perotti (2008) emphasize the importance of markups in the transmission of government spending shocks.[5] However, they remain within the no-entry framework, in which the number of firms and products is constant over time. Second, we provide an empirical investigation into the nexus between government spending shocks, consumption and firm entry.

The remainder of the paper is structured as follows. In Section 2, we present empirical evidence on the response of net business formation and new incorporations to government spending shocks. Section 3 discusses the various theoretical models, where we distinguish between a frictionless and a dynamic framework. Section 4 explains our calibration strategy and analyzes the model features that are required to replicate the impulse responses qualitatively. Section 5 concludes.

2 VAR Evidence

We identify the effect of fiscal expansions in vector autoregressions (VARs) estimated on US data. First, our benchmark specification is a recursively identified four-variable VAR of government spending, GDP, consumption and a measure of the extensive investment margin. The identifying assumption is that government spending reacts only to its own shock within the

[4] Totzek and Winkler (2010) analyze how different types of fiscal expansions (increases in government spending versus tax cuts) affect the number of entrants in the presence of increasing returns to specialization. Here, we limit attention to exogenous changes in government spending.

[5] Another way to obtain consumption crowding-in after a fiscal stimulus are deep habits as in Ravn, Schmitt-Grohé and Uribe (2012). However, this mechanism disappears under price stickiness, see Jacob (2012).

quarter. Second, we estimate an expectations-augmented VAR and identify a fiscal expansion as a shock to a news variable that captures changes in expectations about future government spending. Finally, we estimate a Bayesian VAR and identify spending shocks using sign restrictions. A spending expansion is one that increases government spending for a certian period of time and is orthogonal to a (suitably identified) business cycle shock.

The reduced-form VAR is given by

$$\mathbf{x}_t = \mathbf{u}_t + B^{-1}C\left(L\right)\mathbf{x}_{t-1} + B^{-1}\mathbf{e}_t, \quad (1)$$

where $\mathbf{x}_t$ is the vector of m endogenous variables, $\mathbf{u}_t$ is a vector of constants and time trends, $\mathbf{e}_t$ is a vector of serially and mutually uncorrelated structural shocks with unit variance, $C\left(L\right) = C_0 + C_1L + \ldots + C_qL^q$, L is the lag operator, q is the maximum lag, B comprises the parameters on the contemporaneous endogenous variables. An equation-by-equation ordinary least squares regression of (1) yields estimates of the coefficients, $B^{-1}C\left(L\right)$ and the reduced form residuals $B^{-1}\mathbf{e}_t$, as well as the covariance matrix of the residuals, Σ_e.

2.1 Blanchard-Perotti VAR

In our baseline specification, we estimate a vector autoregression model on US government spending g_t, GDP y_t, consumption c_t, and a measure of extensive-margin investment z_t. Thus $m = 4$ and $\mathbf{x}_t = (g_t, y_t, c_t, z_t)$. All variables are in logarithms. Government spending includes both consumption and investment spending. Private consumption is the sum of expenditures on nondurables and services. Government spending, GDP, and consumption are in real per capita terms. We use two measures of firm entry: net business formation nbf_t and new incorporations ni_t. The data sources, sample periods and variable transformations are given in Table 2.

[insert Table 2 here]

We start our sample in 1954q1 after the Korean War. Perotti (2008) argues that the fiscally turbulent years of the late 1940s and early 1950s give a wrong picture of the size of the consumption fiscal multiplier in US data.[6] Following Blanchard and Perotti (2002), we impose that B is lower triangular. Thus, we assume that within the quarter government spending reacts only its own shocks, such that the contemporaneous response to other shocks is zero. The maximum lag q is set equal to three quarters.

Figure 1 presents the impulse responses to a fiscal expansion given by a positive one-

[6]Estimation results based on the full sample including the Korean War are available from the authors upon request.

standard-deviation government spending shock. Consider first the top panel, Figure 1a, where extensive-margin investment z_t is measured as an index of net business formation, corresponding to *net* firm entry. In all figures, the solid line represents the point estimate, while the dashed and dotted lines are, respectively, the 68% and 95% confidence bands.

[insert Figure 1 here]

We observe a persistent rise in government spending and a hump-shaped increase in output. Private consumption rises significantly in the medium-run between quarters 4 and 14. The finding of a crowding-in effect is consistent with a large number of studies, see Table 1. The increase in GDP is longer-lasting than the positive consumption response. Importantly, there is a significant, though delayed, rise in the net business formation. Figure 1b shows that firm entry measured as the number of new incorporations, is not significantly affected by a fiscal stimulus.

Critics of the Blanchard-Perotti method to identify fiscal expansions argue that government spending increases are (at least partly) anticipated and therefore, one cannot recover the structural shocks from a reduced-form VAR, see Leeper, Walker and Yang (2009). One solution to this non-fundamentalness problem is to include a news variable as a proxy for expected government spending in the VAR model and to analyze a shock to that variable. Another is to impose a non-negative response of government spending for a number of quarters after the shock. We thus analyze the robustness of our finding to two alternative estimation approaches, an expectations-augmented VAR (EVAR) and a VAR with sign restrictions.

2.2 Expectations-Augmented VAR

Fiscal policy is subject to decision and implementation lags, which makes it likely that any actual changes in government spending are anticipated by agents. To deal with such anticipation effects, we introduce a news variable that captures changes in expectations about future government spending. The vector of endogenous variables becomes $\mathbf{x}_t = (f_t, g_t, y_t, c_t, z_t)$, where the fiscal news variable f_t is ordered first. A truly unanticipated fiscal expansion is then identified as an increase in this news variable. The identification scheme is again recursive, such that f_t is not affected contemporaneously by changes in government spending, GDP, consumption or extensive-margin investment. As our fiscal news variable we employ, first, the series constructed by Ramey (2011), which measures the present discounted value of military spending forecasts (normalized by nominal GDP) and, second, the variable proposed by Fisher and Peters (2010), who identify government spending shocks using excess stock returns of military contractors.[7]

[7]Both defense news series were obtained from Valerie Ramey's website.

Consider Figure 2, which presents the impulse responses in the Ramey EVAR.

[insert Figure 2 here]

One clear picture emerges from the figure: after a shock to f_t, net business formation and new incorporations rise significantly at long horizons. Consumption responds insignificantly at the 95% confidence level and actually *falls* at the 68% confidence level. The increases in government spending and GDP are significant only at the 68% confidence level. Indeed, Ramey (2011) points out that her defense news variable is not very informative for the post-Korean War sample. When we include the Korean War and start the estimation in 1948q1, the responses of government spending and GDP become significantly positive with much tighter confidence bands (not shown). Our results concerning consumption and firm entry are qualitatively unchanged.

We now turn to the results obtained from an EVAR using for f_t the news variable from Fisher and Peters (2010). The IRFs are shown in Figure 3.

[insert Figure 3 here]

Strikingly, the consumption response is positive and significant at the 68% confidence level, confirming our Blanchard-Perotti VAR results and contradicting the Ramey EVAR. Net business formation rises significantly at the 95% confidence level, while new incorporations rise significantly only at the 68% level. The confidence bands for consumption and GDP are wider than those obtained in the Blanchard-Perotti VAR.

All in all, the EVAR results indicate that firm entry rises after a fiscal expansion. As in the Blanchard-Perotti VAR, there is evidence of an accelerator effect on extensive-margin investment. The consumption response is negative in the Ramey EVAR and positive in the Fisher-Peters EVAR; in both cases the response is significant at the 68% confidence level. The remainder of this section uses another identification method based on sign restrictions, which is an alternative way to address the econometric problems that arise in the presence of anticipation effects.

2.3 Sign Restrictions VAR

This section checks the robustness of our key findings to the recursive identification scheme. In particular, we follow Mountford and Uhlig (2009) and identify fiscal shocks using sign restrictions. We estimate the reduced-form VAR in (1), where our vector of observables now additionally includes government revenues rev_t, such that $m = 5$. The definition of government revenues is given in Table 1 above.

We identify two shocks: a business cycle shock and a fiscal policy shock.[8] The business cycle shock raises government revenues, GDP, consumption, and firm entry for four consecutive quarters. The fiscal policy shock raises government spending, GDP and the budget deficit, defined as $g_t - rev_t$, for four quarters in a row, and is orthogonal to the business cycle shock. Given that we impose a non-negative response of g_t up a 4-quarter horizon, this method can address the anticipation problem. Suppose that at time t the government announces a spending package which takes three periods to implement. Actual government spending does not change between t and $t + 2$, but increases in $t + 3$. This type of shock is captured with the sign restrictions approach. No restriction is imposed on the effects of fiscal shocks on consumption or the extensive investment margin. The identifying sign restrictions are presented in Table 3.

[insert Table 3 here]

As in the recursively identified VAR, we include a constant and a linear trend in the list of regressors, and the VAR lag length is set to three quarters.

The resulting impulse responses to a government spending shock are presented in Figure 4. We have ordered the impulse responses to obtain a posterior distribution at each horizon. The lines displayed in the figure correspond to the 16th and 84th percentiles of that distribution, as it is conventionally done in the literature on VARs identified with sign restrictions.

[insert Figure 4 here]

The responses of consumption and GDP look similar to the ones in Figure 1 obtained under a recursive identification scheme. We observe a significant rise in private consumption in the medium run. While there is a marginally significant increase in net business formation after about three years, the change in new incorporations is clearly insignificant. These results confirm a consumption crowding-in and suggest that it is unlikely that extensive-margin investment falls.

3 Model

Given the evidence presented, we conclude that - empirically - net firm creation and private consumption tend to rise in response to a government spending expansion. In the following, we

[8]Note that our analysis focuses on real variables; we do not identify a monetary policy shock. Mountford and Uhlig (2009) argue that controlling for monetary policy shocks is not important when analyzing the consequences of fiscal policy.

first outline a *frictionless* variant of the endogenous-entry model of Jaimovich and Floetotto (2008), where entry is instantaneous and the stock of firms depreciates each period. Second, we contrast this framework with the *dynamic* model of Bilbiie, Ghironi and Melitz (2012), where entry is subject to a sunk cost and the stock of firms is a state variable. We generalize the specification of entry costs as a combination of labor and materials. We begin with the features that are common to both models. Let a hatted variable denote the percentage deviation from steady state, and let a variable without a hat or a time subscript denote its steady state level.

3.1 Households

Households maximize expected lifetime utility given by $E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, l_t)$, where β is the subjective discount factor. The period t utility function is increasing and non-convex in consumption C_t and leisure l_t, i.e. it satisfies the following conditions: $U_{C,t} > 0$, $U_{CC,t} \leq 0$, $U_{l,t} > 0$, $U_{ll,t} \leq 0$. Normalizing the time endowment to unity, we have $l_t = 1 - L_t$, where L_t is labor supply. We define the following parameters: $\chi \equiv -\frac{U_{CC}C}{U_C} + \frac{U_{Cl}C}{U_l}$ and $\tilde{\varphi} \equiv \nu + \varphi$, where $\nu \equiv \frac{U_{Cl}L}{U_C}$ and $\varphi \equiv -\frac{U_{ll}L}{U_l}$. The parameter χ measures the wealth effect on labor supply. The parameter $\tilde{\varphi}$ is the inverse of the constant-consumption labor supply elasticity. Consumption and leisure are substitutes (complements) if $\nu < 0$ ($\nu > 0$), which means that the marginal utility of consumption is decreasing (increasing) in leisure. Consumption and labor are complements if consumption and leisure are substitutes, and vice versa. Bilbiie (2011) shows that consumption and leisure are non-inferior and the utility function is concave if the following parameter restrictions are fulfilled: $\tilde{\chi} \geq 0$, $\tilde{\varphi} \geq 0$, and $\nu \leq \frac{\tilde{\chi}\tilde{\varphi}}{\tilde{\chi}+\tilde{\varphi}}$, where $\tilde{\chi} \equiv \chi / c_y$. Notice that for separable preferences in consumption and leisure, i.e. if $\nu = 0$, the Frisch elasticity, $(\varphi + \nu - \frac{\nu\tilde{\chi}}{\tilde{\chi}-\nu})^{-1}$, and the constant-consumption labor supply elasticity coincide at $1/\varphi$.

There are two assets, risk-free real bonds and shares. The household's period budget constraint is

$$B_t + v_t(N_t + N_{E,t})x_t + C_t + T_t = (1 + r_{t-1}) B_{t-1} + (1 - \delta)(v_t + d_t)(N_{t-1} + N_{E,t-1})x_{t-1} + w_t L_t.$$

Expenditure includes purchases of bonds B_t at the price of one currency unit and shares x_t at price v_t, consumption, and lump-sum taxes T_t. Income comprises gross interest income on bond holdings, dividends, the market value of share holdings, and wage income. The variable r_{t-1} denotes the real interest rate on holdings of bonds between $t-1$ and t. The number of producers is N_t, while the number of entrants is denoted $N_{E,t}$.[9] A fraction δ of firms exits the market each period, such that the value of firms $v_t N_t$ is multiplied by $(1 - \delta)$. Since the labor

[9]For expositional purposes, we refer to the measure of firms as 'number' of firms although strictly speaking, it is a continuous *mass*.

market is perfectly competitive, the real wage w_t is set equal to the marginal rate of substitution between leisure and consumption,

$$w_t = \frac{U_{l,t}}{U_{C,t}}. \quad (2)$$

The household chooses the stock of bonds and shares to maximize utility subject to the budget constraint, which results in the following optimality conditions,

$$1 = (1 + r_t)\, E_t\{\Lambda_{t,t+1}\} \quad \text{and} \quad v_t = (1 - \delta)\, E_t\left\{\Lambda_{t,t+1}(v_{t+1} + d_{t+1})\right\},$$

where $\Lambda_{t,t+1} = \beta \frac{U_{C,t+1}}{U_{C,t}}$ is the household's stochastic discount factor.

3.2 Production

Each firm produces a single goods variety under a production technology that is linear in labor and facing a fixed cost, $y_t = l_{C,t} - \phi$. Profits per firm are therefore $d_t = y_t - w_t l_{C,t}$. We now specify two ways in which intermediate goods are combined to produce a final goods bundle.

First, households consume a CES aggregate of N_t goods,

$$C_t = N_t^{\frac{1}{\theta-1}} \left(\int_0^{N_t} c_t(\omega)^{\frac{\theta-1}{\theta}}\, d\omega \right)^{\frac{\theta}{\theta-1}},$$

where the number of available goods indexed by $\omega \in (0, 1)$ is large and the elasticity of substitution across them is θ. Household demand functions for each individual good are $c_t(\omega) = (p_t(\omega)/P_t)^{-\theta} C_t$, where $p_t(\omega)$ is the price of variety ω and P_t is the price index. Note that our CES and Bertrand models are specified such that there is no love of variety.[10] The markup of goods prices over marginal cost,

$$\mu_t = \frac{1}{w_t}, \quad (3)$$

is constant, $\mu_t = \frac{\theta}{\theta-1}$. Denote by η_t the elasticity of the markup with respect to the number of goods and firms, which we call the 'competition effect',

$$\eta_t \equiv \frac{\partial \mu_t}{\partial N_t} \frac{N_t}{\mu_t}. \quad (4)$$

Since the markup is constant in the constant elasticity of substitution (CES) model, the competition effect is nil, $\eta_t = 0$.

[10] Love of variety implies that utility is increasing in the number of goods varieties, even if the total amount consumed is held fixed. With this model feature, the price level is decreasing in the number of available varieties.

Second, we assume an alternative market structure as in Devereux and Lee (2001) and Jaimovich and Floetotto (2008). There exists a large number of differentiated industries on the unit interval, indexed by $i \in (0,1)$. Within each industry, there is oligopolistic competition between a small and variable number of firms, indexed by $f = 1, \ldots, N_t$. The production functions of industrial goods $c_t(i)$ and of the final good C_t are, respectively,

$$c_t(i) = N_t^{\frac{1}{\theta_f - 1}} \left(\sum_{f=1}^{N_t} c_t(f)^{\frac{\theta_f - 1}{\theta_f}} \right)^{\frac{\theta_f}{\theta_f - 1}}, \quad C_t = \left(\int_0^1 c_t(i)^{\frac{\theta_i - 1}{\theta_i}} di \right)^{\frac{\theta_i}{\theta_i - 1}}.$$

Under Bertrand competition in prices, the markup varies negatively with the number of producers,

$$\mu_t = \frac{\theta_f - (\theta_f - \theta_i) \frac{1}{N_t}}{\theta_f - (\theta_f - \theta_i) \frac{1}{N_t} - 1},$$

and the competition effect is

$$\eta_t = \frac{(\theta_f - \theta_i) \frac{1}{N_t}}{\left[\theta_f - (\theta_f - \theta_i) \frac{1}{N_t} - 1\right] \left[\theta_f - (\theta_f - \theta_i) \frac{1}{N_t}\right]}.$$

Aggregate consumption output is firm output multiplied by the number of firms , $Y_t^C = y_t N_t$.[11]

3.3 Government

Government spending G_t is exogenous and follows a first order autoregressive process (in logarithms),

$$\ln G_t = (1 - \rho_g) \ln G + \rho_g \ln G_{t-1} + \varepsilon_t^g, \quad \varepsilon_t^g \sim N(0, \sigma_g). \tag{5}$$

The government finances its expenditure using lump sum taxes, such that its budget constraint is $G_t = T_t$ for all t. The government demands for the individual goods varieties are analogous to those of the household.

3.4 Frictionless Entry Model

The first model assumes full depreciation of firms each period ($\delta = 1$), which implies that entry costs are equivalent to fixed per-period production costs and that the number of entrants is identical to the number of producers, $N_{E,t} = N_t$. The aggregate number of hours worked in all

[11] The translog expenditure function of Bilbiie, Ghironi and Melitz (2012) also delivers a competition effect. With that approach, love of variety cannot be switched off and it becomes more cumbersome to compare model outcomes with the data. For expositional simplicity, we do not follow this route here.

firms coincides with total labor hours, $N_t l_{C,t} = L_t$. Also, total consumption output of all firms equals GDP, $N_t y_t = Y_t$. Total output is used for private and public consumption,

$$Y_t = C_t + G_t. \tag{6}$$

The aggregate production function reads

$$Y_t = L_t - \phi N_t. \tag{7}$$

Firm entry drives profits to zero each period, $d_t = 0$ for all t, and consequently, firm value is also zero at all times, $v_t = 0$ for all t. Combining the production function with the profit function and the definition of the markup, and setting firm profits to zero, we derive the firm-level zero-profit condition $(\mu_t - 1)\, y_t = \phi$. Multiplying this equation by the numbers of firms yields the aggregate free-entry condition that determines the number of firms/entrants,

$$(\mu_t - 1)\, Y_t = \phi N_t. \tag{8}$$

We linearize the labor supply relation (2), the price setting equation (3), the competition effect (4), aggregate expenditure (6), the aggregate production function (7), and the aggregate free-entry condition (8). Tables 4 and 5 summarize the steady state and the six linearized model equations that jointly determine $\hat{L}_t$, $\hat{w}_t$, $\hat{\mu}_t$, $\hat{C}_t$, $\hat{Y}_t$, and $\hat{N}_t$, where $c_y = \frac{C}{Y}$ is the steady state share of private consumption in total output.

[insert Tables 4 and 5 here]

3.5 Dynamic Entry Model

In our second model, the fraction δ of producers and entrants that are hit by an exit shock is below unity, such that the entry decision is dynamic. In addition, it takes one period before an entrant turns into an operational firm. The number of firms becomes a predetermined state variable, which is consistent with the observation that the stock of producers reacts only sluggishly to shocks. Entry costs are sunk costs incurred only once at the beginning of the firm's existence. Consistent with the data, this model variant predicts procyclical profits.

Every period, there exists a mass N_t of firms and an infinite mass of potential entrants. The sunk entry cost is a Cobb-Douglas function of materials and labor, $y_{E,t}^{\alpha} l_{E,t}^{1-\alpha}$, where $\alpha \in [0, 1]$. The demand for materials, $l_{E,t}$, is composed of the same basket of varieties as consumption. Entrants minimize total entry costs $w_t l_{E,t} + y_{E,t}$ with respect to $l_{E,t}$ and $y_{E,t}$, which implies the factor demands $w_t = (1 - \alpha)\, mc_{E,t}(y_{E,t}/l_{E,t})^{\alpha}$ and $1 = \alpha mc_{E,t}(y_{E,t}/l_{E,t})^{\alpha-1}$, where the cost of producing a firm is $mc_{E,t} = w_t^{1-\alpha}/[(1-\alpha)^{1-\alpha}\,\alpha^{\alpha}]$. Firms produce each period until they are hit by an exit shock, which occurs with a probability $\delta \in (0,1]$ each period and affects established and newly created firms equally. Entry occurs until firm value and entry costs are equalized, such that the free-entry condition is $v_t = mc_{E,t}$. The number of producers in period t is

$$N_t = (1-\delta)\,(N_{t-1} + N_{E,t-1}).$$

The aggregate production functions for consumption goods, Y_t^C, and new firms, $N_{E,t}$, are

$$Y_t^C = L_{C,t}, \quad \text{and} \quad N_{E,t} = Y_{E,t}^{\alpha} L_{E,t}^{1-\alpha},$$

where fixed costs are set equal to zero. Labor is used in the production of consumption goods, $L_{C,t} = N_t l_{C,t}$, and in the production of new firms, $L_{E,t} = N_{E,t} l_{E,t}$. The aggregate market clearing condition for consumption goods is $Y_t^C = C_t + G_t + Y_{E,t}$. Aggregating budget constraints of households, imposing bond market clearing $B_t = B_{t-1} = 0$, and using $T_t = G_t$ yields the aggregate accounting identity for GDP,

$$Y_t \equiv Y_t^C + w_t L_{E,t} = N_t d_t + w_t L_t. \tag{9}$$

Total consumption (private and public) plus investment (in new firms) must equal total income (dividend income plus labor income). A labor market equilibrium implies $L_t = L_{C,t} + L_{E,t}$.

4 The Effects of Government Spending Shocks

To study numerically the effects of a change in government spending, we calibrate the model as follows. We impose a period utility function that is separable in its two arguments and logarithmic in consumption, $E_0 \sum_{t=0}^{\infty} \beta^t \left(\ln C_t - \zeta \frac{L_t^{1+\varphi}}{1+\varphi} \right)$, where ζ is the weight on leisure in utility and φ is the inverse Frisch elasticity of labor supply to the real wage. We set the parameter ζ such that steady state labor supply L is normalized to 0.25. The benchmark Frisch elasticity is set to $1/\varphi = 4$; we analyze the sensitivity of our results to this parameter. Our benchmark value implies that labor supply is rather elastic. As we shall see, even such a high elasticity proves insufficient to replicate the empirical patterns discussed in Section 2. We set the elasticity of substitution θ in the CES model to 3.8 as in Bilbiie, Ghironi and Melitz (2012), which implies a steady state markup of 36%. The elasticity of substitution between goods within an industry θ_f in the dynamic Bertrand model is adjusted to make the steady state markup equal to the one in the CES model, $\mu = \frac{\theta}{\theta-1}$. The resulting value is $\theta_f = 6.67$. The substitution elasticity across industries is $\theta_i = 1.001$, such that $\theta_f > \theta_i$. The overhead cost ϕ is set to 18% of output in the frictionless model and to zero in the dynamic model; this calibration ensures that the steady state markup is equalized across the frictionless and dynamic model variants. This value is slightly higher than the estimates of fixed costs in US industries provided by Domowitz, Hubbard and Petersen (1988) which range from around 5% to 17% with a mean (median) value of 11% (10%). However, these authors point out that their estimates probably underestimate the true degree of fixed costs.

In the dynamic model, we have to calibrate three additional parameters. The discount factor is set to $\beta = 0.99$, such that the steady state annual real interest rate is 4%. We set a conventional value for the firm exit rate, $\delta = 0.025$. Finally, setting $\alpha = \{0, 1\}$ allows us to nest the two specifications considered by Bilbiie, Ghironi and Melitz (2008): the benchmark case where entry is subject to a labor requirement, as well as the case where entry costs are materials costs specified in terms of final output.

4.1 Responses in Frictionless Entry Model

The frictionless entry model is simple enough to provide analytical results and a graphical illustration of the effects at work, following in spirit the example in Corsetti and Pesenti (2007). First, combining labor supply with the price setting condition to substitute out the real wage, replacing $\hat{\mu}_t$ with $-\eta\hat{N}_t$ from the definition of the competition effect, and eliminating the number of firms by using the free-entry condition, we obtain the labor market equilibrium (LL) relation

$$\hat{C}_t = \frac{1}{\chi}\left(\frac{(\mu-1)\eta}{\mu-1+\eta} - \tilde{\varphi}\right)\hat{L}_t. \tag{10}$$

In general, provided that $\chi > 0$, the LL curve is upward-sloping in ($\hat{L}_t$,$\hat{C}_t$)-space if $\frac{(\mu-1)\eta}{\mu-1+\eta} - \tilde{\varphi} > 0$. In the CES model where $\eta = 0$, the LL curve is upward sloping only if the inverse of the constant-consumption labor supply elasticity, $\tilde{\varphi}$, is negative. Recall that $\tilde{\varphi} < 0$ violates the parameter restrictions required for non-inferiority and concavity.

Let us consider as a benchmark the model with separability in consumption and leisure ($\nu = 0$, such that $\tilde{\varphi} = \varphi$) and logarithmic consumption utility ($\chi = 1$). In this model, the LL curve is upward-sloping if at least one of two conditions are satisfied: (1) there is a sufficiently large competition effect (η is large), (2) labor supply is sufficiently elastic (φ is small).

Second, setting total expenditure equal to total production, replacing $\hat{\mu}_t$ and $\hat{N}_t$ using respectively the competition effect and the free-entry condition, we can characterize the goods market equilibrium (GG) by

$$\hat{C}_t = \frac{(\mu-1)+\mu\eta}{[(\mu-1)+\eta]\,c_y}\hat{L}_t - \frac{1-c_y}{c_y}\hat{G}_t. \tag{11}$$

Consider Figure 5 with labor on the horizontal axis and consumption on the vertical axis. The goods market equilibrium (11) is represented by an upward-sloping curve, which is the same in both panels. In the left panel, the LL curve is upward-sloping. The opposite is true in the right panel. Suppose there is a positive government spending shock, $\hat{G}_t = 1$. The GG curve shifts down by $\frac{1-c_y}{c_y}$ which is below unity for typical calibrations in which the government spending share in output is less than one half. The equilibrium moves from point E_0 to point E_1. In the left panel, consumption *increases* in response to the shock. In the right panel, consumption *decreases*; the movement along the unchanged LL curve represents the crowding-out effect on consumption.

[insert Figure 5 here]

We can derive analytically the response coefficients of output, the number of firms, and consumption to government spending shocks,

$$\hat{Y}_t = \frac{1-c_y}{1-c_y\Phi}\hat{G}_t > 0,$$

$$\hat{N}_t = \frac{\mu-1}{\mu-1+\eta\mu}\hat{Y}_t > 0,$$

$$\hat{C}_t = \frac{1-c_y}{c_y}\left(\frac{1}{1-c_y\Phi}-1\right)\hat{G}_t \lesseqgtr 0,$$

where

$$\Phi = \frac{(\mu-1)\eta - \varphi\left[(\mu-1)+\eta\right]}{(\mu-1)+\mu\eta}.$$

Notice that, irrespective of the calibration of the frictionless model, output and the number of firms respond positively to the shock, in accordance with our VAR evidence. However, depending on parameter values, consumption may be crowded out by the expansion in government spending. We can derive an upper bound on the inverse Frisch elasticity of labor supply for which consumption reacts positively to the government spending shock. This is the case for $\Phi > 0$, which is equivalent to the condition for an upward-sloping LL curve. The threshold depends on the steady state markup and on the size of the competition effect. Notice that, for a constant markup μ, the threshold is a positive function of the steady state competition effect. Let $F = \log(\bar{\varphi})$ and so $\frac{\partial \log F}{\partial \eta} = \frac{1}{\eta} - \frac{1}{(\mu-1)+\eta} > 0$. In the Bertrand model, both μ and η are functions of the within-industry substitution elasticity θ_f. In the remainder of this section, we analyze numerically how the threshold changes when we vary θ_f in a plausible range.

To start with, we compute the threshold inverse Frisch elasticity under the benchmark calibration in the CES and Bertrand frameworks. Under CES preferences, the competition effect is nil, $\eta = 0$. Therefore, the threshold $\bar{\varphi}$ is zero (implying an infinitely elastic labor supply) and the condition for consumption crowding-in cannot be satisfied. The threshold in the model with Bertrand competition and $\theta_f = 6.67$ is $\bar{\varphi} = 0.1537$, implying a minimum Frisch elasticity of around 6.5. The difference between the threshold values can be explained by the countercyclical markup movement in the Bertrand model coming from the competition effect.

These required Frisch elasticities, $1/\varphi$, are very high compared with existing empirical evidence based on microeconomic estimates. In their survey, Keane and Rogerson (2012) pick three Frisch elasticity estimates based on life-cycle models: 0.09, 0.15, and 0.31. They then argue that certain extensions to the basic model, e.g. the introduction of capital accumulation, may lead to higher estimates of $1/\varphi$, thereby reconciling the tension between micro-based estimates and parameter calibrations in representative-agent macro models. However, they regard values in the range of 1 to 2 as typical in macro models, which is still much lower than our threshold values.

We now vary the within-industry substitution elasticity θ_f and investigate whether a higher competition effect η can produce a higher threshold $\bar{\varphi}$ and thus a lower Frisch elasticity needed to obtain consumption crowding-in. In Figure 6 we vary the parameter θ_f within the interval $(2, 20)$ and compute the corresponding values for the markup μ, the competition effect η and the threshold $\bar{\varphi}$. Given the estimates in Broda and Weinstein (2006), we regard this as a plausible parameter range.

[insert Figure 6 here]

As the figure shows, the competition effect becomes stronger as we raise θ_f. However, since the markup goes down as goods become more substitutable, the rise in the competition effect and thus the threshold is limited. For a substitution elasticity as high as $\theta_f = 20$, the threshold is still only $\bar{\varphi} = 0.1718$.

The Bertrand model therefore does not deliver a competition effect that is strong enough to overturn the consumption crowding-out response to spending expansions. Empirical evidence based on identified monetary policy shocks is consistent with the notion of a small competition effect, see Lewis and Poilly (2012).

4.2 Responses in Dynamic Entry Model

In the *dynamic* model, government spending is assumed to follow a first-order autoregressive process with persistence ρ_g and innovation standard deviation σ_g as in (5). The stock of firms does not depreciate fully each period ($0 < \delta < 1$), such that N_t becomes a state variable. The size of the shock persistence parameter turns out to be a crucial determinant of the entry response. The more persistent is the fiscal expansion, the greater the expected discounted value of the future profit stream generated by the additional demand, and the higher the incentives to enter the market.

Figure 7 depicts the impulse responses of GDP (Y_t), consumption (C_t), firm entry ($N_{E,t}$), and the markup (μ_t) to a one standard deviation shock in government spending, where $\sigma_g = 0.01$ and the persistence of the process is set to three different values, $\rho_g = 0.5$, $\rho_g = 0.9$, and $\rho_g = 0.99$. Unless indicated otherwise, we assume Bertrand competition as the prevailing market structure. Since there exists a competition effect under Bertrand competition and not under monopolistic competition, this assumption gives the model the greatest chance to generate a rise in the real wage and therefore a crowding-in of consumption.

[insert Figure 7 here]

We observe that entry rises only if government spending is highly persistent ($\rho_g = 0.9$ or $\rho_g = 0.99$), and therefore expected profits rise by a sufficiently large amount to stimulate entry. This is consistent with Finn (1998), who shows that the more persistent is the shock to g_t, the more likely it is that capital investment rises, too. In the data, government spending appears to be highly persistent as we can observe from Figures 1 to 3. Using Bayesian techniques, Smets and Wouters (2007) estimate a value of 0.97 for the autoregressive coefficient on spending shocks. In the Bertrand model with a competition effect, the markup falls when firm entry increases. Thus the real wage, which equals the inverse of the markup, rises. For conventional values of the Frisch labor supply elasticity ($1/\varphi \leq 4$) the model produces a drop in consumption, which is inconsistent with the empirical evidence shown in Section 2. The reason is that the wealth effect is increasing in the persistence of the government spending expansion (Baxter and King, 1993; Finn, 1998).

To conclude, we note that higher shock persistence is like a double-edged sword: it increases the present discounted value of profits and hence the incentives for a firm to enter, but at the same time it increases the wealth effect, which makes consumption crowding-out more likely. In the dynamic model under our baseline calibration, an accelerator effect on firm entry and a crowding-in of consumption can be obtained simultaneously only if the shock is sufficiently persistent and labor supply is *extremely* elastic.

4.3 Model Extensions

The main insight from the exercise in the frictionless model is that the Frisch elasticity needs to be implausibly high for consumption to react positively to a fiscal expansion. It is well known that the canonical real business cylce model and the standard New Keynesian model are not able to generate a crowding-in of private consumption. A substantial research effort has tried to extend the models in numerous ways so as to overcome this inconsistency. We consider three such extensions here. The first is the introduction of rule-of-thumb consumers as in Galí, López-Salido and Vallés (2007). The second is the utility function in Greenwood, Hercovitz and Huffman (1988) which exhibits no wealth effect on labor supply. This form of preferences generates a rise in real wages and consumption in response to a positive government spending shock in the standard New Keynesian model, as shown by Monacelli and Perotti (2008). The third model extension is utility-enhancing government spending as in Linnemann and Schabert (2004).

As mentioned above, the negative wealth effect of a rise in government spending shifts out the labor supply curve and lowers real wages, a result which can be overturned through a mechanism that shifts out the labor demand curve such that real wages ultimately rise. In Galí, López-Salido and Vallés (2007), a rise in real wages boosts the consumption of households that have no access to a savings technology and for which consumption is mainly determined by their current labor income. In Monacelli and Perotti (2008), a rise in real wages overturns the negative wealth effect because the substitution away from leisure towards consumption is strong enough.

In both models, the countercyclical movement of the markup, which leads to a real wage increase, is driven by *sticky prices*. In our setup, prices are flexible, but markups are nevertheless countercyclical due to the *competition effect*. One might therefore expect a similar mechanism to arise in our model. As we will show, rule-of-thumb consumers and GHH preferences induce a drop in entry and an associated fall in real wages and consumption. Allowing for price stickiness does not alter this finding.

Rule-of-Thumb Consumers

In the first model extension, we stipulate that a constant fraction λ of agents do not have access to financial markets and therefore cannot engage in consumption smoothing. These agents do not save or borrow, but simply consume their entire income, net of taxes, each period. Formally, indexing these rule-of-thumb consumers (RTC) with a subscript 'n', we have $B_{n,t} = N_{n,t} = 0$ and the budget constraint $C_{n,t} + T_n = w_t L_{n,t}$. Taxes on rule-of-thumb consumers are assumed constant. This assumption gives the model the best chance at raising $C_{n,t}$ and hence economy-wide consumption. Aggregating over the two types of households yields $C_t = \lambda C_{n,t} + (1-\lambda) C_{o,t}$, where optimizing (Ricardian) households are denoted with an 'o'-subscript. Analogous equations exist that define total labor supply and total lump-sum taxes.

Galí, López-Salido and Vallés (2007) show that under a sufficiently high proportion of rule-of-thumb consumers, government spending expansions lead to a rise in aggregate consumption. The mechanism is the following. Since prices are sticky and do not immediately increase, markups fall in response to a positive government spending shock. Markups are inversely related to real marginal costs, which in this simple setup coincide with the real wage. The labor demand curve shifts out and the real wage rises, which has a positive effect on consumption of rule-of-thumb agents. If there are enough of these agents, total consumption increases.

In Figure 8, we plot the impulse response function of GDP, consumption ($C_{n,t}$, $C_{o,t}$, and C_t), and entry for different values of the fraction of rule-of-thumb consumers: $\lambda = 0.1$, $\lambda = 0.5$, and $\lambda = 0.8$. Entry costs are specified in terms of labor units, $\alpha = 0$. Importantly, the persistence of the spending shock is set to $\rho_g = 0.9$.

[insert Figure 8 here]

Remarkably, the Galí, López-Salido and Vallés (2007)-result does not prevail in our setup. Consumption falls even in the case where rule-of-thumb consumers dominate, $\lambda = 0.8$. To see why this is so, notice that firm entry responds less positively, and indeed declines, the larger is λ. The reason is that firm entry reflects an investment activity which is confined to Ricardian households. The fewer of them there are, the less investment responds to the rise in profit opportunities that accrue only in future periods. Markups increase as entry falls, which shifts inward the labor demand curve and reduces the real wage, such that consumption, by rule-of-thumb consumers and overall, falls.

To summarize, the introduction of non-Ricardian 'rule-of-thumb' households does not help to generate consumption crowding-in, unlike in the no-entry model of Galí, López-Salido and Vallés (2007). We carried out two robustness checks on this result.[12] First, whether we specify entry costs as labor costs ($\alpha = 0$) or materials costs ($\alpha = 1$) does not change the relevant impulse responses qualitatively. Second, dropping the time-to-build lag in extensive-margin investment and assuming instead instantaneous entry leaves our conclusion unaltered.

Complementarity between Labor and Consumption

In a second model variant, we assume non-separable preferences in the spirit of Greenwood, Hercovitz and Huffman (1988), henceforth GHH. Under GHH preferences, the wealth effect is shut off, which raises the probability of obtaining consumption crowding-in in a model with countercyclical markups, see Bilbiie (2011) and Monacelli and Perotti (2008). Consider the following utility function,

$$U\left(C_t, L_t\right) = \ln\left(C_t - \frac{\zeta}{1+\tilde{\varphi}} L_t^{1+\tilde{\varphi}}\right),$$

[12]Results are available from the authors upon request.

where $U_{Cl,t} = \zeta L_t^{\tilde{\varphi}} U_{CC,t} < 0$. Under this specification, labor and consumption are complements ($\nu < 0$) and the wealth effect on labor supply is zero ($\chi = 0$). The labor supply equation is $w_t = \zeta L_t^{\tilde{\varphi}}$, where $\tilde{\varphi}$ is the inverse of the Frisch elasticity which is equal to the constant-consumption labor supply elasticity since $\chi = 0$. Consider first the frictionless entry model and recall the labor market equilibrium (LL) relation $\chi \hat{C}_t = \left(\frac{(\mu-1)\eta}{\mu-1+\eta} - \tilde{\varphi} \right) \hat{L}_t$. Note that if $\chi = 0$, the LL curve is vertical at $\hat{L}_t = 0$. Labor, and hence output, the number of firms and real wages, remain unchanged in response to an increase in government spending. Consumption is thus fully crowded out, regardless of the size of the labor supply elasticity or the competition effect.

Turning to the dynamic model, we find that entry falls in response to a fiscal expansion when the wealth effect is turned off, independently of the persistence of the shock. The drop in entry raises the markup, which shifts inward the labor demand curve. Real wages and consumption decline. Recall that the Frisch elasticity is set to 4 and the market structure is one of Bertrand competition. Neither the size of the Frisch elasticity nor the specification of entry costs are driving this finding.

To summarize, a preference specification with a zero wealth effect on labor supply does not help to generate a joint rise of extensive-margin investment and consumption in response to an increase in government spending.

Sticky Prices

In the two preceding sections, we combined features that lower the wealth effect with our countercyclical markup mechanism working through firm entry and the competition effect. In models where markup countercyclicality is driven by sticky prices, these wealth-effect-reducing features lead to the desired consumption crowding-in result. In our model, they do not. We now introduce price setting frictions in our model and analyze whether sticky price and the competition effect jointly can generate crowding-in. To this end, we introduce quadratic price adjustment costs à la Rotemberg (1982). The profit maximization problem of the representative firm producing variety ω becomes

$$\max_{\{p_t(\omega)\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta_{0,t} \left[\frac{p_t(\omega)}{P_t} - w_t - \frac{\kappa}{2} \left(\frac{p_t(\omega)}{p_{t-1}(\omega)} - 1 \right)^2 \right] y_t(\omega), \tag{12}$$

subject to the demand constraint $y_t(\omega) = (p_t(\omega)/P_t)^{-\varepsilon_t} Y_t^C$, where ε_t is the price-elasticity of demand. In the CES model, $\varepsilon_t = \theta$. In the Bertrand model, $\varepsilon_t = \theta_f - (\theta_f - \theta_i) \frac{1}{N_t}$. The last term in the square brackets in (12) captures price adjustment costs. Under symmetry, the first order condition for prices is

$$\pi_t\left(\pi_t - 1\right) = \frac{\varepsilon_t}{\kappa}\left(w_t - \frac{1}{\mu_t}\right) + E_t\left\{\Lambda_{t,t+1}\pi_{t+1}\left(\pi_{t+1} - 1\right)\frac{y_{t+1}}{y_t}\right\},$$

where $\mu_t = \varepsilon_t/(\varepsilon_t - 1)$ is the desired markup. Monetary policy is described by a simple interest rate feedback rule, $\hat{R}_t = \tau\hat{\pi}_t$, where τ is set to satisfy the Taylor Principle, in particular $\tau = 1.5$. We intentionally do not allow for any feedback of monetary policy on output, because a positive feedback coefficient makes crowding-out of consumption more likely. Moreover, Hall (2009) argues that it is not necessary to take separate stands on the various features of a nominal model, such as the frequency of price adjustment or the central bank's reaction function. What matters for fiscal multipliers is the reduction in the markup when output expands.

In the baseline dynamic entry model, we find that introducing price adjustment costs does not overturn the negative consumption response (figure not shown). Interestingly, price stickiness boosts (respectively: dampens) the response of firm entry relative to the benchmark model in the case where entry costs are specified in terms of materials (respectively: labor units).

We now combine price stickiness with the two wealth-effect-reducing features. Figure 9 shows the impulse response functions of the CES model together with the Bertrand model. The top panel (9a) shows the sticky-price version of the model with rule-of-thumb consumers, where their share is set to $\lambda = 0.9$. The bottom panel (9b) shows the sticky-price model with GHH preferences.

[insert Figure 9 here]

As in the flexible-price economy described above, firm entry falls. In the CES model, the desired markup is constant and the only markup variation stems from price stickiness. The countercyclical response of the actual markup leads to a rise in consumption, as shown by Galí, López-Salido and Vallés (2007) and Monacelli and Perotti (2008), respectively. However, if there is a competition effect, as in the Bertrand model, the rise in the desired markup outweighs the drop in the markup due to price stickiness. As a consequence, the actual markup rises and consumption falls.[13]

In sum, our results reveal that the competition effect impedes the crowding-in of consumption in a sticky-price economy with GHH preferences or rule-of-thumb consumers.

[13] In Galí, López-Salido and Vallés (2007), investment in physical capital falls for a large fraction of rule-of-thumb consumers. However, in their model there is no link going from investment to consumption via markups and the real wage as there is here.

Complementarity between Public and Private Consumption

In this section, we consider complementarity between public and private consumption, which has proved to be able to generate a consumption crowding-in within no-entry models (Bouakez and Rebei, 2007; Linnemann and Schabert, 2004).

We assume that consumption utility is derived from a composite of private and public consumption,

$$\tilde{C}_t = \left[\xi C_t^{\gamma} + (1-\xi) G_t^{\gamma}\right]^{\frac{1}{\gamma}},$$

where $\gamma \in (-\infty, 1)$ and $\xi \in (0, 1]$. The elasticity of substitution between private and public goods is $\frac{1}{1-\gamma}$. The benchmark model in which government spending does not provide utility is given by $\xi = 1$. We continue to assume that utility is logarithmic in the composite, $U(\tilde{C}_t) = \ln \tilde{C}_t$, and additively separable in composite consumption and leisure. In steady state, we have $1 = \xi c_C + (1-\xi) c_G$, where we define $c_C = (C/\tilde{C})^{\gamma} > 0$ and $c_G = (G/\tilde{C})^{\gamma} > 0$. The marginal utility of private consumption is $U_{C,t} = \xi C_t^{\gamma-1} \tilde{C}_t^{-\gamma}$. We restrict attention to the case where public and private consumption are complements; the marginal utility of private consumption is increasing in government spending. Formally, in the log-utility case complementarity is obtained if $\frac{\partial U_{C,t}}{\partial G_t} > 0$, which is the case if $\gamma < 0$.

To illustrate how this utility specification can generate consumption crowding-in, we first go back to the frictionless entry model. In linearized form, the labor-consumption tradeoff equation becomes

$$\hat{w}_t = \varphi \hat{L}_t + \hat{C}_t + \gamma (1 - \xi c_C)(\hat{G}_t - \hat{C}_t),$$

and we obtain the new labor market equilibrium (LL) relation

$$\hat{C}_t = \frac{\frac{(\mu-1)\eta}{\mu-1+\eta} - \varphi}{1 - \gamma(1-\xi c_C)} \hat{L}_t - \frac{\gamma(1-\xi c_C)}{1-\gamma(1-\xi c_C)} \hat{G}_t,$$

which is drawn as the bold-faced LL curve in Figure 5. Suppose that labor supply is not very elastic, such that φ is large and $\frac{(\mu-1)\eta}{\mu-1+\eta} < \varphi$. Then the LL curve is downward-sloping as $1 - \gamma(1-\xi c_C) > 0$, since $(1-\xi c_C) > 0$ and $\gamma < 0$. Unlike in the benchmark model with wasteful government spending ($\xi = 1$), the LL curve *shifts* in response to a change in government spending. This is because a rise in government spending increases the marginal utility of private consumption. As a result, households substitute away from leisure into consumption and supply more labor. The LL curve shifts upwards. As in the benchmark model, the goods market equilibrium (GG) schedule (11), shifts down. Thus, there are two opposing effects on consumption. The rightward shift of the LL curve can induce a crowding-in of consumption. In particular, for a given value of ξ, the more negative is γ, the flatter is the LL curve and the larger is the shift in the LL curve:

$$\lim_{\gamma \to -\infty} \frac{\frac{(\mu-1)\eta}{\mu-1+\eta} - \varphi}{1-\gamma\left(1-\xi c_C\right)} = 0 \quad \text{and} \quad \lim_{\gamma \to -\infty} \frac{-\gamma\left(1-\xi c_C\right)}{1-\gamma\left(1-\xi c_C\right)} = 1.$$

Higher complementarity between private and public consumption increases the consumption multiplier through its effect on both the slope and the shift of the LL curve. Complementarity between C_t and G_t allows us to reduce considerably the labor supply elasticity required for a positive consumption response to a fiscal stimulus, consistent with our evidence. For instance, suppose $\gamma = -0.5$. Then to obtain a crowding-in effect on consumption, φ must be smaller than 1.11 in the Bertrand model and 0.63 in the CES model.

Let us now turn to the dynamic entry model. The only change to the model relates to the marginal utility of private consumption as discussed above. Figure 10 displays impulse response functions of Y_t, C_t, $N_{E,t}$ and μ_t to a government spending shock under three assumptions for the degree of complementarity, $\gamma = -1$, $\gamma = -0.5$, and $\gamma = 0$. The share parameter in the consumption composite is set to $\xi = 0.8$.

[insert Figure 10 here]

As demonstrated in the frictionless model, consumption reacts positively if public and private goods are sufficiently complementary. Firm entry rises due to our assumption of a sufficiently persistent government spending shock. Notice that a rising degree of complementarity (more negative γ) boosts the firm entry response. The reason is that under a fairly elastic labor supply, as under our baseline calibration, households are not forced to cut back on extensive-margin investment in order to satisfy their increased consumption demand.

The question arises whether complementarity between private and public consumption is a plausible assumption. The empirical evidence on this matter is inconclusive. While Aschauer (1985) finds that private and public consumption are substitutes, Amano and Wirjanto (1998) find that they are unrelated (in the sense that the marginal utility of private consumption does not depend on government spending). By contrast, the estimates of Bouakez and Rebei (2007) or Karras (1994) support the assumption that private and public consumption are complements.

To conclude, complementarity between public and private consumption, while empirically debated, reconciles theory and evidence on the joint dynamics of private consumption and extensive-margin investment after a government spending shock.

5 Conclusion

We estimate the effects of government spending shocks in US data, using a vector autoregression analysis. Net firm entry and consumption both rise in response to spending expansions. Business cycle models with endogenous entry struggle to explain this pattern. In a frictionless entry model with full depreciation of the stock of firms each period, entry reacts positively to the shock, but consumption falls for conventional values of the Frisch elasticity of labor supply. In a dynamic entry model, the number of firms rises only if the spending shock is sufficiently persistent. However, even in that case, consumption falls due to strong wealth effects of expected future tax increases to finance the current rise in spending. We introduce two additional features that help to reduce the wealth effect in models with a constant number of producers. First, the presence rule-of-thumb agents who consume their entire income each period does not bring the model closer to the data. This is because such agents do not invest in new firms and therefore this model extension leads to a counterfactual drop in entry. Second, we introduce a particular preference specification which allows us to switch off the wealth effect. In the model variant with flexible prices, entry falls, such that markups rise and consumption contracts. This negative consumption response cannot be overcome through the introduction of price rigidities. To predict a rise in both entry and consumption, the model needs either an extremely elastic labor supply or utility-enhancing government spending.

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Table 1. Empirical Results on the Effects of Government Spending Expansions in the US

Study	Consumption Response	Investment Response
Blanchard and Perotti (2002)	positive	negative
Alesina et al (2002)	n.a.	negative
Galí, López-Salido and Vallés (2007)	positive	insignificant
Caldara and Kamps (2008)	positive	n.a.
Monacelli and Perotti (2008)	positive	negative
Mountford and Uhlig (2009)	positive	negative
Fisher and Peters (2010)	positive	n.a.
Ramey (2011)	negative	negative
Ravn, Schmitt-Grohé and Uribe (2012)	positive	n.a.

Table 2. Data

Standard macroeconomic variables	Data Range	Source	Weblink
(1): Gross Domestic Product	1948q1-2011q2	BEA	research.stlouisfed.org/fred2/series/GDP
(2): Personal Cons. Expenditures: Services	1948q1-2011q2	BEA	research.stlouisfed.org/fred2/series/PCESV
(3): Personal Cons. Expenditures: Nondurable Goods	1948q1-2011q2	BEA	research.stlouisfed.org/fred2/series/PCND
(4): Government Cons. Expenditures & Gross Investment	1948q1-2011q2	BEA	research.stlouisfed.org/fred2/series/GCE
(5): Government Current Receipts	1948q1-2011q2	BEA	research.stlouisfed.org/fred2/series/GRECPT
(6): Gross Domestic Product: Implicit Price Deflator	1948q1-2011q2	BEA	research.stlouisfed.org/fred2/series/GDPDEF
(7): Civilian Noninstitutional Population	1948q1-2011q2	BLS	research.stlouisfed.org/fred2/series/CNP16OV
Extensive margin variables	**Data Range**	**Source**	**Weblink**
(8): New Incorporations	1948q1-1996q3	BEA	www.bea.gov/scb/pdf/NATIONAL/...
(9): Net Business Formation	1948q1-1995q3	BEA	...BUSCYCLE/1994/1194cpgs.pdf (page C-29)

Data sources: BEA: U.S. Department of Commerce: Bureau of Economic Analysis. BLS: U.S. Department of Labor: Bureau of Labor Statistics. ERP: Economic Report of the President (1966 and 2004). *Data series:* Real GDP is [(1)/(6)]/(7). Real consumption is [(2+3)/(6)]/(7). Real government spending is [(4)/(6)]/(7). Real government revenues are [(5)/(6)]/(7). As our measure of the extensive margin we use the series (8) and (9).

Table 3. Identifying Sign Restrictions

	g_t	y_t	c_t	z_t	rev_t	$g_t - rev_t$
Business Cycle Shock		+	+	+	+	
Government Spending Shock	+	+				+

Table 4. Steady State

$w = \dfrac{U_l}{U_C} = \begin{cases} \zeta L^{\varphi} C & \text{(log-separable preferences)} \\ \zeta L^{\tilde{\varphi}} & \text{(GHH preferences)} \end{cases}$	Labor supply
$\mu = \dfrac{1}{w}$	Price setting
$\mu = \begin{cases} \frac{\theta}{\theta-1} & \text{(CES)} \\ \frac{\theta_f-(\theta_f-\theta_i)\frac{1}{N}}{\theta_f-(\theta_f-\theta_i)\frac{1}{N}-1} & \text{(Bertrand)} \end{cases}$	Markup
$\eta = \begin{cases} 0 & \text{(CES)} \\ \frac{(\theta_f-\theta_i)\frac{1}{N}}{\left[\theta_f-(\theta_f-\theta_i)\frac{1}{N}-1\right]\left[\theta_f-(\theta_f-\theta_i)\frac{1}{N}\right]} & \text{(Bertrand)} \end{cases}$	Competition effect
Frictionless Entry Model	
$Y = C + G$	Goods market clearing
$Y = L - \phi N$	Production function
$(\mu - 1)Y = \phi N$	Free entry condition
Dynamic Entry Model	
$Y^C = C + G + Y_E$	Goods market clearing
$Y^C = L_C - \phi N$	Production function
$v = w^{1-\alpha}/[(1-\alpha)^{1-\alpha}\,\alpha^{\alpha}]$	Free entry condition
$N_E = Y_E^{\alpha} L_E^{1-\alpha}$	Entrants
$\dfrac{v}{d} = \dfrac{\beta(1-\delta)}{1-\beta(1-\delta)}$	Optimal share holdings
$Y^C + wL_E = dN + wL$	Aggregate accounting
$Y = Y^C + wL_E$	Gross domestic product
$N = \frac{1-\delta}{\delta} N_E$	Law of motion for firms
$dN = Y^C - wL_C$	Aggregate profits
$L = L_C + L_E$	Labor market clearing

In the *frictionless* entry model, we have a system of 7 equations that determines the 7 steady state variables L, w, μ, η, C, Y, N, given parameter values for ζ, φ ($\tilde{\varphi}$), ϕ, and θ (in the CES model) or θ_f and θ_i (in the Bertrand model).
In the *dynamic* entry model, we have a system of 14 equations that determines the 14 steady state variables L, w, μ, η, and C, L_C, N_E, Y_E, v, Y_C, Y, N, d, L_E, given parameter values for ζ, φ ($\tilde{\varphi}$), ϕ, and θ (in the CES model) or θ_f and θ_i (in the Bertrand model), as well as α, β, δ.

Table 5. Linearized Frictionless Entry Model

$\hat{w}_t = \chi \hat{C}_t + \tilde{\varphi} \hat{L}_t$	Labor supply
$\hat{\mu}_t = -\hat{w}_t$	Price setting
$\hat{\mu}_t = -\eta \hat{N}_t$	Competition effect
$\hat{Y}_t = c_y \hat{C}_t + (1 - c_y)\, \hat{G}_t$	Aggregate demand
$Y \hat{Y}_t = L \hat{L}_t - \phi N \hat{N}_t$	Aggregate production function
$(\mu - 1) Y \hat{Y}_t + Y \mu \hat{\mu}_t = \phi N \hat{N}_t$	Aggregate free entry condition

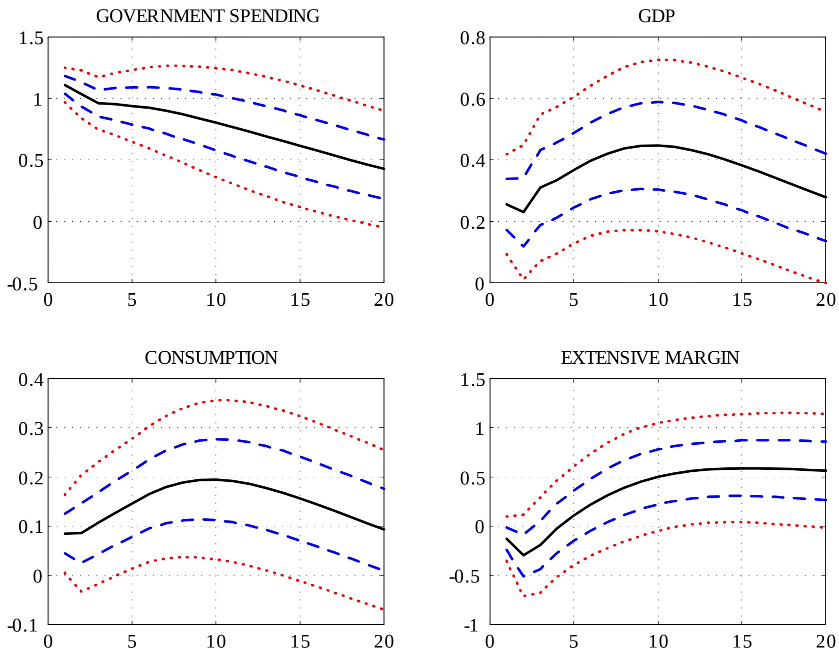


Figure 1a: Blanchard-Perotti VAR with Net Business Formation

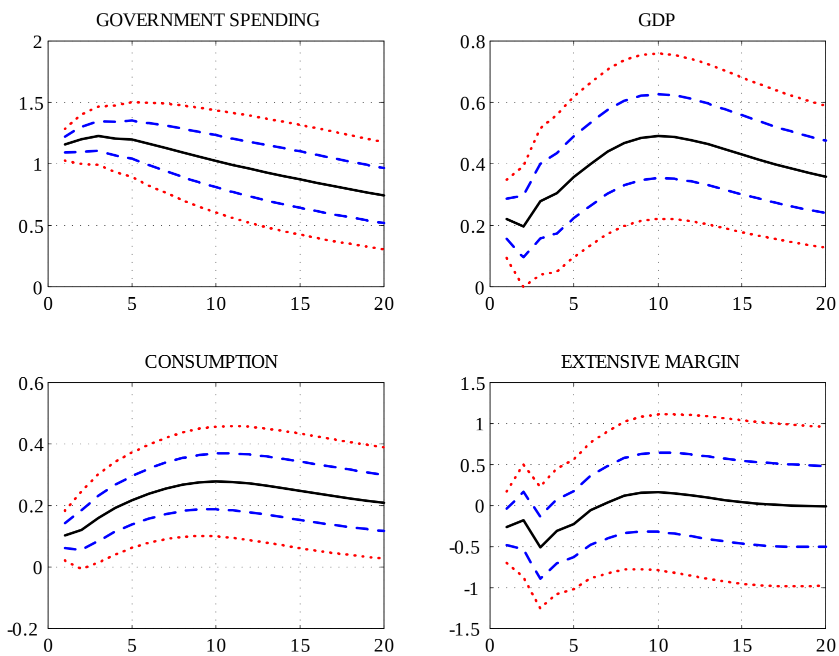


Figure 1b: Blanchard-Perotti VAR with New Incorporations

The figure shows the impulse response functions (IRFs) to a one-standard-deviation government spending shock in a structural VAR. The shock is identified recursively as in Blanchard and Perotti (2002). Entry is measured as net business formation in the top panel and as new incorporations in the bottom panel. The IRFs have been multiplied by 100, so as to give percentage deviations. On the horizontal axes, the horizon is given in quarters. The confidence bands around the IRF point estimates have been computed by bootstrapping. The dashed lines are the 68% confidence bands, the dotted lines are the 95% confidence bands.

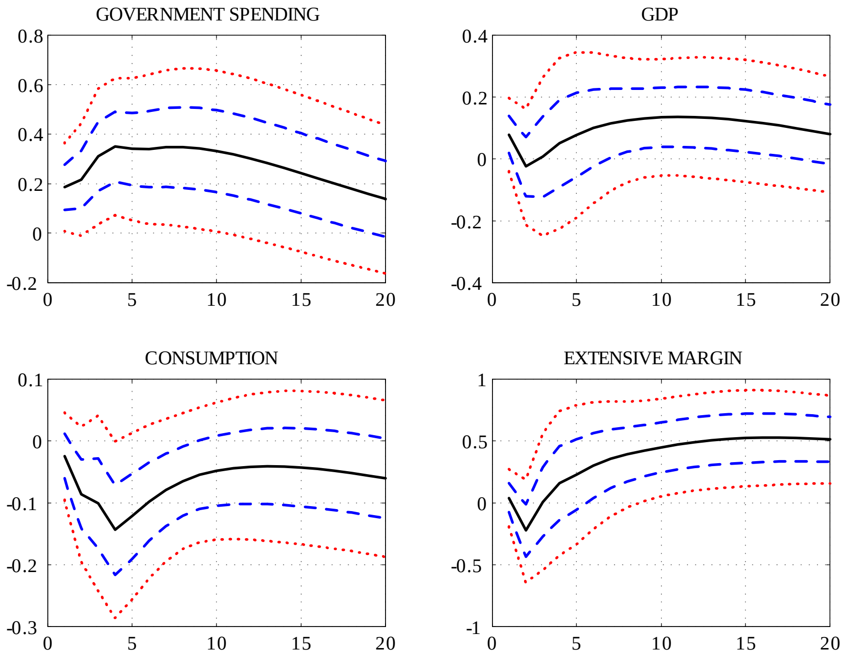


Figure 2a: Ramey EVAR with Net Business Formation

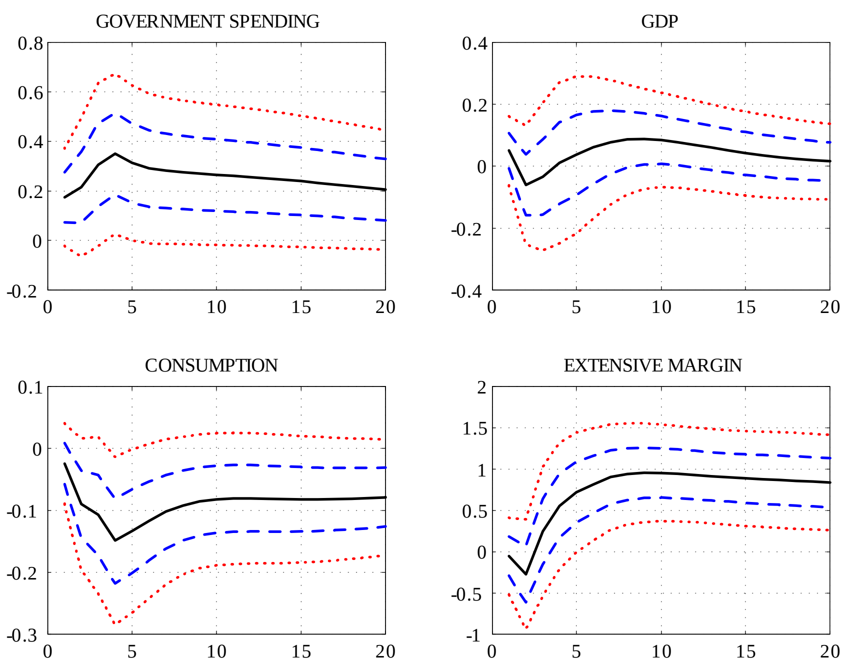


Figure 2b: Ramey EVAR with New Incorporations

The figure shows the impulse response functions (IRFs) to a one-standard-deviation fiscal news shock in an expectations-augmented VAR (EVAR). The shock is identified recursively as in Ramey (2011), with the news variable ordered first. Entry is measured as net business formation in the top panel and as new incorporations in the bottom panel. The IRFs have been multiplied by 100, so as to give percentage deviations. On the horizontal axes, the horizon is given in quarters. The confidence bands around the IRF point estimates have been computed by bootstrapping. The dashed lines are the 68% confidence bands, the dotted lines are the 95% confidence bands.

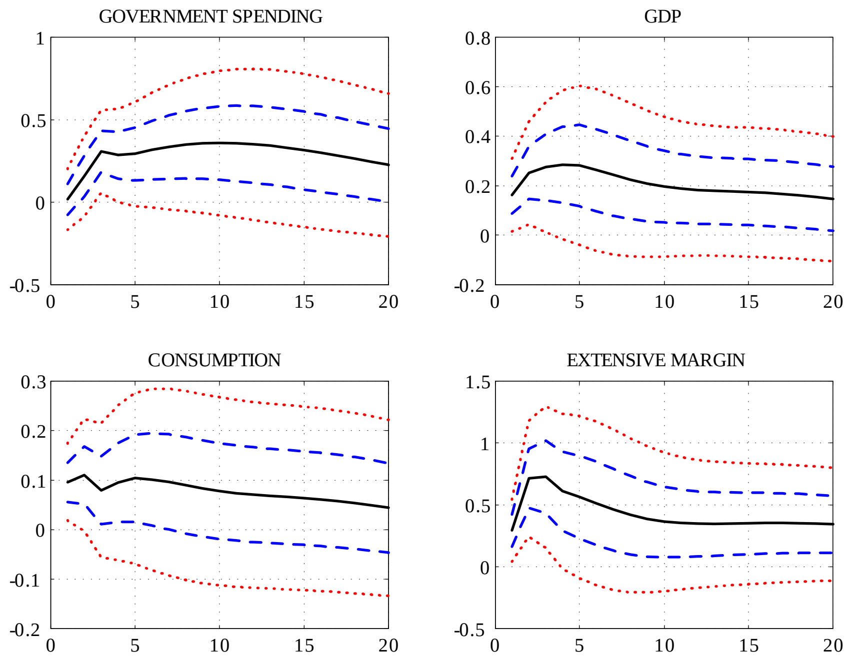


Figure 3a: Fisher-Peters EVAR with Net Business Formation

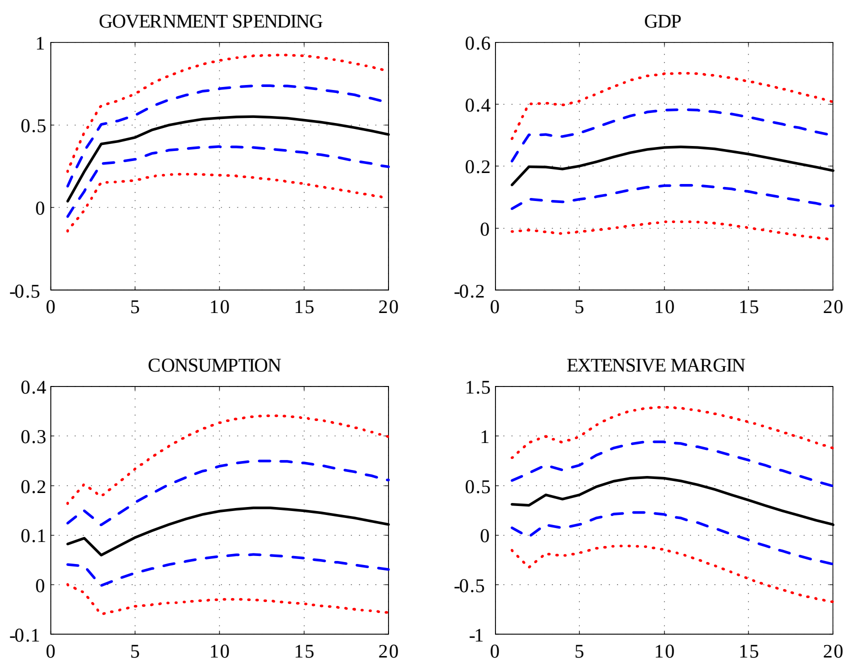


Figure 3b: Fisher-Peters EVAR with New Incorporations

The figure shows the impulse response functions (IRFs) to a one-standard-deviation fiscal news shock in an expectations-augmented VAR (EVAR). The shock is identified recursively as in Fisher and Peters (2012), with the news variable ordered first. Entry is measured as net business formation in the top panel and as new incorporations in the bottom panel. The IRFs have been multiplied by 100, so as to give percentage deviations. On the horizontal axes, the horizon is given in quarters. The confidence bands around the IRF point estimates have been computed by bootstrapping. The dashed lines are the 68% confidence bands, the dotted lines are the 95% confidence bands.

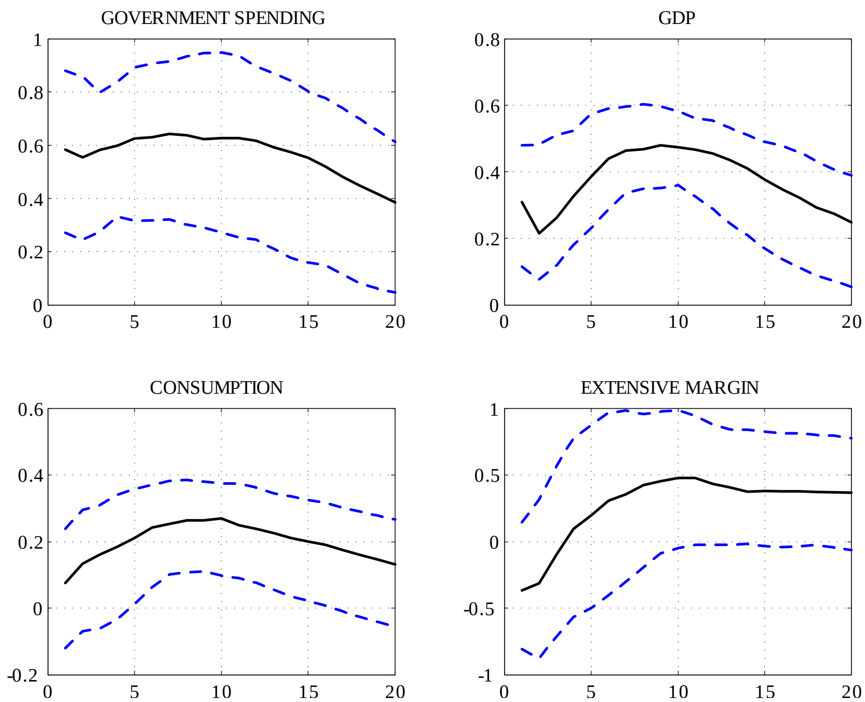


Figure 4a: Sign Restrictions VAR with Net Business Formation

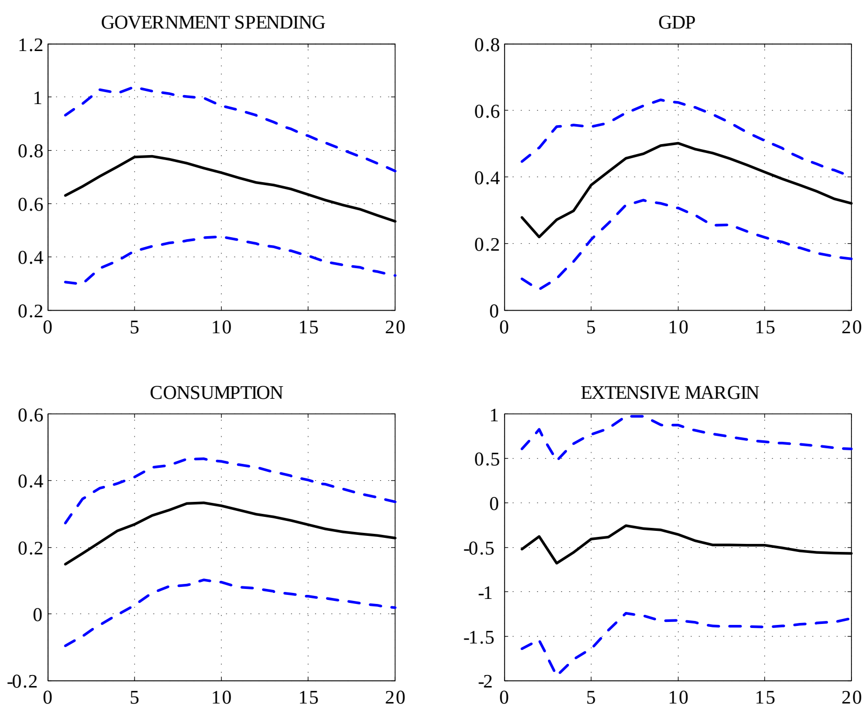
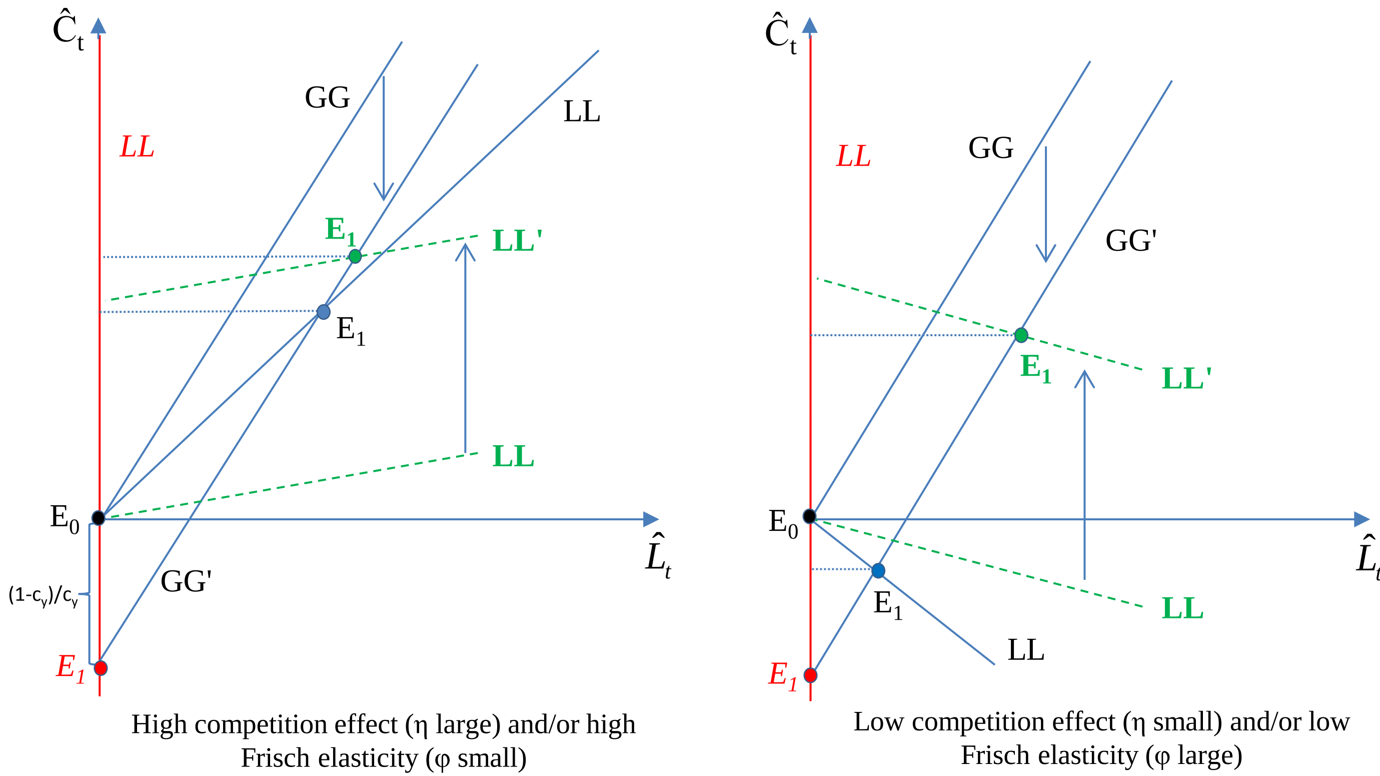


Figure 4b: Sign Restrictions VAR with New Incorporations

The figure shows the impulse response functions (IRFs) to a one-standard-deviation government spending shock. The shock is identified with sign restrictions as in Mountford and Uhlig (2002), though we do not include nominal variables and we do not identify monetary policy shocks. Entry is measured as net business formation in the top panel and as new incorporations in the bottom panel. The IRFs have been multiplied by 100, so as to give percentage deviations. On the horizontal axes, the horizon is given in quarters. We display the median, as well as the 16th and 84th percentiles of the IRF estimates sorted at each horizon.

Figure 5: Frictionless Entry Model



This figure shows the effects of a government spending expansion in the frictionless entry model with full depreciation of firms and zero profits each period. Labor is measured on the horizontal axis, consumption is measured on the vertical axis. Both variables are in deviations from the steady state, which is located at the origin. The increase in G_t is represented by a rightward shift of the upward-sloping goods market equilibrium (GG) curve. Two cases are considered. In the left hand panel, the Frisch elasticity is high and labor is very elastic to the real wage (φ is small) and/or the competition effect is high (η is large); the labor market equilibrium (LL) curve is upward-sloping. In the right hand panel, the Frisch elasticity is low and labor is inelastic (φ is large) and/or the competition effect is low (η is small); the LL curve is downward-sloping. If government spending is utility-enhancing, labor market equilibrium is given by the **LL** curve (in bold), which is flatter and shifts upwards in response to a government spending expansion. Crowding-in of consumption is possible in that case. The *LL* curve (in italics) represents the case with GHH preferences and full consumption crowding-out.

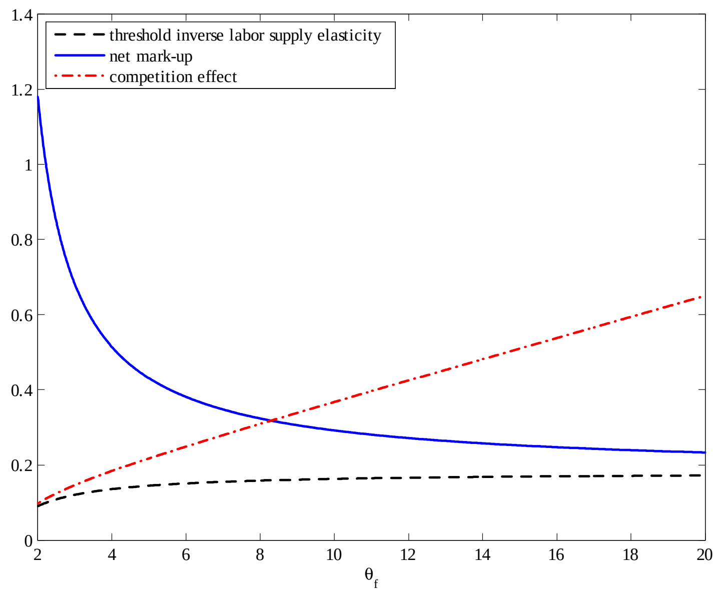


Figure 6: Threshold Inverse Labor Supply Elasticity

The figure shows the steady state markup μ, the competition effect η and the threshold inverse labor supply elasticity $\bar{\varphi}$ in the Bertrand model as a function of the within-industry elasticity of substitution.

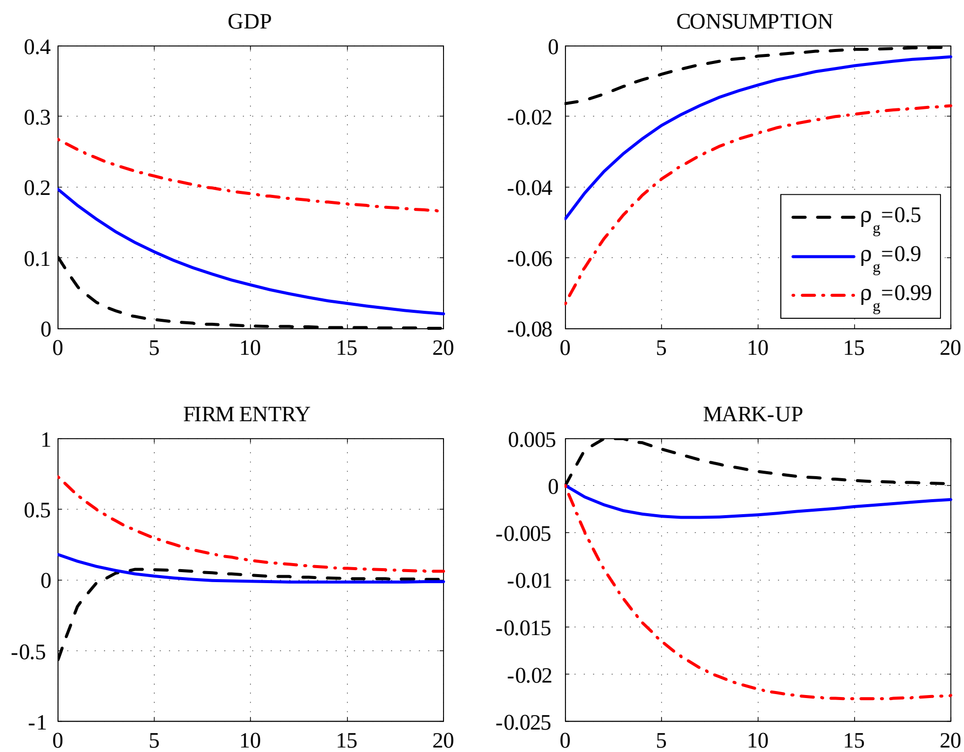


Figure 7: Benchmark Model, Effect of Shock Persistence

The figure shows the model-based impulse response functions (IRFs) of GDP, consumption, firm entry and the markup to a one-standard-deviation government spending shock in the benchmark model. On the vertical axis, the IRFs are measured in percentage changes. On the horizontal axes, the horizon is given in quarters. We restrict attention to Bertrand competition. The shock persistence parameter ρ_g is set to 0.5, 0.9 and 0.99 in three experiments. Firm entry reacts positively if the shock is sufficiently persistent ($\rho_g = 0.9$ or $\rho_g = 0.99$): in that case, the present discounted value of future profits exceeds current entry costs. Consumption is crowded out in all three cases.

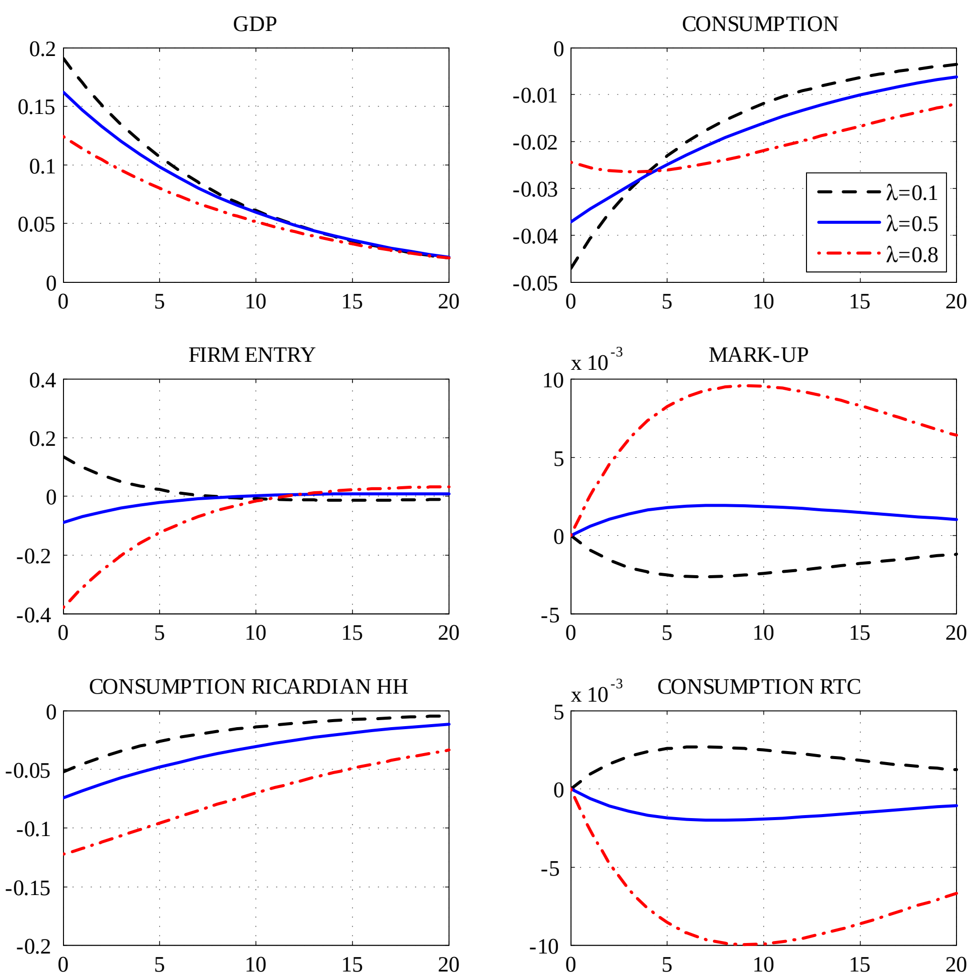


Figure 8: Model with Rule-of-Thumb Consumers

The figure shows the model-based impulse response functions (IRFs) of GDP, consumption, firm entry and the markup to a one-standard-deviation government spending shock in the model with rule-of-thumb consumers. On the vertical axis, the IRFs are measured in percentage changes. On the horizontal axes, the horizon is given in quarters. We restrict attention to Bertrand competition. The shock persistence parameter ρ_g is set to 0.9. The proportion of rule-of-thumb consumers λ is set to 0.1, 0.5 and 0.8 in three experiments. Consumption crowding-out prevails in all three cases. The response of firm entry is positive (negative) if the share of rule-of-thumb consumers is small (large).

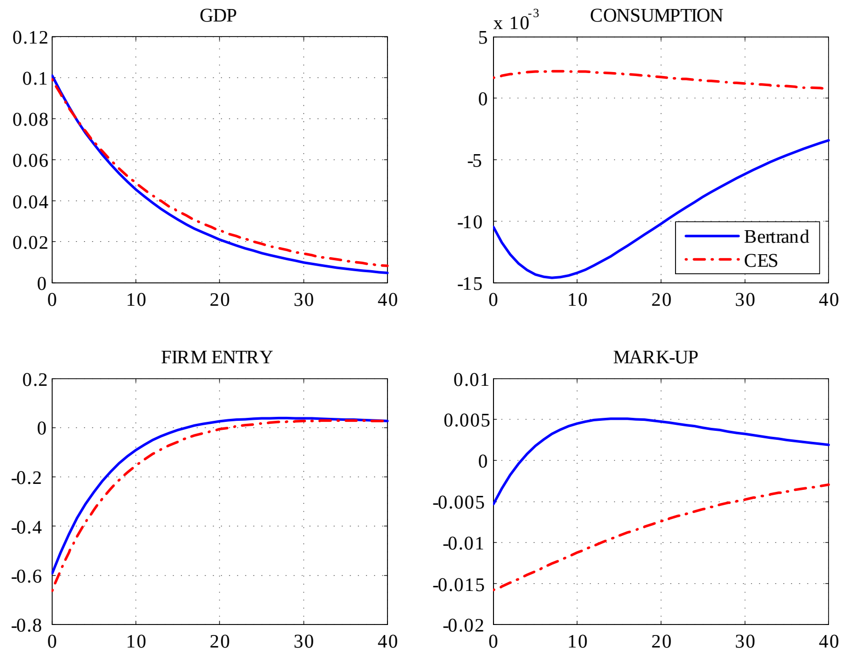


Figure 9a: Sticky-Price Model with Rule-of-Thumb Consumers

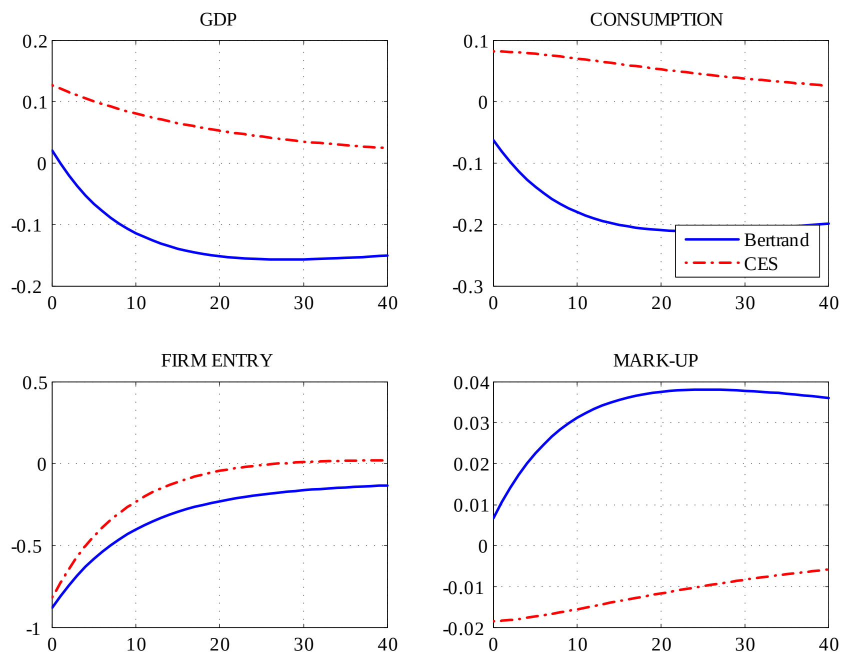


Figure 9b: Sticky-Price Model with GHH Preferences

The figure shows the model-based impulse response functions (IRFs) of GDP, consumption, firm entry and the markup to a one-standard-deviation government spending shock in the model with sticky prices. In the top panel, a fraction $\lambda = 0.9$ of consumers display "rule-of-thumb" behavior. In the bottom panel, households have GHH preferences, see Greenwood, Hercovitz and Huffman (1988). On the vertical axis, the IRFs are measured in percentage changes. On the horizontal axes, the horizon is given in quarters.

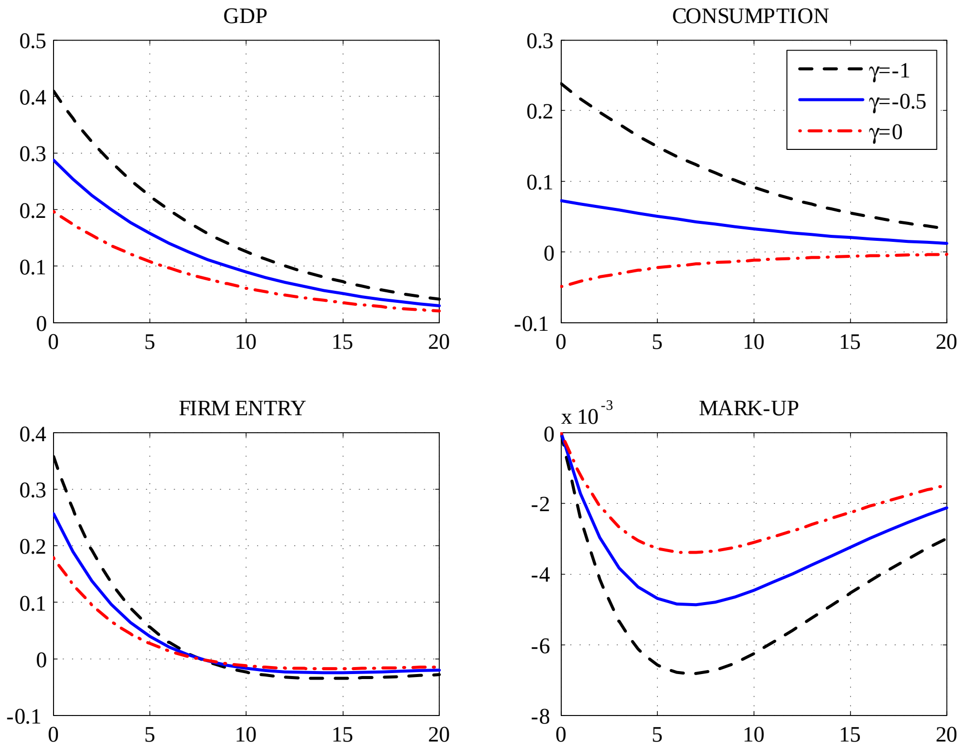


Figure 10: Model with Utility-Enhancing Government Spending

The figure shows the model-based impulse response functions (IRFs) of GDP, consumption, firm entry and the markup to a one-standard-deviation government spending shock in the model with utility enhancing government spending. On the vertical axis, the IRFs are measured in percentage changes. On the horizontal axes, the horizon is given in quarters. We restrict attention to Bertrand competition. The complementarity between private and public goods consumption γ is set to -1, -0.5 and 0 in three experiments.