Government Spending, Entry and the Consumption Crowding-in Puzzle*

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Abstract

This paper documents empirically that net firm entry robustly rises after a US government spending expansion. We use this new finding to test the empirical validity of various model features that have been put forward to generate a crowding-in of consumption after an expenditure shock. In particular, we show that models with endogenous entry can simultaneously generate an increase in consumption and firm entry in response to a positive government expenditure shock if entry has a very strong negative effect on markups, if labor supply is highly elastic, or if public consumption is utility- or productivity-enhancing. Model features that dampen the wealth effect, such as credit-constrained consumers or GHH preferences, instead tend to reduce entry as well as consumption.

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1 Introduction

We document that a government spending expansion in the US stimulates firm entry and private consumption. We use the joint dynamics observed in the data to test the empirical validity of various model features that address the so-called consumption crowding-in puzzle. That puzzle describes the inability of standard business cycle models to account for the crowding-in of private consumption after a positive government spending shock, which has been observed in numerous empirical studies.

The effect of government spending expansions on private economic activity is hotly debated amongst economists and policy makers alike, especially since the onset of the Great Recession in 2007. This paper sheds light on a particular form of economic activity, the entry into the market of new firms (and products), which represents investment along the extensive margin. Understanding the determinants of entry is important from a policy maker's perspective, as 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]

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 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. In the first part of the paper, we estimate a VAR model on US data and identify government spending shocks applying different identification methods. As our benchmark, we use the method by Blanchard and Perotti (2002). Our empirical results indicate that government spending expansions lead to higher private consumption and a rise in net

[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.

business formation. We show that this finding is robust to two alternative identification methods using, respectively, an expectations-augmented VAR and sign restrictions.

After providing the evidence, we turn to the second part of the paper in which we investigate which model features are needed to generate a crowding-in of consumption and entry, as observed in the data. To this end, we specify a benchmark business cycle model with endogenous entry. The entry mechanism builds on Bilbiie, Ghironi and Melitz (2012), where entry costs are sunk costs incurred once at the beginning of a firm's existence, and the number of producers is a state variable. Importantly, we allow for countercyclical markups through changes in competition. Hall (2009) demonstrates that countercyclical markups have the potential to generate a consumption crowding-in after a fiscal expansion.

Under oligopolistic competition, as in e.g. Colcagio and Etro (2010), markups vary inversely with market entry. More precisely, markups drop as firm entry raises the degree of competition in an oligopolistic market.[2] We call this the 'competition effect'. The resulting outward shift of the labor demand curve allows for real wages and consumption to rise in the wake of a government spending expansion. This is in contrast to the standard real business cycle model. There, 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. See e.g. Baxter and King (1993).

We first illustrate this crowding-in mechanism in a simplified model variant that has an analytical solution. A positive consumption response can be obtained if either the competition effect is large so that real wages rise strongly, or if labor supply is very elastic. Second, we calibrate our benchmark model and show that firm entry reacts positively if the government spending increase is sufficiently persistent. However, our numerical 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 and the elasticity of substitution across goods.

We consider two alternative consumption crowding-in mechanisms that have been proposed in the literature. First, we make government spending useful as in, for example, Linnemann and Schabert (2004, 2006). One possibility is that public consumption enters the representative agent's

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

utility function in the form of public goods, which are complementary to private goods. Another is to assume that public goods enter the production function as a complement to other inputs. We demonstrate that both specifications can lead to a joint rise in private consumption and firm entry after a spending expansion.

The second mechanism to replicate the observed crowding-in of consumption relies on a reduction of the wealth effect on labor supply. First, we consider a preference specification which shuts off the wealth effect, as in Greenwood, Hercowitz and Huffman (1988). Bilbiie (2011) and Monacelli and Perotti (2008) show that this specification generates a consumption crowding-in in a model with countercyclical markups stemming from sticky prices. Second, we allow for credit-constrained or 'rule-of-thumb' households that neither save nor borrow, as in Galí, López-Salido and Vallés (2007). Both modeling 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 firm entry, which pushes up the markup through weaker competition and thereby generates a drop in consumption. Strikingly, introducing price stickiness in addition to GHH preferences or rule-of-thumb consumers does not help to generate a consumption crowding-in.[3]

In related work, Devereux, Head and Lapham (1996) 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. 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, in contrast, abstracts from 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. However, they remain within the no-entry framework, in which the number of firms and products is constant over time.

The remainder of the paper is structured as follows. In Section 2, we present empirical evidence

[3]Two other ways to induce an increase in private consumption after a spending expansion are worth emphasizing. One is deep habits as in Ravn, Schmitt-Grohé and Uribe (2012). However, this mechanism disappears under price stickiness, see Jacob (2012). Another is a home production sector as in Gnocchi, Hauser and Pappa (2012). In their model, (capital) investment falls in the presence of home-produced goods. We conjecture that this also holds for extensive-margin investment (firm entry) and thus we do not follow this route here.

on the response of firm entry. Section 3 discusses the benchmark model. Section 4 presents analytical results in a simplified model variant and numerical results in the calibrated benchmark model. Section 5 analyzes, through the lens of the endogenous-entry model, alternative specifications that have been proposed in the literature to generate a crowding-in effect on private consumption after a government spending shock. Section 6 concludes.

2 Empirical 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 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 certain period of time and is orthogonal to a (suitably identified) business cycle shock.

The reduced-form VAR is given by

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

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, $C(L) = C_0 + C_1 L + \ldots + C_q L^q$, 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, $B^{-1}C(L)$ 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 firm entry 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.[4] 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-standard-deviation government spending shock. Consider first the top panel, Figure 1a, where 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 spending impulse.

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

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

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 firm entry. 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.

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 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.[5] The business cycle shock raises GDP, consumption, firm entry and government revenues and lowers the budget deficit, defined as $g_t - rev_t$, for four consecutive quarters. The fiscal policy shock raises government spending, GDP and the budget deficit 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

[5] 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.

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. 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 insignificant. These results confirm a consumption crowding-in and suggest that it is likely that firm entry rises.

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 outline a business cycle model which builds on Bilbiie, Ghironi and Melitz (2012). Investment takes place at the extensive margin, entry is subject to a sunk cost incurred once at the time of entry, and there is a time-to-build lag in firm startups. Let a variable without 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 $\tilde{\chi} \equiv \frac{\chi}{c_y}$ and $c_y = \frac{C}{Y}$ is the steady state share of private consumption in total output. Notice that for separable preferences in consumption and leisure, i.e. if $\nu = 0$, the Frisch elasticity, $\frac{1}{\varphi+\nu-\frac{\nu\tilde{\chi}}{\tilde{\chi}-\nu}}$, and the constant-consumption labor supply elasticity $1/\tilde{\varphi}$ coincide at $1/\varphi$.

The household's period budget constraint is

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

Expenditure includes purchases of shares x_t at price v_t, consumption, and lump-sum taxes T_t. Income comprises dividends, the market value of share holdings, and wage income. The number of producers is N_t, while the number of entrants is denoted $N_{E,t}$. The household buys shares in operating firms and new entrants. A fraction δ of firms exits the market each period, such that only the fraction $(1-\delta)(N_{t-1} + N_{E,t-1})$ of firms pay dividends d_t at time t. Since the labor market is perfectly competitive, the real wage w_t is set equal to the marginal rate of substitution between leisure and consumption,

$$w_t = \frac{U_{l,t}}{U_{C,t}}. \tag{2}$$

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

$$v_t = (1-\delta) E_t \left\{ \Lambda_{t,t+1}(v_{t+1} + d_{t+1}) \right\}, \tag{3}$$

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

3.2 Production

We assume a two-layer production 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 function of the final good Y_t^C is

$$Y_t^C = \left(\int_0^1 y_t\,(i)^{\frac{\theta_i - 1}{\theta_i}}\, di \right)^{\frac{\theta_i}{\theta_i - 1}},$$

where $y_t(i)$ denotes the output of industry i and θ_i denotes the elasticity of substitution between industry goods. The production function of industry goods $y_t\,(i)$ is

$$y_t\,(i) = N_t^{-\frac{1}{\theta_f - 1}} \left(\sum_{f=1}^{N_t} y_t\,(i,f)^{\frac{\theta_f - 1}{\theta_f}} \right)^{\frac{\theta_f}{\theta_f - 1}},$$

where $y_t(i,f)$ is the output of firm f in industry i and θ_f denotes the elasticity of substitution between goods within an industry. Note that the production function of industry goods is specified such that there is no love of variety.[6]

Each intermediate goods firm f in industry i produces a single goods variety under a production technology that is linear in labor and facing a fixed cost, $y_t(i,f) = l_{C,t}(i,f) - \psi$. Profits per firm are therefore $d_t(i,f) = \frac{p_t(i,f)}{P_t} y_t(i,f) - w_t l_{C,t}(i,f)$, where $p_t(i,f)/P_t$ is the price of variety f in industry i relative to the final goods price P_t. The firm takes marginal costs w_t as given. Under Bertrand competition, intermediate goods firms set prices to maximize profits. Each firm takes into account how its price setting affects its own industry's price, while taking as given the prices chosen by other firms in the industry and the price levels of other industries. The firm's optimal price is set as a markup over marginal cost, $\frac{p_t(i,f)}{P_t} = \mu_t(i,f) w_t$.

In a symmetric equilibrium, $p_t(i,f) = p_t = P_t$, $y_t(i,f) = y_t$, $\mu_t(i,f) = \mu_t$, and $d_t(i,f) = d_t$. The symmetric price setting condition is

$$1 = \mu_t w_t. \tag{4}$$

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

[6]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.

markup,

$$\mu_t = \frac{\theta_f N_t - (\theta_f - \theta_i)}{(\theta_f - 1) N_t - (\theta_f - \theta_i)}, \tag{5}$$

varies negatively with the number of producers for $\theta_f > \theta_i$. If the between- and within-industry substitution elasticities are equal, $\theta_f = \theta_i$, the negative effect of entry on markups under Bertrand competition disappears and we revert to the constant elasticity of substitution (CES) structure à la Dixit and Stiglitz (1977). Broda and Weinstein (2006) estimate substitution elasticities between goods for different levels of aggregation. As they disaggregate product categories, goods varieties appear to be more substitutable to each other. This suggests that $\theta_f > \theta_i$ is a reasonable assumption and we will make this assumption throughout the remainder of the paper. Denote by η_t the (negative) elasticity of the markup with respect to the number of goods and firms, which we call the 'competition effect', $\eta_t = -\frac{\partial \mu_t}{\partial N_t}\frac{N_t}{\mu_t}$.[7] Under Bertrand competition in prices, the competition effect is

$$\eta_t = \frac{(\theta_f - \theta_i)}{[(\theta_f - 1) N_t - (\theta_f - \theta_i)] [\theta_f N_t - (\theta_f - \theta_i)]}. \tag{6}$$

Profits per firm are given by

$$d_t = \left(1 - \frac{1}{\mu_t}\right) \frac{Y_t^C}{N_t}. \tag{7}$$

The existence of profits in excess of entry costs leads to market entry by firms.

3.3 Entry

Every period, there exist N_t intermediate goods firms and an infinite mass of potential entrants. Setting up a new firm requires one labor unit, such that sunk entry costs are equal to w_t.[8] Entry occurs until firm value and entry costs are equalized, such that the free-entry condition is

$$v_t = w_t. \tag{8}$$

It takes one period until an entrant turns into an operational firm. 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. The number of producers in period t is thus

[7] 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.

[8] Alternatively, we can assume that entry costs per new firm are given by y_E units of final output Y^C. All our qualitative results go through under this alternative entry cost specification.

given by

$$N_t = (1-\delta)\,(N_{t-1} + N_{E,t-1}). \tag{9}$$

This concludes the description of the entry mechanism.

3.4 Aggregate Accounting

The aggregate production functions for consumption goods and new firms are $Y_t^C = L_{C,t} - \psi N_t$ and $N_{E,t} = L_{E,t}$, respectively, where $L_{C,t} = N_t l_{C,t}$ is labor used in the production of consumption goods and $L_{E,t}$ is labor used in the production of new firms. The aggregate market clearing condition for consumption goods is

$$Y_t^C = C_t + G_t. \tag{10}$$

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

$$\ln G_t = (1-\rho_g)\ln G + \rho_g \ln G_{t-1} + \varepsilon_t^g, \quad \varepsilon_t^g \sim N\left(0, \sigma_g\right). \tag{11}$$

The government finances its expenditure using lump sum taxes, such that its budget constraint is $G_t = T_t$ for all t.

Aggregating budget constraints of households, imposing equity market clearing, $x_t = x_{t-1} = 1$, and using the production function for new firms $L_{E,t} = N_{E,t}$, the government budget constraint $G_t = T_t$, as well as the law of motion of firms (9) yields the aggregate accounting identity,

$$Y_t^C + w_t N_{E,t} = N_t d_t + w_t L_t. \tag{12}$$

Total consumption (private and public) plus investment (in new firms) must equal total income (dividend income plus labor income). GDP is thus defined as

$$Y_t = N_t d_t + w_t L_t. \tag{13}$$

Finally, equilibrium in the labor market implies $L_t = L_{C,t} + L_{E,t}$. A formal definition of equilibrium is given below.

Definition 1. *A competitive equilibrium in the benchmark model is a set of sequences* $\{Y_t, Y_t^C, C_t, L_t, N_t, N_{E,t}, v_t, w_t, d_t, \mu_t\}_{t=0}^{\infty}$ *that satisfy the household's first order conditions for labor and shares*

(2) and (3), price setting (4), markups (5), firm profits (7), free entry (8), the law of motion of the number of firms (9), goods market clearing (10), aggregate accounting (12) and the definition of GDP (13), given an exogenous stream of government spending $\{G_t\}_{t=0}^{\infty}$.

4 Model Results

In this section, we analyze the effects of government spending shocks in the endogenous-entry model. We investigate under which conditions the model is capable of generating the joint dynamics of output, firm entry and consumption observed in the data. We proceed in two steps. In the first step, we consider a simplified version of the model which allows us to provide analytical results and a graphical illustration of the effects at work. We use this model to understand the basic mechanisms driving the responses of entry and consumption to a government spending shock. In the second step, we consider a calibrated version of the benchmark model and present numerical results.

4.1 Analytical Results in a Simplified Model Variant

In the following, we outline a simplified variant of our benchmark entry model. We call this model variant, which is close to the endogenous-entry model of Jaimovich and Floetotto (2008), the 'frictionless' entry model. The frictionless entry model assumes instantaneous entry and 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 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,

$$Y_t = C_t + G_t. \tag{14}$$

The aggregate production function reads

$$Y_t = L_t - \psi N_t. \tag{15}$$

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 yields the firm-level zero-profit condition $(\mu_t - 1)\, y_t = \psi$. Multiplying this equation by the numbers of firms yields the aggregate free-entry condition that determines the number of firms/entrants,

$$(\mu_t - 1)\, Y_t = \psi N_t. \tag{16}$$

A formal definition of equilibrium in the frictionless model reads as follows.

Definition 2. *A competitive equilibrium in the frictionless entry model is a set of allocations* $\{Y_t, C_t, L_t, N_t\}$ *and prices* $\{w_t, \mu_t\}$ *that satisfy the household's first order condition for labor (2), the price setting equation (4), the markup equation (5), goods market clearing (14), the aggregate production function (15), and the free-entry condition (16), given government spending* G_t.

We proceed by log-linearizing the equilibrium conditions. Table 3 summarizes the six linearized model equations that jointly determine $\hat{Y}_t$, $\hat{C}_t$, $\hat{L}_t$, $\hat{N}_t$, $\hat{w}_t$ and $\hat{\mu}_t$, where a hatted variable denote the percentage deviation from steady state.

[insert Table 3 here]

We now provide a graphical analysis of the effects of a rise in government spending, following in spirit the example in Corsetti and Pesenti (2007). To this end, we condense the model into two equations in consumption and labor, one describing labor market equilibrium, the other describing goods market equilibrium.

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

$$\hat{C}_t = \frac{1}{\chi} \left(\frac{(\mu - 1)\eta}{\mu - 1 + \eta} - \tilde{\varphi} \right) \hat{L}_t. \tag{17}$$

In general, provided that there exists a wealth effect, $\chi > 0$, the LL curve is upward-sloping in $(\hat{L}_t, \hat{C}_t)$-space if $\frac{(\mu-1)\eta}{\mu-1+\eta} - \tilde{\varphi} > 0$. For a competition effect η equal to zero as in the Dixit and Stiglitz (1977) CES model, the LL curve would be upward-sloping only if the inverse of the constant-consumption labor supply elasticity, $\tilde{\varphi}$, were negative. This is not a valid calibration, however. Recall from Section 3.1 that $\tilde{\varphi} < 0$ violates the parameter restrictions required for non-inferiority and concavity. Hence, the LL curve is upward-sloping if at least one of the following two conditions are satisfied: (a) there is a sufficiently large competition effect, η is large; (b) labor supply is sufficiently elastic, $\tilde{\varphi}$ is small.

Setting total expenditure equal to total production and 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

$$\hat{C}_t = \frac{(\mu - 1) + \mu\eta}{[(\mu - 1) + \eta]\, c_y} \hat{L}_t - \frac{1 - c_y}{c_y} \hat{G}_t. \tag{18}$$

Consider Figure 5 with labor on the horizontal axis and consumption on the vertical axis.

[insert Figure 5 here]

The goods market equilibrium (18) is represented by an upward-sloping curve, which is the same in both panels. In the left panel, the LL curve is upward-sloping, with a slope that is smaller than the slope of the GG curve. In right panel, the LL curve is downward-sloping. 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, $c_y < 0.5$. 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.

The following proposition formalizes the findings of our graphical illustration.

Proposition 1. *In the frictionless entry model, a rise in government spending leads to a rise in output and in the number of firms,* $\frac{d\hat{Y}_t}{d\hat{G}_t} > 0$ *and* $\frac{d\hat{N}_t}{d\hat{G}_t} > 0$*, if* $\tilde{\chi} > 0$ *and* $\tilde{\chi} > \Phi$*, where* $\tilde{\chi} = \chi / c_y$*, and* $\Phi = \frac{(\mu-1)\eta - \tilde{\varphi}[(\mu-1)+\eta]}{(\mu-1)+\mu\eta} \lesseqgtr 0$*. The impact of a rise in government spending on private consumption is positive,* $\frac{d\hat{C}_t}{d\hat{G}_t} > 0$*, if* $\tilde{\chi} > \Phi > 0$*.*

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

$$\hat{Y}_t = \phi_1 \hat{G}_t, \qquad \hat{N}_t = \phi_2 \hat{G}_t, \qquad \hat{C}_t = \phi_3 \hat{G}_t,$$

where $\phi_1 = \frac{(1-c_y)\tilde{\chi}}{\tilde{\chi}-\Phi}$, $\phi_2 = \frac{(\mu-1)(1-c_y)\tilde{\chi}}{(\mu-1+\eta\mu)(\tilde{\chi}-\Phi)}$, and $\phi_3 = \frac{1-c_y}{c_y}\left(\frac{\tilde{\chi}}{\tilde{\chi}-\Phi} - 1\right)$. Since $0 < c_y < 1$ and $\mu > 1$, the coefficients ϕ_1 and ϕ_2 are positive if $\tilde{\chi} > 0$ and $\tilde{\chi} > \Phi$ and the coefficient ϕ_3 is positive if $\tilde{\chi} > \Phi > 0$. □

A necessary condition for government spending to raise output and the number of firms is that $\tilde{\chi} = \chi/c_y > 0$, i.e. that the wealth effect on labor supply, χ, is positive. From the perspective of our graphical illustration, this condition ensures that the slope of the LL curve is finite. The condition $\tilde{\chi} > \Phi$ ensures that the slope of the LL curve is smaller than the slope of the GG curve. Provided that the conditions for a rise in output and entry are satisfied, government spending crowds in private consumption if $\Phi > 0$, which is equivalent to the condition for an upward-sloping LL curve, i.e. $\frac{(\mu-1)\eta}{\mu-1+\eta} - \tilde{\varphi} > 0$. A necessary condition for an upward-sloping LL curve is that the model features a competition effect, i.e. that $\eta > 0$. In the presence of the competition effect, the rise in the number of firms leads to a drop in markups, which in turn causes real wages to rise. The rise in real wages may overturn the negative wealth effect of higher taxation. This is the case either if the competition effect η is large, so that real wages rise strongly, or if labor supply is very elastic, i.e. $\tilde{\varphi}$ is small. In the latter case, the substitution away from leisure towards consumption is sufficiently large for a given wage increase.

4.2 Numerical Results in the Benchmark Model

While the analytical results of the previous section help to build intuition, we also wish to study the effects of spending expansions in the calibrated benchmark model. The aim is to investigate whether the model is able to generate a crowding-in of firm entry and consumption for plausible values of the competition effect and the labor supply elasticity. We will show that an additional parameter is of importance in the dynamic benchmark model, namely the persistence of the spending shock.

Calibration

We calibrate the model as follows. As a benchmark, we consider separability in consumption and leisure implying $\nu = 0$, such that $\tilde{\varphi} = \varphi$, and logarithmic consumption utility implying $\chi = 1$. The benchmark Frisch elasticity is set to $1/\varphi = 4$, such that labor supply is rather elastic. We set the weight on leisure in utility such that steady state labor supply L is normalized to 0.25. The discount factor is set to $\beta = 0.99$, such that the steady state annual real interest rate is 4%. The elasticity of substitution between goods within an industry is set to $\theta_f = 6.67$. This value implies a steady state markup equal to 36%, as in Bilbiie, Ghironi and Melitz (2012), and a competition effect equal to $\eta = 0.14$. Following Jaimovich and Floetotto (2008), the substitution elasticity across industries is $\theta_i = 1.001$, such that $\theta_f > \theta_i$. We set a conventional value for the firm exit rate, $\delta = 0.025$. The persistence of the government spending process is set to $\rho_g = 0.9$ and the standard deviation of the government spending shock is normalized to $\sigma_g = 0.01$.

In the following, we discuss the implications of perturbations in three key parameters: shock persistence ρ_g, the substitution elasticity between goods within industries θ_f, which determines the competition effect η, and the labor supply elasticity $1/\varphi$.

Shock Persistence

The more persistent is the fiscal expansion, the greater is the expected discounted value of the future profit stream generated by the additional demand, and the higher are the incentives to enter the market. The top row of Figure 6 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 the persistence of the process is set to three different values, $\rho_g = 0.5$, $\rho_g = 0.9$, and $\rho_g = 0.99$.[9]

[insert Figure 6 here]

We observe that entry rises 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

[9] Strictly speaking, the model variable corresponding to net business formation is entry $N_{E,t}$ minus exit $\delta(N_t + N_{E,t})$. In the model, the two variables differ by only a small amount given the small exit rate and the fact that the stock of firms N_t is predetermined. The results are qualitatively unchanged when using the alternative mapping.

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. 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 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.

Competition Effect

As can be seen from equation (6), the competition effect is tied to the elasticity of substitution between goods within an industry θ_f, holding constant the elasticity of substitution between industries θ_i. More specifically, the competition effect η becomes stronger as we raise θ_f and as the gap between the two elasticities widens. However, the middle row of Figure 6 shows that this rise in the competition effect is not strong enough to overturn the consumption crowding-out response to spending expansions.[10] Broda and Weinstein (2006) report empirical estimates of substitution elasticities for various industries in the range of 1.2 to 17. Here, consumption falls even for a substitution elasticity as high as $\theta_f = 17$. Indeed, changing the parameter θ_f has only a very limited effect on the model dynamics.

Labor Supply Elasticity

The bottom row of Figure 6 presents impulse responses for three values of the inverse of the labor supply elasticity φ, in particular, $\varphi = 0.1$, $\varphi = 0.25$ and $\varphi = 1$. The figure shows that, as we make labor supply more elastic by lowering φ, consumption falls less strongly. However, consumption still falls for all three values of φ that we consider, which imply a Frisch elasticity of 10, 4 and 1, respectively. Therefore, the Frisch elasticity required to generate a crowding-in effect

[10] Empirical evidence based on identified monetary policy shocks is consistent with the notion of a small competition effect, see Lewis and Poilly (2012).

on consumption is far above any plausible value. The numbers we consider here are already 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 lower than the value needed for a positive consumption response in our model. The figure also shows that firm entry falls, too, if the labor supply elasticity is low ($\varphi = 1$).

The main insight from our numerical analysis is that either the competition effect or the labor elasticity needs to be very high for consumption to react positively to a fiscal expansion. Neither condition is likely to be fulfilled in a plausible calibration.

5 Alternative Consumption Crowding-in Mechanisms

It is well known that neither the canonical real business cycle model nor the standard New Keynesian model is able to generate a crowding-in of private consumption. A substantial research effort has tried to extend the models in various ways so as to overcome this inconsistency. We consider two main approaches here through the lens of the endogenous-entry model and in light of the empirical evidence presented above.

The first approach is to make government spending useful, either by assuming that public goods provide utility or by treating public goods as inputs in the production function, see e.g. Linnemann and Schabert (2004 and 2006).

The second approach is to reduce the importance of the wealth effect. In this regard, we consider two possible model features. The first model feature is the utility function in Greenwood, Hercowitz and Huffman (1988), henceforth GHH, which exhibits no wealth effect on labor supply. That preference specification 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 second model feature is 'rule-of-thumb' behavior by households as in Galí, López-Salido and Vallés (2007).

5.1 Useful Government Spending

Traditional business cycle models treat government spending as wasteful, i.e. as using up resources without generating welfare in any way. An alternative route, which we follow in this section, is to make government spending useful either by allowing for households to enjoy utility directly from the consumption of public goods, or by letting government spending raise productivity.

Utility-Enhancing Government Spending

To start with, 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).

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 $\xi = 1$. 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, such that 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 (2) is

$$\hat{w}_t = \varphi \hat{L}_t + \hat{C}_t + \gamma\,(1-\xi c_C)\,(\hat{G}_t - \hat{C}_t), \tag{19}$$

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 (18) shifts down. Thus, there are two opposing effects on consumption. The upward 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:

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

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 the labor supply elasticity or the competition effect required for a positive consumption response to a fiscal stimulus, consistent with our evidence.

Let us now turn to the benchmark model. The only change to the model relates to the marginal utility of private consumption as discussed above. Figure 7a 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 7 here]

As demonstrated in the frictionless model, consumption reacts positively if public and private goods are sufficiently complementary. Firm entry rises in response to a persistent government spending shock. Notice that a rising degree of complementarity (more negative γ) boosts the firm entry response. The can be explained as follows. First, the increase in household's consumption demand raises the present discounted value of future profits. Second, a rise in government spending lowers real wages for a given level of consumption, see (19). This, in turn, depresses entry costs.

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 firm entry after a government spending shock.

Productivity-Enhancing Government Spending

Let us now consider productive government spending as an alternative way to generate consumption crowding-in, see Linnemann and Schabert (2006). Suppose that each intermediate good $y_t(i,f)$ is produced using labor $l_{C,t}(i,f)$ and firm-level government expenditures $g_t = G_t/N_t$,

$$y_t(i,f) = l_{C,t}(i,f)^{\alpha} g_t^{1-\alpha} - \psi,$$

where $\alpha \in (0,1]$. The benchmark model with unproductive government spending is given by $\alpha = 1$. If $\alpha < 1$, government spending raises production and the marginal productivity of labor. Optimal price setting in a symmetric equilibrium reads $\mu_t = \frac{1}{mc_t}$, where the marginal costs $mc_t = w_t \frac{1}{\alpha}\left(\frac{l_{C,t}}{g_t}\right)^{1-\alpha}$ depend negatively on government expenditure. The aggregate production function is given by $Y_t^C = L_{C,t}^{\alpha} G_t^{1-\alpha} - \psi N_t$.

To illustrate how productive government spending can generate consumption crowding-in, we first analyze the frictionless entry model. After log-linearization, we obtain a new labor market equilibrium (LL) relation,

$$\hat{C}_t = \frac{1}{\chi}\left\{\left(\left[\alpha\frac{(\mu-\alpha)\eta}{\mu-\alpha+\alpha\eta} - (1-\alpha)\right] - \tilde{\varphi}\right)\hat{L}_t + (1-\alpha)\frac{\mu-\alpha+\mu\eta}{\mu-\alpha+\alpha\eta}\hat{G}_t\right\}, \tag{20}$$

and a new goods market equilibrium (GG) relation,

$$\hat{C}_t = \alpha\frac{\mu-\alpha+\mu\eta}{(\mu-\alpha+\alpha\eta)\,c_y}\hat{L}_t - \frac{1-c_y}{c_y}\hat{G}_t + (1-\alpha)\frac{\mu-\alpha+\mu\eta}{(\mu-\alpha+\alpha\eta)\,c_y}\hat{G}_t. \tag{21}$$

There are two differences compared with the benchmark model. First, both the LL curve and the GG curve rotate clockwise if government spending is productive ($\alpha < 1$). Second, *both* the LL curve and the GG curve shift in response to a change in government spending. An increase in government spending raises the marginal productivity of labor. The labor market equilibrium moves towards higher employment and higher consumption: the LL curve (20) shifts upwards. The GG curve may shift up or down, depending on the relative strength of two countervailing effects of an increase in government spending on consumption. On the one hand, for a given output level, a rise in government spending crowds out private consumption. As a consequence, the GG curve shifts down, see the second term on the right-hand side of (21), which is negative. On the other hand, the production possibility frontier expands, which shifts the GG curve up. This shift is captured by the third term in (21), which is positive.

Figure 8 visualizes the impact of government spending shocks. We suppose that labor supply is not very elastic and that the competition effect is not very strong, such that the LL curve is downward-sloping.

[insert Figure 8 here]

Consider, first, the left panel in which the GG curve shifts down. In this case, consumption rises if the share of government spending in the production function, $1 - \alpha$, is sufficiently large, which translates into a strong enough upward shift of the LL curve. In the right panel, the GG curve shifts up. This will be the case for very large values of the share of government spending in the production function. As a result, consumption unambiguously rises.

Let us now turn the benchmark entry model. Figure 7b shows the impulse responses for three different parameters governing the share of government spending in the production function, $\alpha = 1$ (unproductive government spending), $\alpha = 0.96$, and $\alpha = 0.9$. An expansion of productive government spending induces households to consume more if the share of government spending in the production function, $1 - \alpha$, is sufficiently large. As aforementioned, this can be explained by two expansionary effects on consumption. First, the increase in the production possibility frontier mitigates the negative wealth effect, such that the labor supply curve shifts out by less. Second, an increase in productive government spending raises the marginal productivity of labor so that the labor demand curve shifts out. If this shift is large enough, real wages rise which induces households to substitute away from leisure towards consumption. Firm entry rises if the fiscal expansion is sufficiently persistent, as it assumed here. The impact of an increasing share of government spending on firm entry is negligible, at least for a reasonable parameter range.

5.2 Reducing the Importance of the Wealth Effect

As mentioned above, the negative wealth effect of a rise in government spending induces households to consume less and to work more. The labor supply curve shifts out, such that real wages fall. This result can be overturned through a countercyclical movement of the markup that shifts out the labor demand curve, such that real wages ultimately rise. This induces households to substitute away from leisure towards consumption. In our baseline setup, the latter effects dominates the negative wealth effect only for implausible calibrations regarding the size of markup movements (determined by the competition effect) or the substitution elasticity between consumption and leisure (determined by the labor supply elasticity). In this section, we investigate whether the model is able to generate an increase in entry and consumption for plausible calibrations if we reduce the importance of the wealth effect. We consider two wealth-effect reducing features here: GHH preferences and rule-of-thumb consumers.

Monacelli and Perotti (2008) demonstrate that GHH preferences together with countercyclical markup movements can generate a consumption crowding-in after a fiscal expansion. In Galí, López-Salido and Vallés (2007), a rise in real wages boosts the consumption of rule-of-thumb households that have no access to a savings technology and for which consumption is determined by their current labor income. 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 firm entry and an associated fall in real wages and consumption. Allowing for price stickiness does not alter this finding.

GHH Preferences

In a first model variant, we assume non-separable preferences in the spirit of Greenwood, Hercowitz and Huffman (1988). Under GHH preferences, the wealth effect on labor supply is shut off, which allows for a consumption crowding-in in a sticky price model, see Bilbiie (2011) and Monacelli and

Perotti (2008). Consider the following utility function,

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

where $U_{Cl,t} = \zeta L_t^{\tilde{\varphi}} U_{CC,t} < 0$. Under this specification, labor and consumption are complements, i.e. $\nu < 0$, and the wealth effect on labor supply is zero, i.e. $\chi = 0$. The labor supply equation is $w_t = \zeta L_t^{\tilde{\varphi}}$, where $\tilde{\varphi}$ is the inverse of the constant-consumption labor supply elasticity, which is identical to the Frisch elasticity since $\chi = 0$.

Consider first the frictionless entry model and recall the labor market equilibrium (LL) relation $\chi \hat{C}_t = \left(\frac{(\mu-1)\eta}{\mu-1+\eta} - \tilde{\varphi}\right) \hat{L}_t$. 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. To understand this, consider the labor market equilibrium. In the presence of a negative wealth effect, the labor supply curve shifts out. Real wages decline, which induces firms to increase their demand for labor. As a consequence, output and, for given markups, profits go up. This, in turn, induces new firms to enter the market. If the wealth effect on labor supply is shut off, as it is assumed here, this transmission mechanism breaks down since the supply of hours stays constant. Consequently, the competition effect does not come into play and there is no countercyclical markup movement, since there is no change in the number of firms.

In contrast, the standard New Keynesian model with GHH preferences does generate a consumption crowding-in. As mentioned above, GHH preferences shut off the wealth effect, preventing an outward shift of the labor supply curve. At the same time, markups remain countercyclical because prices do not adjust fully and firms raise production as demand for goods expands.

Turning to our calibrated benchmark model with endogenous model, we find that entry falls in response to a government spending expansion when the wealth effect is turned off, independently of the persistence of the shock. The reason is twofold. First, the wealth effect puts downward pressure on real wages and thus entry costs. Under GHH preferences, this effect vanishes, which in isolation depresses entry, compared to our benchmark preference structure. Second, the strong negative wealth effect on consumption under GHH preferences puts upward pressure on the real interest rate defined as the inverse of the stochastic discount factor. This lowers the value of a firm, which in turn discourages new firms to enter the market. The drop in entry raises the markup, which shifts inward the labor demand curve. Real wages and consumption decline. This holds independently of the size of the labor supply elasticity.

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

Rule-of-Thumb Consumers

In a second model variant, 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 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 our 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 9, we plot the impulse response function of GDP, consumption ($C_{n,t}$, $C_{o,t}$, and C_t), firm entry and markups for different values of the fraction of rule-of-thumb consumers: $\lambda = 0.1$, $\lambda = 0.5$, and $\lambda = 0.8$.

[insert Figure 9 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 sticky-price model of Galí, López-Salido and Vallés (2007).

Introducing Sticky Prices

In the two preceding sections, we combined features that reduce the importance of the wealth effect with our countercyclical markup mechanism working through firm entry and the competition effect. In models where markup countercyclicality is driven by price stickiness, 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 consumption crowding-in. To this end, we introduce quadratic price adjustment costs à la Rotemberg (1982), nominal bonds and a monetary policy rule.

The household can now invest in risk-free nominal bonds as well as shares. The modified household budget constraint (in real terms) reads as follows

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

Expenditure now additionally includes purchases of bonds B_t at the price of one currency unit. Income includes gross interest income on bond holdings. The variable r_{t-1} denotes the real interest rate on holdings of bonds between $t - 1$ and t.

The profit maximization problem of the representative firm producing variety (i, f) becomes

$$\max_{\{p_t(i,f)\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta_{0,t} \left[\frac{p_t\,(i, f)}{P_t} - w_t - \frac{\kappa}{2} \left(\frac{p_t\,(i, f)}{p_{t-1}\,(i, f)} - 1 \right)^2 \right] y_t\,(i, f)\,, \tag{22}$$

subject to the demand constraint $y_t(i,f) = (p_t(i,f)/P_t)^{-\varepsilon_t} Y_t^C$, where the price-elasticity of demand under Bertrand competition is given by $\varepsilon_t = \theta_f - (\theta_f - \theta_i)\frac{1}{N_t}$. Recall that for $\theta_f = \theta_i$, we obtain the CES structure à la Dixit and Stiglitz (1977). The last term in the square brackets in (22) captures price adjustment costs. Under symmetry, the first order condition for prices is

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

where $\mu_t = \varepsilon_t/(\varepsilon_t - 1)$ is the desired markup.

The real interest rate r_t is linked to the policy rate R_t through the Fisher relation, $r_t = R_t[E_t\{\pi_{t+1}\}]^{-1}$. Monetary policy is described by a simple interest rate feedback rule, $R_t = \pi_t^\tau$, where τ is set to a standard value of 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.

We now combine price stickiness with the two wealth-effect-reducing features. Figure 10 shows the impulse response functions of the CES model together with the oligopolistic competition (Bertrand) model. The top panel (10a) 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 (10b) shows the sticky-price model with GHH preferences.

[insert Figure 10 here]

As in the flexible-price economy described above, firm entry falls. This can be explained as follows. On the one hand, the demand expansion combined with price stickiness puts upward pressure on wages. This, in isolation, raises entry costs. On the other hand, there is a countervailing effect on wages which stems from the increase in labor supply due to the wealth effect. This puts downward pressure on entry costs. Under GHH preferences, the latter effect is turned off. As a consequence, higher entry costs induces a fall in entry. In the model with rule-of-thumb consumers, the small share of Ricardian households depresses the economy's investment activity. As a consequence, firm entry falls.

The drop in entry leads to a rise in the desired markup if the competition effect is present. In the CES model, though, 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 oligopolistic competition 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.[11]

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.

6 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 labor supply elasticity and the elasticity of substitution between goods. In a dynamic entry model, the number of firms rises if the spending shock is sufficiently persistent. However, even in that case, consumption falls due to the wealth effect of expected (future) tax increases to finance the current rise in spending. To predict a rise in both entry and consumption, the model needs either an extremely elastic labor supply or a strong competition effect. We introduce two additional features that help to reduce the wealth effect in sticky-price models with a constant number of firms. First, the presence rule-of-thumb households 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 variant leads to a counterfactual drop in entry. Second, we introduce a particular preference specification which allows us to switch off the wealth effect. In both models, entry falls, such that markups rise and consumption

[11] 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.

contracts. This negative consumption response cannot be overcome through the introduction of price rigidities. We propose useful, i.e. utility- or productivity-enhancing, government spending as a device to solve the consumption crowding-in puzzle while generating an expansion of firm entry in response to positive spending shocks.

References

[1] Amano, R.A., Wirjanto, T.S., 1998. Government Expenditures and the Permanent Income Model. Review of Economic Dynamics 1, 719-730.

[2] Alesina, A., Ardagna, S., Perotti, R., Schiantarelli, F., 2002. Fiscal Policy, Profits, and Investment. American Economic Review 92, 571-589.

[3] Aschauer, D., 1985. Fiscal Policy and Aggregate Demand. American Economic Review 75, 117-27.

[4] Baxter, M., King, R.G., 1993. Fiscal Policy in General Equilibrium. American Economic Review 83, 315-34.

[5] Bilbiie, F.O., 2011. Nonseparable Preferences, Frisch Labor Supply, and the Consumption Multiplier of Government Spending: One Solution to a Fiscal Policy Puzzle. Journal of Money, Credit and Banking 43, 221-251.

[6] Bilbiie, F.O., Ghironi, F., Melitz, M.J., 2012. Endogenous Entry, Product Variety, and Business Cycles. Journal of Political Economy 120, 304-345.

[7] Blanchard, O., Perotti, R., 2002. An Empirical Characterization of The Dynamic Effects of Changes in Government Spending and Taxes On Output. Quarterly Journal of Economics 117, 1329-1368.

[8] Bouakez, H., Rebei, N., 2007. Why Does Private Consumption Rise after a Government Spending Shock? Canadian Journal of Economics 40, 954-979.

[9] Broda, C., Weinstein, D.E., 2006. Globalization and the Gains from Variety. Quarterly Journal of Economics 121, 541-585.

[10] Caldara, D., Kamps, C., 2008. What are the Effects of Fiscal Shocks? A VAR-based Comparative Analysis. Working Paper Series 877, European Central Bank.

[11] Colciago, A., Etro, F., 2010. Endogenous Market Structures and the Business Cycle. Economic Journal 120, 1201-1233.

[12] Colciago, A., Rossi, L., 2012. Endogenous Market Structures and Labor Market Dynamics. Manuscript, University of Pavia and University of Milan - Biccocca.

[13] Corsetti, G., Pesenti, P., 2007. The Simple Geometry of Transmission and Stabilization in Closed and Open Economies. NBER International Seminar on Macroeconomics, 65-116 National Bureau of Economic Research, Inc.

[14] Davis, S.J., Haltiwanger, J., 1990. Gross Job Creation and Destruction: Microeconomic Evidence and Macroeconomic Implications. NBER Macroeconomics Annual 5, 123-168.

[15] Devereux, M.B., Head, A.C., Lapham, B.J., 1996. Monopolistic Competition, Increasing Returns, and the Effects of Government Spending. Journal of Money, Credit and Banking 28, 233-54.

[16] Devereux, M.B., Lee, K.M., 2001. Dynamic Gains from International Trade with Imperfect Competition and Market Power. Review of Development Economics 5, 239-55.

[17] Dixit, A.K., Stiglitz, J.E., 1977. Monopolistic Competition and Optimum Product Diversity. American Economic Review 67, 297-308.

[18] Domowitz, I., Hubbard, R.G., Petersen, B.C., 1988. Market Structure and Cyclical Fluctuations in U.S. Manufacturing. Review of Economics and Statistics 70, 55-66.

[19] Finn, M.G., 1998. Cyclical Effects of Government's Employment and Goods Purchases. International Economic Review 39, 635-57.

[20] Fisher, J.D.M., Peters, R., 2010. Using Stock Returns to Identify Government Spending Shocks. Economic Journal 120, 414-436.

[21] Galí, J., López-Salido, J.D., Vallés, J., 2007. Understanding the Effects of Government Spending on Consumption. Journal of the European Economic Association 5, 227-270.

[22] Gnocchi, S., Hauser, D., Pappa, E., 2012. Housework and fiscal expansion. UAB Working Paper.

[23] Greenwood, J., Hercowitz, Z., Huffman, G.H., 1988. Investment, Capacity Utilization, and the Real Business Cycle. American Economic Review 78, 402-417.

[24] Hall, R.E., 2009. By How Much Does GDP Rise if the Government Buys More Output? Brookings Papers on Economic Activity 40, 183-249.

[25] Jacob, P., 2013. Deep Habits, Price Rigidities and the Consumption Response to Government Spending. Ghent University Faculty of Economics and Business Administration Working Paper 2010/641.

[26] Jaimovich, N., Floetotto, M., 2008. Firm Dynamics, Markup Variations, and the Business Bycle. Journal of Monetary Economics 55, 1238-1252.

[27] Karras, G., 1994. Government Spending and Private Consumption: Some International Evidence. Journal of Money, Credit, and Banking 26, 9-22.

[28] Keane, M., Rogerson, R., 2012. Micro and Macro Labor Supply Elasticities: A Reassessment of Conventional Wisdom. Journal of Economic Literature 50, 464-76.

[29] Leeper, E.M., Walker, T.B., Yang, S.S., 2009. Fiscal Foresight and Information Flows. NBER Working Papers 14630, National Bureau of Economic Research, Inc.

[30] Lewis, V., Poilly, C., 2012. Firm Entry, Markups and the Monetary Transmission Mechanism. Journal of Monetary Economics 59, 670-685.

[31] Linnemann, L., Schabert, A., 2006. Productive Government Expenditure In Monetary Business Cycle Models. Scottish Journal of Political Economy 53, 28-46, 02.

[32] Linnemann, L., Schabert, A., 2004. Can Fiscal Spending Stimulate Private Consumption? Economics Letters 82, 173-179.

[33] Monacelli, T., Perotti, R., 2008. Fiscal Policy, Wealth Effects, and Markups. Manuscript.

[34] Mountford, A., Uhlig, H., 2009. What are the Effects of Fiscal Policy Shocks? Journal of Applied Econometrics 24, 960–992.

[35] Perotti, R., 2008. In Search of the Transmission Mechanism of Fiscal Policy. NBER Macroeconomics Annual 22, 169-226.

[36] Ramey, V.A., 2011. Identifying Government Spending Shocks: It's all in the Timing. Quarterly Journal of Economics 126, 1-50.

[37] Ravn, M.O., Schmitt-Grohé, S., Uribe, M., 2012. Consumption, Government Spending, and the Real Exchange Rate. Journal of Monetary Economics 59, 215-234.

[38] Rotemberg, J.J., 1982. Monopolistic Price Adjustment and Aggregate Output. Review of Economic Studies 49, 517-31.

[39] Smets, F., Wouters, R., 2007. Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach. American Economic Review 97, 586-606.

[40] Spletzer, J.R., 1998. The Contribution of Establishment Births and Deaths to Employment Growth, Bureau of Labor Statistics Working Paper 310.

Table 1. Effects of US Government Spending Expansions: Empirical Results

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
Firm entry 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 firm entry measure we use the series (8) and (9). Notice that the latter series were discontinued in the mid-1990s.

Table 3. 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
$Y \hat{Y}_t = L \hat{L}_t - \psi N \hat{N}_t$	Aggregate production function
$(\mu - 1) Y \hat{Y}_t + Y \mu \hat{\mu}_t = \psi N \hat{N}_t$	Aggregate free entry condition

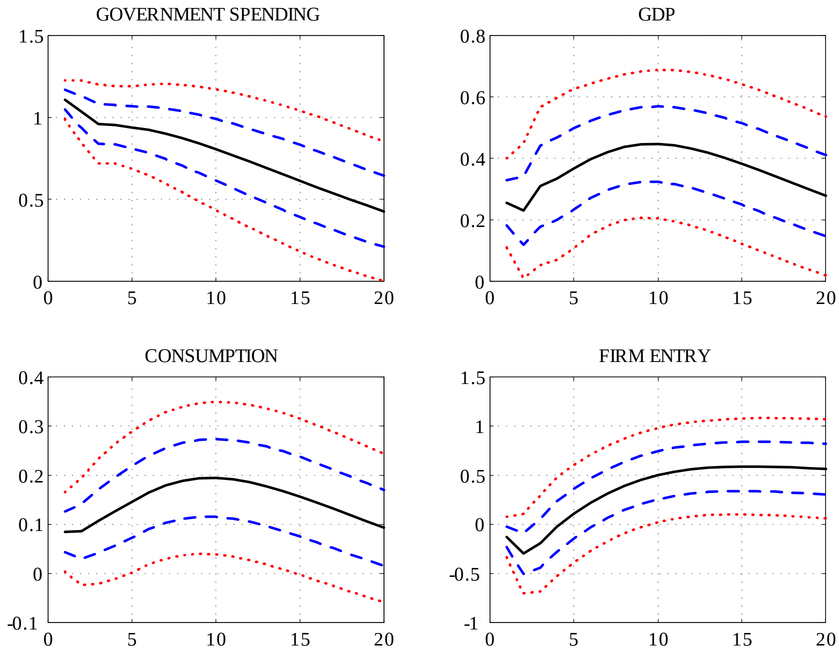


Figure 1a: Blanchard-Perotti VAR with Net Business Formation

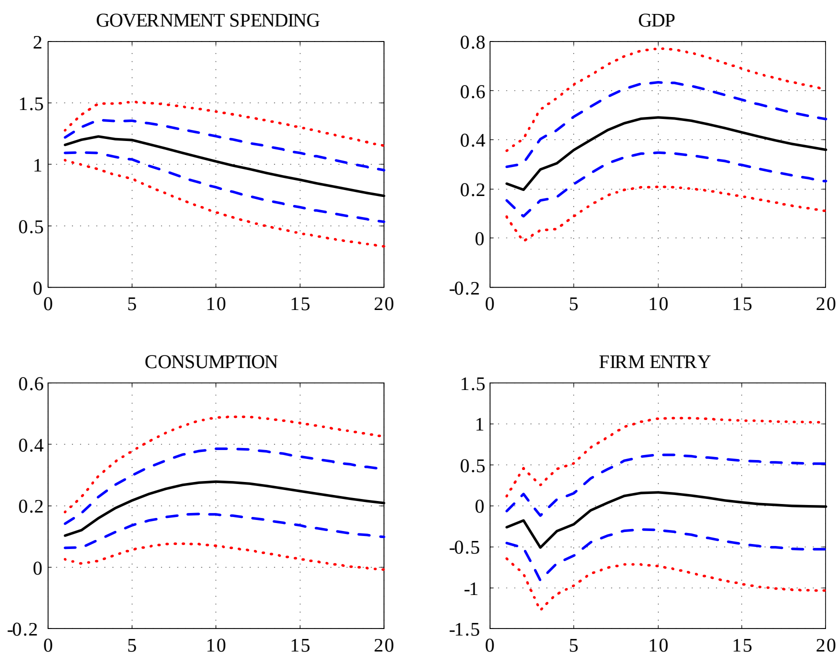


Figure 1b: Blanchard-Perotti VAR with New Incorporations

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.

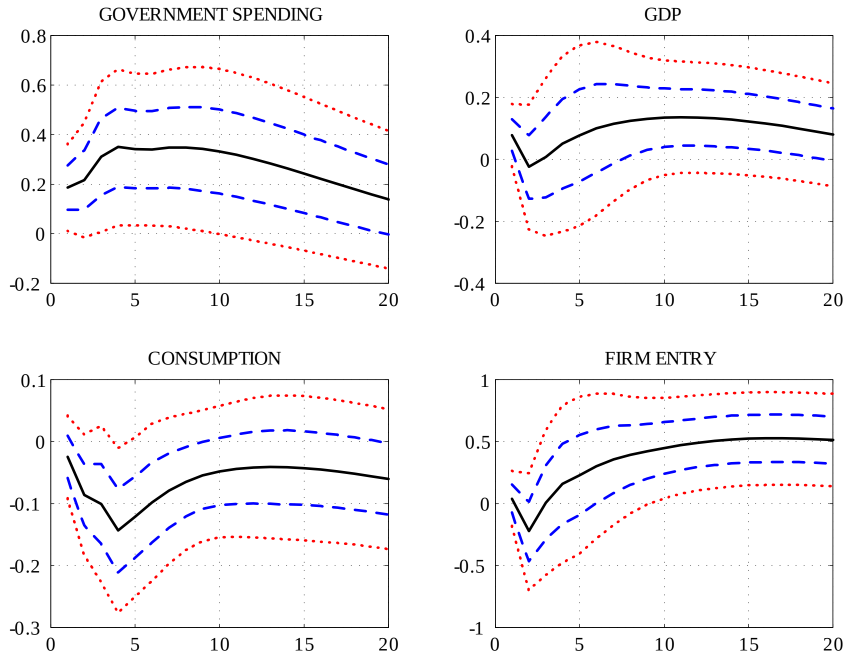


Figure 2a: Ramey EVAR with Net Business Formation

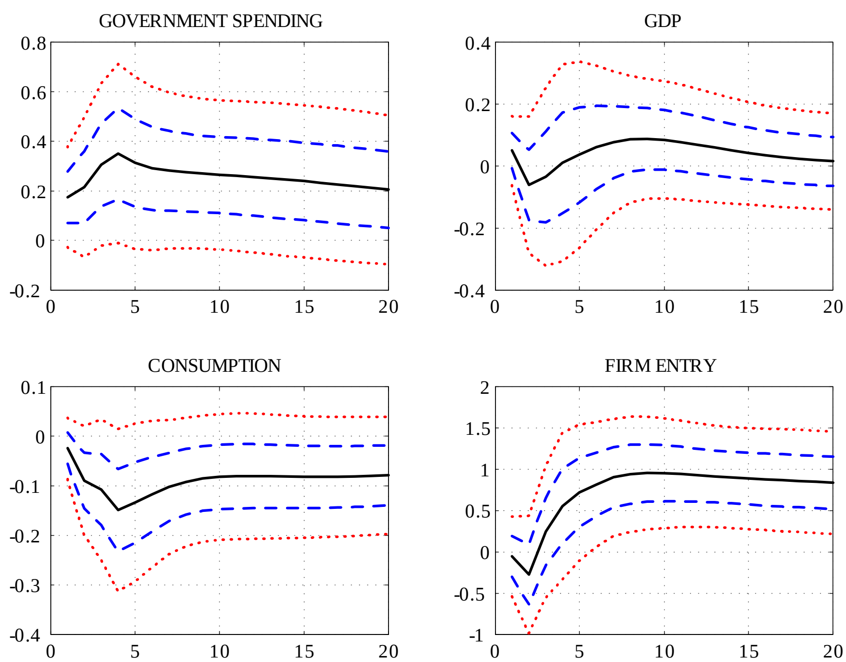


Figure 2b: Ramey EVAR with New Incorporations

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.

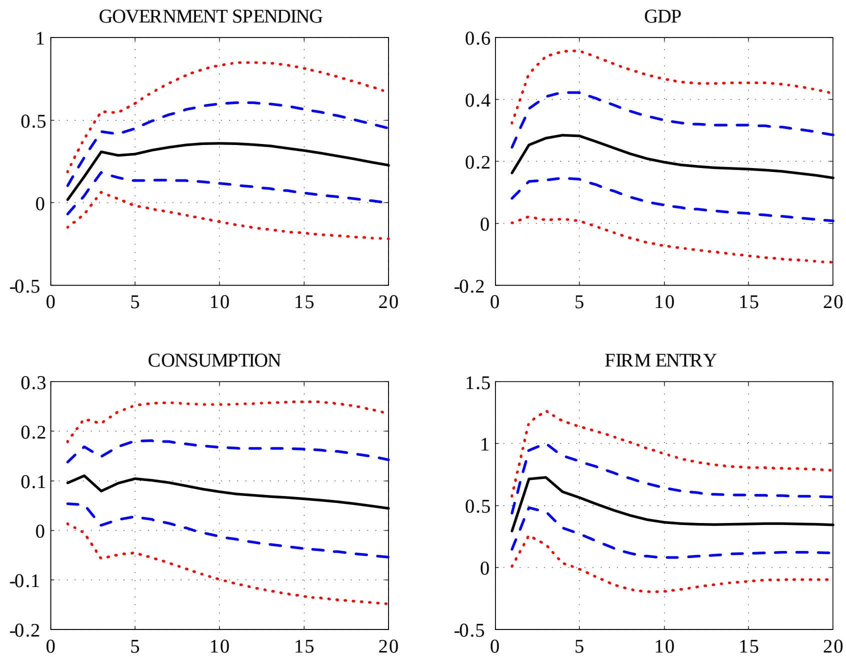


Figure 3a: Fisher-Peters EVAR with Net Business Formation

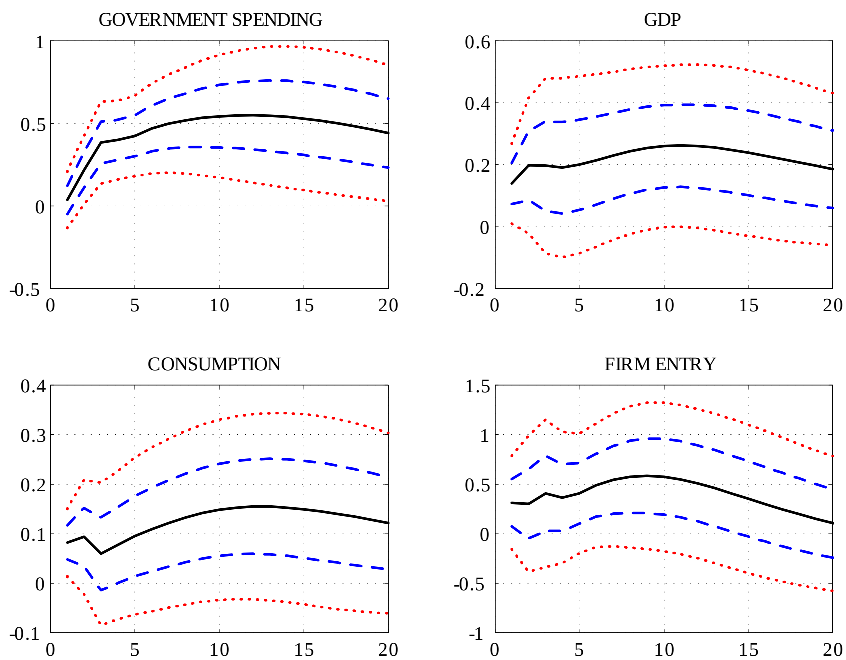


Figure 3b: Fisher-Peters EVAR with New Incorporations

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.

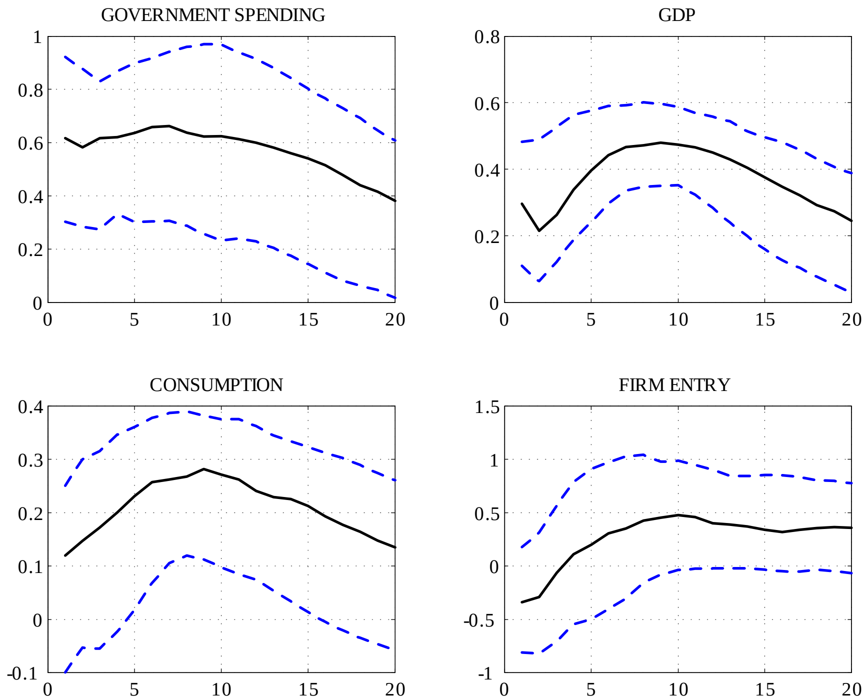


Figure 4a: Sign Restrictions VAR with Net Business Formation

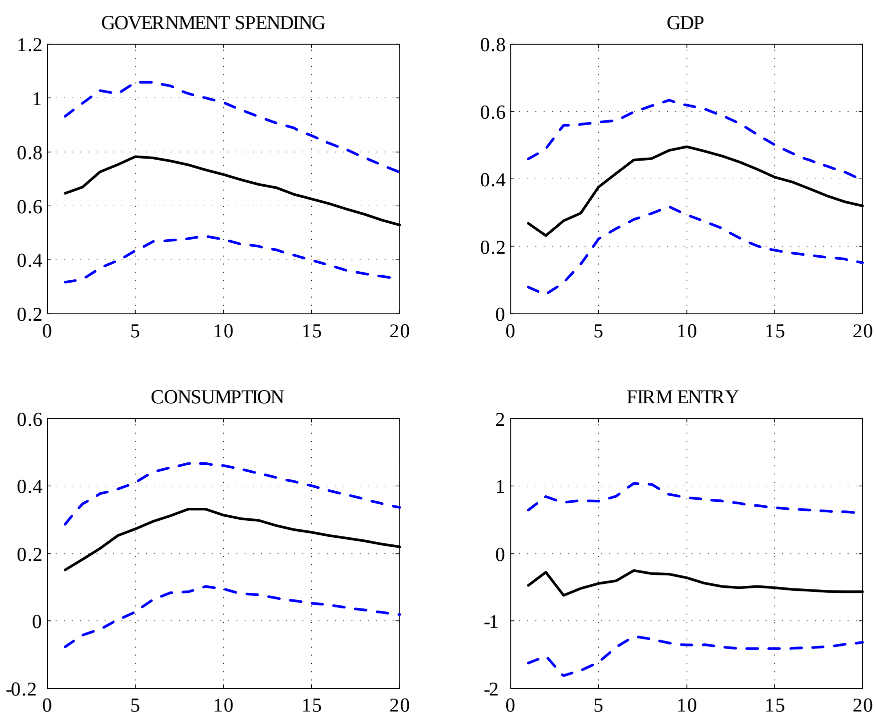
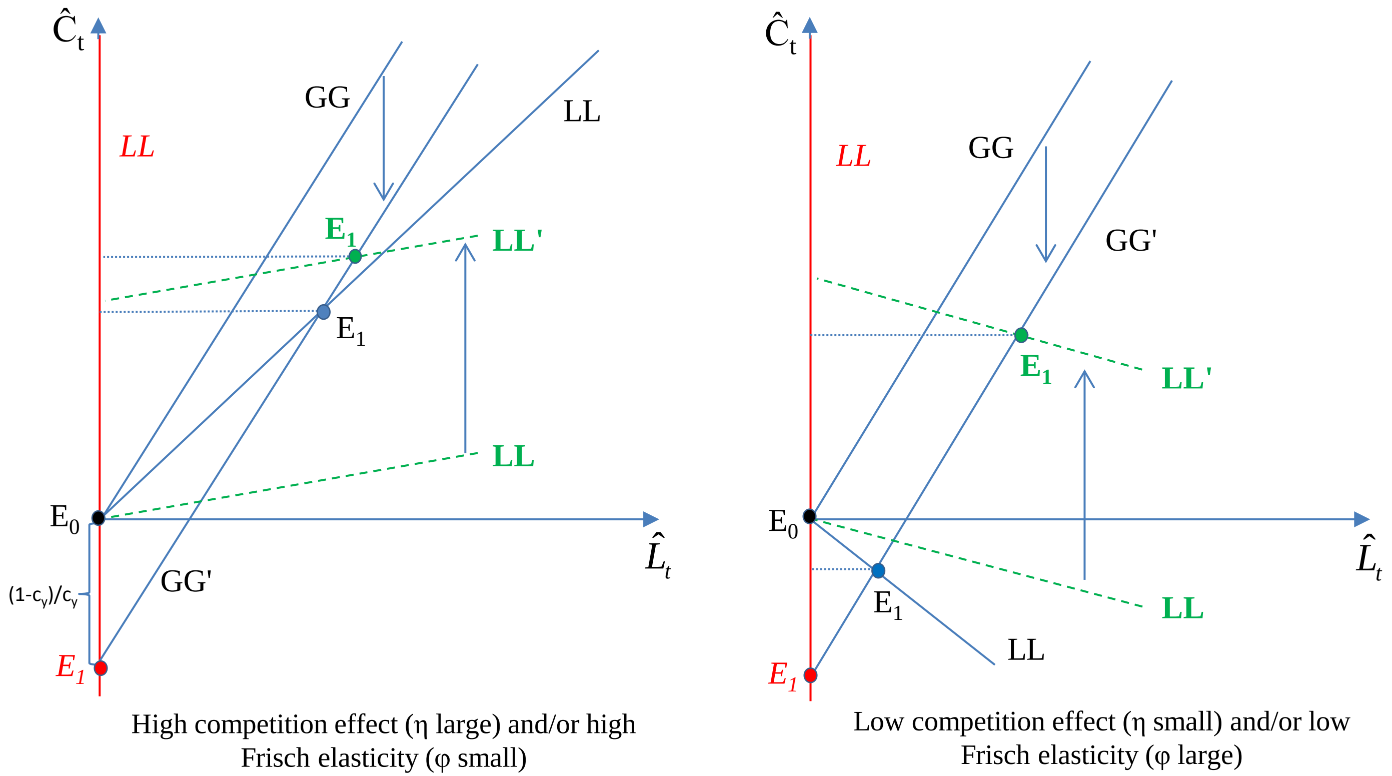


Figure 4b: Sign Restrictions VAR with New Incorporations

The figure shows the impulse response functions (IRFs) to a one-standard-deviation government spending shock. The shock is identified with sign restrictions similar to 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.

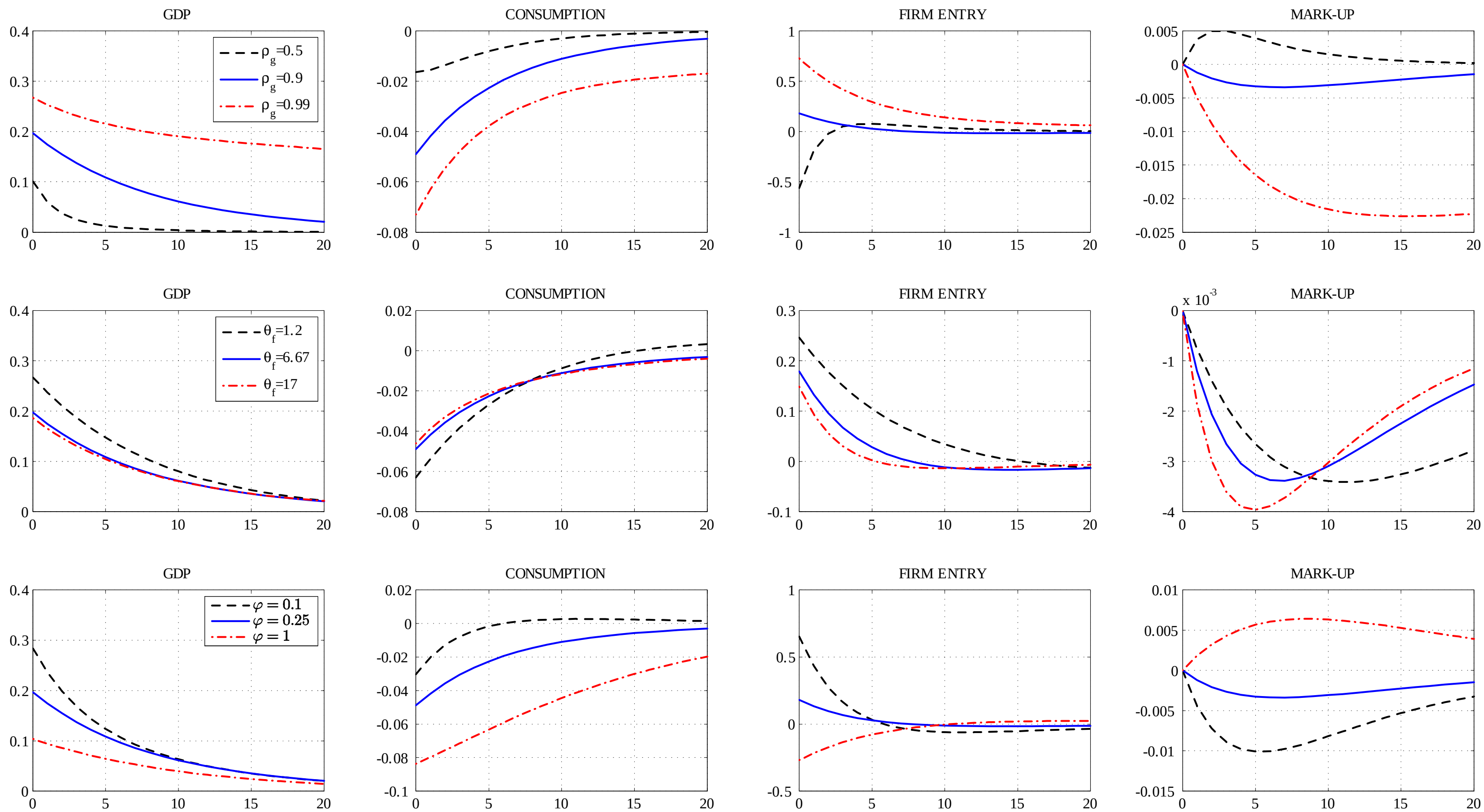


Figure 6: Benchmark Model: Varying Shock Persistence, Competition Effect and Labor Supply Elasticity

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 carry out parameter perturbations for the shock persistence parameter $\rho_g \in \{0.5, 0.9, 0.99\}$, the competition effect $\theta_f \in \{1.2, 6.67, 17\}$, and the labor supply elasticity $\varphi \in \{0.1, 0.25, 1\}$.

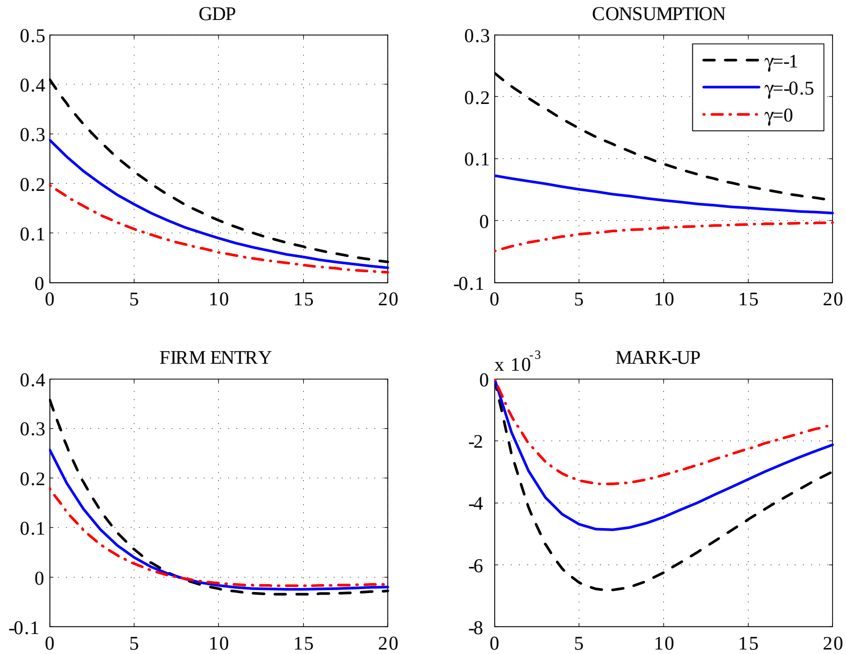


Figure 7a: Model with Utility-Enhancing Government Spending

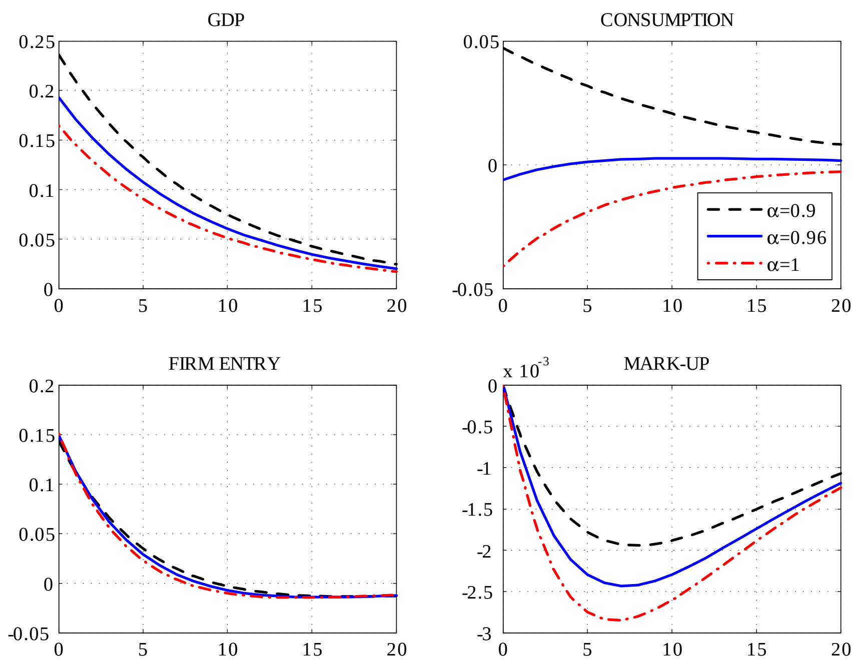
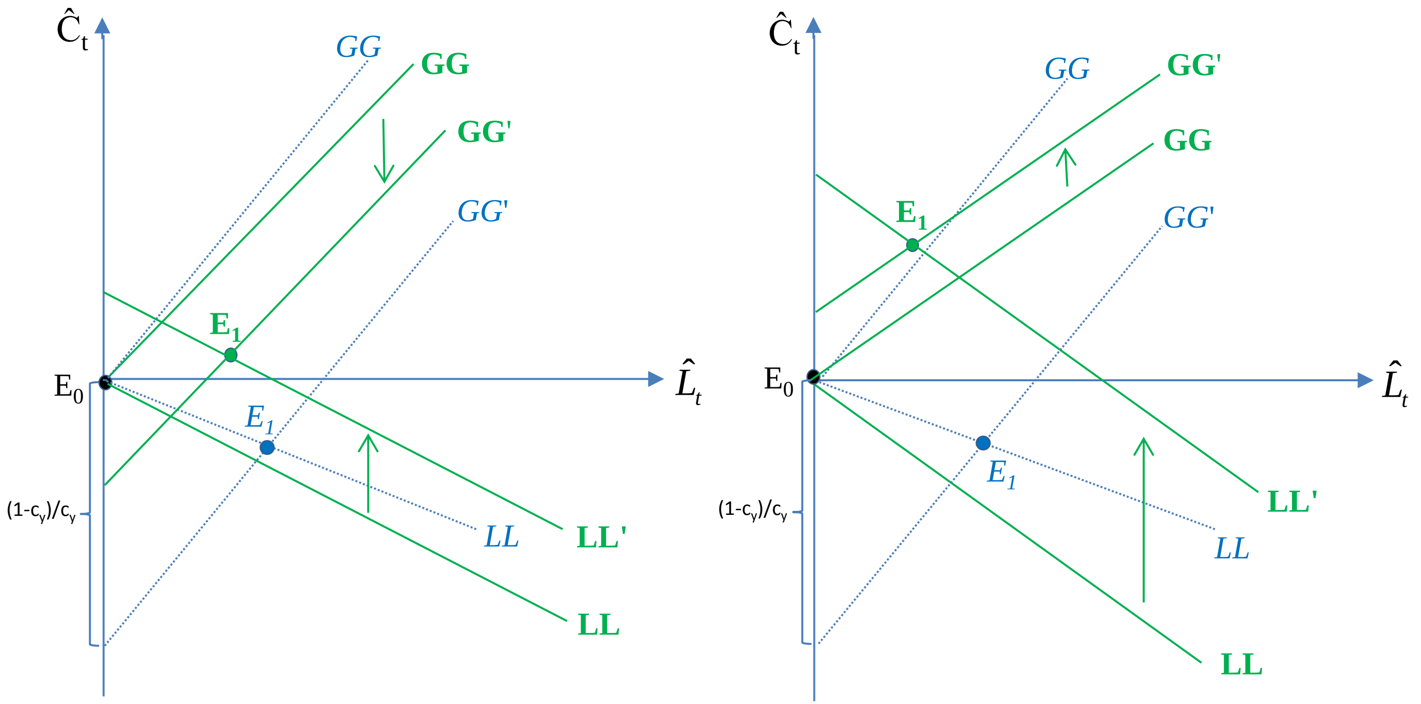


Figure 7b: Model with Productivity-Enhancing Government Spending

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- or productivity-enhancing government spending. On the vertical axis, the IRFs are measured in percentage changes. On the horizontal axes, the horizon is given in quarters.

Figure 8: Frictionless Entry Model with Productive Government Spending



Large share of govt spending in production 1-α

Very large share of govt spending in production 1-α

This figure shows the effects of a government spending expansion in the frictionless entry model with productive government spending. 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. We focus on the case of a downward-sloping LL curve. The *LL* and *GG* curve (in italics) represents the case of unproductive government spending which is depicted for the sake of comparison. As (1-α) increases, the **GG** and **LL** (both in bold letters) curves rotate clockwise. If the share of government spending (1-α) is sufficiently large, as it is assumed here, crowding-in of consumption is still possible. If government spending is productive, the **LL** curve shifts upwards in response to a government spending expansion. The **GG** curve also shifts in response to government spending expansions. In the left panel, in which the share of government spending in the production function (1-α) is assumed to be fairly large, the **GG** curve shifts down. The new equilibrium **E_1** is associated with higher consumption and employment. In the right panel, where the share of government spending in the production function (1-α) is assumed to be very large, the **GG** curve shifts up and consumption rises unambiguously.

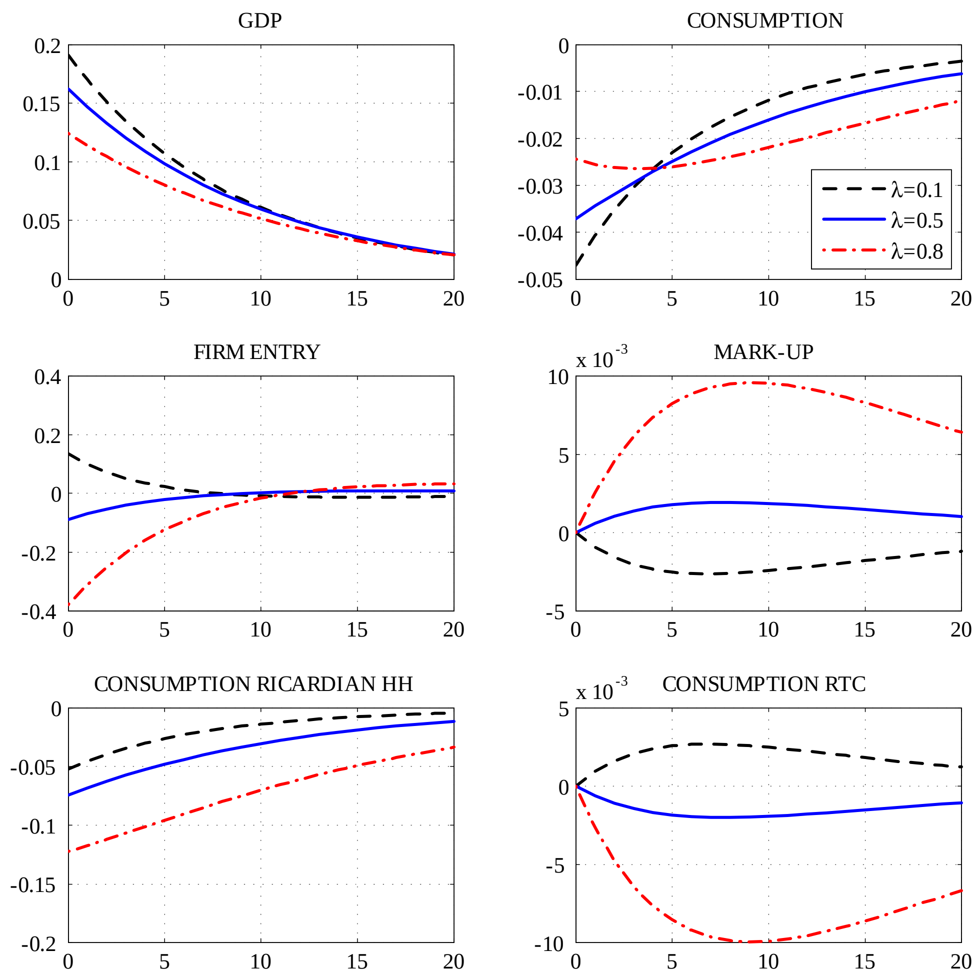


Figure 9: Model with Rule-of-Thumb Consumers

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. 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).

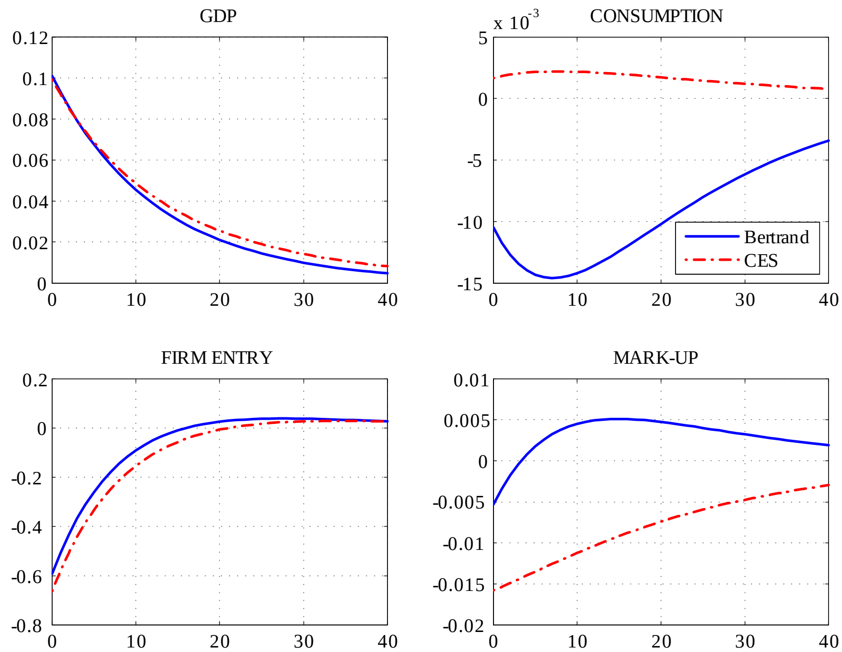


Figure 10a: Sticky-Price Model with Rule-of-Thumb Consumers

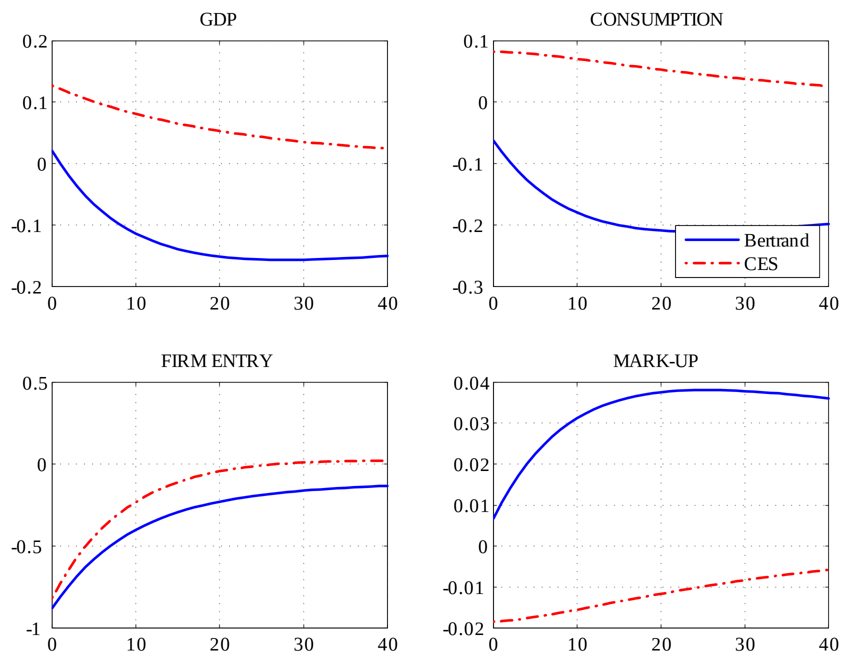


Figure 10b: Sticky-Price Model with GHH Preferences

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, Hercowitz and Huffman (1988). On the vertical axis, the IRFs are measured in percentage changes. On the horizontal axes, the horizon is given in quarters. The label 'Bertrand' refers to the benchmark model with an oligopolistic market structure and a competition effect, 'CES' refers to the model without a competition effect.