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## Conference Paper

# Fiscal Stimulus and the Extensive Margin

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2013: Wettbewerbspolitik und Regulierung in einer globalen Wirtschaftsordnung - Session: Fiscal Policy, No. D01-V2

### Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

*Suggested Citation:* Winkler, Roland; Lewis, Vivien (2013) : Fiscal Stimulus and the Extensive Margin, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2013: Wettbewerbspolitik und Regulierung in einer globalen Wirtschaftsordnung - Session: Fiscal Policy, No. D01-V2, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg

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# Fiscal Stimulus and the Extensive Margin\*

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15th January 2013

## Abstract

Using VAR analysis on US data, we show that unanticipated fiscal expansions boost private consumption and business formation. Models with an extensive investment margin, i.e. endogenous firm and product entry, have difficulties explaining these two phenomena simultaneously. Considering different variants of an endogenous-entry business cycle model, we show that crowding-in of both consumption and entry can be generated only under very specific assumptions. In a static model with full depreciation, labor supply has to be extremely elastic. In a dynamic model, the fiscal stimulus must be sufficiently persistent such that future profits are high enough to generate entry. However, consumption falls for conventional parameter values. Lowering the wealth effect through the introduction of rule-of-thumb consumers or GHH preferences does not help to bring the model closer to the data.

JEL classification: E21, E32, E62

Keywords: entry, extensive margin, competition effect, consumption, crowding-out, fiscal expansion

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\*We thank Christian Bredemeier, Falko Juessen and Stefania Villa for helpful discussions. All remaining errors are ours.

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# 1 Introduction

What are the effects of fiscal expansions? To answer this question, researchers have estimated vector autoregressions (VARs) where an exogenous shock to government spending is identified. Most of these VAR studies focus on private consumption as the main variable of interest. In this paper, we additionally investigate the effects of government spending on firm/product entry, both empirically and theoretically. The reasons are twofold.

First, there is a tension in the literature between empirical studies on the one hand, which typically find evidence for a crowding-in effect on consumption, and standard business cycle models on the other hand, which instead predict a crowding-out effect. In those models, the negative wealth effect of a positive government spending shock induces households to consume less and to work more. The labor supply curve shift to right, which causes real wages to decline along an unchanged labor demand schedule. A way to overturn the crowding-out result is to allow for mechanisms that generate an increase in real wages as a result of an upward shift of the labor demand curve. An upward shift of the labor demand curve in response to an increase in government spending can be explained through countercyclical markups. One mechanism to generate countercyclical markups is the ‘competition effect’ by which markups drop when firm and product entry raises the degree of competition in an economy, which is usually the case in an expansionary phase of the business cycle.

The second motivation to study the response of firm entry to government spending shocks is that firm turnover is associated with a substantial amount of job creation and destruction. Davis and Haltiwanger (1990) attribute 25% of US annual job destruction to firm exit and 20% of annual job creation to entry, while Spletzer (1998) reports over one third for these two measures. Since employment opportunities have a large impact on individual welfare, it is important to understand, in a first step, how entry reacts to a fiscal stimulus.<sup>1</sup>

Most empirical studies suggest that private consumption responds positively after an expansionary government spending shock. Evidence on the effect of fiscal expansions on firm and product entry is so far missing in the literature. Lewis (2009) shows that net business formation rises significantly after an expansionary aggregate demand shock. In that paper, aggregate demand shocks are broadly defined and identified with sign restrictions. Here, we want to isolate government spending shocks and therefore apply the identification method of Blanchard and Perotti (2002).

We then analyze different variants and calibrations of the endogenous-entry model with the aim of capturing, at least qualitatively, the observed dynamics. The first (‘static’) model

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<sup>1</sup>A first attempt to model both endogenous firm entry and unemployment jointly has been made by Colciago and Rossi (2012), who show that the extensive margin of job creation due to firm entry amplifies the response of labor market variables to technology shocks.

assumes that firms must pay a fixed per-period cost for the right to produce. The second (‘dynamic’) model builds on Bilbiie, Ghironi and Melitz (2012), where investment takes the form of new product introductions and entry costs are sunk costs incurred only once at the time of entry. We allow for a more general entry cost specification that combines materials and labor. This enables us to nest two cases that have been considered in the literature: one where entry costs are in terms of final output and one where entry requires labor services. Regarding the determination of the markup, we consider three alternative setups: monopolistic competition, Bertrand competition and demand-side complementarities through a translog expenditure function. Markups are constant in the first case, but countercyclical in the other two.

Our empirical results indicate that fiscal expansions lead to higher private consumption and a delayed rise in net business formation. We show that in the model, it is not straightforward to replicate these two phenomena simultaneously.

In the *static* model, entry rises unambiguously, while consumption falls in a typical calibration. It is well understood that this result comes from a negative wealth effect. Higher (future) taxes raise the shadow value of wealth, which reduces current consumption. The sign of the consumption response can be turned around only by assuming an implausibly high labor supply elasticity. In such a case, the rise in real wages due to the drop in markups overturns the negative wealth effect since the substitution effect away from leisure towards consumption is strong enough.

In the *dynamic* model, firm entry, which represents investment at the extensive margin, reacts positively only if the government spending increase is sufficiently persistent. As for the consumption response, two alternatives to the elastic-labor-assumption proposed in the literature are a significant role for ‘rule-of-thumb’ households that neither save nor borrow, or a more general specification of preferences with a reduced intertemporal wealth effect. We demonstrate that neither of these two modelling devices is successful in generating a rise in consumption. The reason is that a reduced wealth effect leads to a reduction in extensive-margin investment, which pushes up the markup through the competition effect and thereby results in a drop in consumption. Whether entry costs are specified in terms of final output or in labor units does not change our findings qualitatively.

The paper that is closest to ours is Devereux, Head and Lapham (1996), who analyze government spending shocks in the presence of increasing returns to specialization. We ignore specialization or variety effects here and focus instead on markup countercyclicity coming from changes in competition. Monacelli and Perotti (2008) emphasize the importance of markups in the transmission of fiscal policy shocks. However, they remain within the fixed-variety framework, in which the number of firms and products is constant over time. Bilbiie

(2011) discusses some of the mechanisms we introduce in the model, but does not consider a combination of them as we do here. Finally, Totzek and Winkler (2010) analyze how different types of fiscal expansions affect the number of entrants. In this paper, we limit attention to exogenous changes in government spending.

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

## 2 VAR Evidence

In this section, we identify the effect of fiscal expansions in vector autoregressions estimated on US data. First, our benchmark specification is a recursively identified four-variable VAR of government spending, output, consumption and a measure of the extensive margin. The identifying assumption is that government spending is the only variable that reacts to fiscal shocks within the quarter. Second, we estimate a Bayesian VAR and identify fiscal expansions using sign restrictions. A fiscal shock is one that increases government spending and is orthogonal to a (suitably identified) business cycle shock.

The reduced-form VAR is given by

$$\mathbf{x}_t = \boldsymbol{\mu} + B^{-1}C(L)\mathbf{x}_{t-1} + B^{-1}\boldsymbol{\varepsilon}_t, \quad (1)$$

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

### 2.1 Recursive Identification

In our baseline specification, we estimate a vector autoregression model on US government spending  $g_t$ , output  $y_t$ , consumption  $c_t$ , and a measure of the extensive margin  $x_t$ . Thus  $m = 4$  and  $\mathbf{x}_t = (g_t, y_t, c_t, x_t)$ . All variables are in logarithms. We use two measures of entry: net business formation  $nbf_t$  and new incorporations  $ni_t$ . The data sources, sample periods

and variable transformations are given in Table 1.

[ insert Table 1 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.<sup>2</sup> Following Blanchard and Perotti (2002), we impose that  $B$  is lower triangular. Thus, we assume that government spending reacts only to fiscal shocks within the quarter, such that the contemporaneous response to other shocks is zero. The maximum lag  $q$  is set equal to three quarters.

Figures 1 and 2 present the impulse responses to a fiscal expansion given by a one percent rise in government spending. Consider first Figure 1, where the extensive margin  $x_t$  is measured as an index of net business formation, corresponding to *net* firm entry.

[ insert Figure 1 here ]

We observe a hump-shaped rise in government spending that dies out after eight quarters. Private consumption rises significantly in the medium-run between quarters 4 and 15. The finding of a crowding-in effect is consistent with a large number of studies, including Blanchard and Perotti (2002) and Galí et al (2007). The increase in output is longer-lasting than the positive consumption response. Importantly, there is a significant, though delayed, rise in the net business formation.

[ insert Figure 2 here ]

Figure 2 shows that firm entry measured as the number of new incorporations, is not significantly affected by a fiscal stimulus. Given the evidence presented, we conclude that net firm creation and private consumption rise in response to a fiscal expansion. The remainder of this section analyzes whether this finding is robust to the identification method and to the measure of government spending used.

## 2.2 Identification with Sign Restrictions

This section checks the robustness of our key findings to the VAR 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 private investment  $inv_t$  and government revenues  $rev_t$ , such that

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<sup>2</sup>Estimation results based on the full sample including the Korean War are available from the authors upon request.

$m = 6$ . The definitions of government revenues and investment are given in Table 1.

We identify two shocks: a business cycle shock and a fiscal policy shock. The business cycle shock raises government revenues, GDP, consumption and investment for four quarters. The fiscal policy shock raises government spending for four quarters in a row, and is orthogonal to the business cycle shock. No restriction is imposed on the effects of fiscal shocks on the other variables. Also, no restriction is imposed on the response of the extensive margin measure to either of the two shocks. The identifying sign restrictions are presented in Table 2.

[ insert Table 2 here ]

Since our analysis focus 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. As in the recursively identified VAR, we include a constant and a 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 3. 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 is conventionally done in the literature on VARs identified with sign restrictions. Recall that the only restrictions imposed are an increase in government spending during the first four quarters after the shock and the orthogonality with respect to the business cycle shock.

[ insert Figure 3 here ]

The responses of consumption and output look similar to the ones in Figures 1 and 2 obtained under a recursive identification scheme. We observe a significant rise in both variables in the medium run. Private investment and government revenues also rise significantly. Although the increase in net business formation is marginally insignificant, these results confirm that crowding-out of consumption or of firm entry is not supported by the data.

### 2.3 Robustness

So far, we have used total government expenditure as our measure of  $g_t$ . Mountford and Uhlig (2009) propose a measure of government spending that excludes expenditures that vary over the business cycle, such as transfer payments. [ *to be added* ]

### 3 Model

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

#### 3.1 Households

Households maximize lifetime utility given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left( \ln C_t - \chi \frac{L_t^{1+\varphi}}{1+\varphi} \right),$$

where  $C_t$  is consumption,  $L_t$  is labor supply,  $\chi$  is a constant and  $\varphi$  is the inverse Frisch elasticity of labor supply to the real wage. There are two assets, risk-free real bonds and shares. The household's period budget constraint is

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

Expenditure includes purchases of bonds  $B_t$  at the price of one currency unit and shares  $x_t$  at price  $v_t$ , consumption, and lump-sum taxes  $T_t$ . Income comprises gross interest income on bond holdings, dividends, the market value of share holdings, and wage income. The variable  $r_{t-1}$  denotes the real interest rate on holdings of bonds between  $t - 1$  and  $t$ . The number of producers is  $N_t$ , while the number of entrants is denoted  $N_{E,t}$ .<sup>3</sup> A fraction  $\delta$  of firms exits the market each period, such that the value of firms  $v_t N_t$  is multiplied by  $(1 - \delta)$ . Since the labor market is perfectly competitive, the real wage is set equal to the marginal rate of substitution between leisure and consumption,

$$w_t = \chi L_t^\varphi C_t. \tag{2}$$

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<sup>3</sup>For expositional purposes, we refer to the measure of firms and goods as ‘number’ of goods although strictly speaking, it is a continuous *mass* of firms and goods.



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

$$C_t^{-1} = \beta (1 + r_t) E_t C_{t+1}^{-1}, \quad v_t = \beta (1 - \delta) E_t \frac{C_t}{C_{t+1}} (v_{t+1} + d_{t+1}).$$

### 3.2 Production

Each firm produces a single goods variety under a production technology that is linear in labor and facing a fixed cost,  $y_t = l_{C,t} - \phi$ . Profits per firm are therefore  $d_t = \rho_t y_t - w_t (y_t + \phi)$ , where the real wage  $w_t$  is the marginal cost of production and a firm's relative price is defined  $\rho_t = p_t/P_t$ . We now specify three alternative ways in which intermediate goods  $\omega$  are combined to produce a final goods bundle. First, households consume a CES aggregate of  $N_t$  goods,

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

where the number of available goods is large and the elasticity of substitution across them is  $\theta$ . Household demands for each individual good are  $c_t = \rho_t^{-\theta} C_t$ . The relative price equals unity and the markup of goods prices over marginal cost,

$$\mu_t(N_t) = \frac{\rho_t(N_t)}{w_t}, \tag{3}$$

is constant. Denote by  $\eta_t(N_t)$  the elasticity of the markup with respect to the number of firms, which we call the ‘competition effect’,

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

In a more general setting, this elasticity may depend (negatively) on the number of firms. However, since the markup is constant in the CES model, the elasticity here is nil. Therefore,

$$\rho_t(N_t) = 1, \quad \mu_t(N_t) = \frac{\theta}{\theta - 1}, \quad \eta_t(N_t) = 0.$$

Second, we assume an alternative market structure as in Devereux and Lee (2001) and Jaimovich and Floetotto (2008). There exists a large number of differentiated industries on the unit interval, indexed by  $i \in [0, 1]$ . Within each industry, there is oligopolistic competition between a small and variable number of firms, indexed by  $f = 1, \dots, N_t$ . The

production functions of industrial goods  $c_t(i)$  and of the final good  $C_t$  are, respectively,

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

Under Bertrand competition, the relative price is again unity, while the markup in this case varies negatively with the number of producers,

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

and the competition effect is

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

Third, we follow Bilbiie, Ghironi and Melitz (2012), who stipulate a translog expenditure function on the differentiated products, which delivers a relative price, markup and competition effect given by

$$\rho_t(N_t) = \exp\left(-\frac{1}{2} \frac{\tilde{N} - N_t}{\tilde{\sigma} \tilde{N} N_t}\right), \quad \mu_t(N_t) = \frac{1 + \tilde{\sigma} N_t}{\tilde{\sigma} N_t}, \quad \eta_t(N_t) = \frac{1}{1 + \tilde{\sigma} N_t},$$

where  $\tilde{N}$  is the (large) number of all conceivable goods, while  $\tilde{\sigma}$  captures the price-elasticity of the share of spending on a particular good. Aggregate consumption output (in real terms) is firm revenue multiplied by the number of firms and by the relative price,  $Y_t = \rho_t y_t N_t$ .

### 3.3 Government

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

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

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

### 3.4 Static Entry Model

The first model assumes full depreciation of existing 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. 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,  $N_t y_t \rho_t(N_t) = Y_t$ . Total output is used for private and public, consumption

$$Y_t = C_t + G_t. \quad (6)$$

Firm entry drives profits to zero, such that the free entry condition is  $d_t = 0$ . As a consequence, firm value is also zero,  $v_t = 0$  for all  $t$ . Rearranging the definition of the markup as  $mc_t = \rho_t(N_t)/\mu_t(N_t)$ , the zero-profit condition becomes

$$(\mu_t(N_t) - 1) y_t = \phi. \quad (7)$$

Together with the production function, the zero-profit condition (7) implies that GDP and the number of firms/entrants are, respectively,

$$Y_t = \frac{\rho_t(N_t) L_t}{\mu_t(N_t)}, \quad (8)$$

$$N_t = \frac{(\mu_t(N_t) - 1) L_t}{\mu_t(N_t) \phi}. \quad (9)$$

Table 3 summarizes the three variants of the static model: CES, Bertrand and Translog.

[ insert Table 3 here]

### 3.5 Dynamic Entry Model

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

such that the free entry condition is  $v_t(\omega) = mc_{E,t}$ . The number of producers in period  $t$  is

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

The aggregate production functions for goods and new firms are

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

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

$$Y_t^C + w_t L_{E,t} = N_t d_t + w_t L_t. \tag{10}$$

Total consumption (private plus public) plus investment (in new firms) must equal total income (dividend income plus labor income). Labor market equilibrium implies that total labor supply  $L_t$  must equal labor used in production of the consumption good plus labor used in the production of new firms,  $L_t = L_{C,t} + L_{E,t}$ .

## 4 Fiscal Stimulus, Consumption and Entry

In the following, we consider the effects of a fiscal expansion in both the static and the dynamic version of the model. Table 4 gives our benchmark calibration.

[ insert Table 4 here ]

We set the parameter  $\chi$ , the weight on leisure in utility, such that steady state labor supply  $L$  is normalized to 0.25. The benchmark Frisch elasticity of labor supply to the real wage is set to the value  $1/\varphi = 4$ ; we analyze the sensitivity of our results to this parameter. Our benchmark value implies that labor supply is rather elastic. As we shall see, even such a high elasticity proves insufficient to replicate the empirical patterns discussed in Section 2. We set the elasticity of substitution  $\theta$  in the CES model to 3.8 as in Bilbiie, Ghironi and Melitz (2012), which implies a steady state markup of 36%. In the Bertrand and Translog models, the elasticity of substitution between goods  $\theta_f$  and the price-elasticity of the spending share  $\tilde{\sigma}$ , respectively, are adjusted to ensure that the steady state markup is equalized across the three model variants. In the Bertrand model, the elasticity of substitution between goods

within an industry is set to  $\theta_f = 6.67$ , while the substitution elasticity across industries is  $\theta_i = 1.001$ , such that  $\theta_f > \theta_i$ . In the Translog model, the number of conceivable goods is set to  $\tilde{N} = 10^9$ , and the price-elasticity of the spending share is  $\tilde{\sigma} = 1.4177$ . The overhead cost  $\phi$  is set to 15% of output in the static CES model, following Jaimovich and Floetotto (2008), and to zero in the dynamic model.<sup>4</sup>

In the dynamic model, we have three additional parameters. The discount factor is set to  $\beta = 0.99$ , such that the steady state annual real interest rate is 4%. We set a conventional value for the firm exit rate,  $\delta = 0.025$ . Setting  $\alpha = \{0, 1\}$  allows us to nest the two specifications considered by Bilbiie, Ghironi and Melitz (2012): the benchmark case where entry is subject to a labor requirement, as well as the case where entry costs are materials costs specified in terms of final output.

Before we compare the model-predicted impulse response functions with their empirical counterparts, a remark is in order. Love of variety (LOV) 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. Our CES and Bertrand models are specified in such a way that LOV is zero. However, LOV is an inherent feature of the translog model which cannot be switched off. Under the assumption that statistical agencies cannot observe the welfare-consistent price level  $P_t$  and instead use  $p_t$  as their cost of living index, we need to adjust our model-based variables to make them consistent with the empirical ones. This means that any variable  $x_t$  which is specified in real terms must be multiplied by  $P_t$  and divided by  $p_t$ . Following Bilbiie, Ghironi and Melitz (2012), we define the data-consistent variable  $x_t^R = x_t/\rho_t$ . In particular, we do this for private and public consumption, the real wage and output.

## 4.1 Responses in Static Entry Model

In the following, we provide a graphical illustration of the effects at work in the *static* entry model, following in spirit the example in Corsetti and Pesenti (2007). We linearize the labor-consumption tradeoff (2), the price setting equation (3), aggregate expenditure (6), equilibrium output (8), and the equilibrium number of firms (9), to obtain

$$\hat{w}_t^R = \varphi \hat{L}_t + \hat{C}_t^R, \quad (11)$$

$$\hat{\mu}_t = -\hat{w}_t^R, \quad (12)$$

$$\hat{Y}_t^R = c_y \hat{C}_t^R + (1 - c_y) \hat{G}_t^R, \quad (13)$$

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<sup>4</sup>In the static Bertrand and Translog models, we need the overhead cost parameter to make the steady state markup equal to the one in the CES model.

$$\hat{Y}_t^R = -\hat{\mu}_t + \hat{L}_t, \quad (14)$$

$$\hat{N}_t = \frac{1}{\mu - 1} \hat{\mu}_t + \hat{L}_t. \quad (15)$$

where  $c_y = \frac{C}{Y}$  is the steady state share of private consumption in total output, and  $\hat{x}_t^R = \frac{dx_t^R}{x}$  denotes the deviation of a data-consistent variable  $x_t^R$  from its steady state value. Replacing  $\hat{\mu}_t$  with  $-\eta\hat{N}_t$  from the definition of the competition effect (4), combining (11) and (12), and eliminating the number of firms by using (15), we obtain an aggregate supply (AS) relation

$$\hat{C}_t^R = \left( \frac{(\mu - 1)\eta}{(\mu - 1) + \eta} - \varphi \right) \hat{L}_t. \quad (16)$$

The AS curve is upward-sloping if

$$\frac{(\mu - 1)\eta}{(\mu - 1) + \eta} - \varphi > 0,$$

i.e. if labor supply is very elastic, such that  $\varphi$  is small. Setting total demand (13) equal to total production (14), replacing  $\hat{\mu}_t$  with  $-\eta\hat{N}_t$ , and eliminating the number of firms by using (15), we can characterize aggregate demand (AD) by

$$c_y \hat{C}_t^R = -(1 - c_y) \hat{G}_t^R + \frac{(\mu - 1) + \mu\eta}{(\mu - 1) + \eta} \hat{L}_t. \quad (17)$$

Consider Figure 4 with labor on the horizontal axis and data-consistent consumption on the vertical axis. Aggregate demand (17) is represented by an upward-sloping curve, which is the same in both panels. In the left panel, the AS curve (16) is upward-sloping: labor supply is fairly elastic,  $\varphi$  is small. The opposite is true in the right panel: labor supply is rather inelastic, such that the Frisch elasticity is small and  $\varphi$  is large. Suppose there is a positive government spending shock,  $\hat{G}_t^R = 1$ . The AD curve shifts out by an amount determined by the steady state government spending share. The equilibrium shifts from point  $E_1$  to point  $E_2$ . In the left panel, consumption increases in response to the shock. In the right panel, consumption decreases.

[ insert Figure 4 here ]

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

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

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

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

where

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

Notice that, irrespective of the calibration of the static model, data-consistent output and the number of firms respond positively to the shock, in accordance with our VAR evidence. However, depending on parameter values, (data-consistent) consumption may be crowded out by the expansion in government spending. We can derive an upper bound on the inverse Frisch elasticity of labor supply for which consumption reacts positively to the government spending shock. This is the case for  $\Phi > 0$ , which implies the following condition,

$$\frac{d\hat{C}_t^R}{d\hat{G}_t^R} > 0 \quad \text{if} \quad \varphi < \bar{\varphi} = \frac{(\mu - 1)\eta}{(\mu - 1) + \eta}. \quad (18)$$

The inverse Frisch elasticity needs to fall below a certain threshold, i.e. labor supply needs to be elastic enough, for condition (18) to be satisfied.<sup>5</sup> The threshold depends on the steady state markup and on the size of the competition effect, which are functions of the deep parameters of the underlying model. Notice that the threshold is a positive function of the steady state competition effect. Let  $F = \log(\bar{\varphi})$  and so

$$\frac{\partial \log F}{\partial \eta} = \frac{1}{\eta} - \frac{1}{(\mu - 1) + \eta} > 0.$$

We compute the threshold inverse Frisch elasticity under the benchmark calibration in the CES, Bertrand and Translog framework, respectively. Under CES preferences, the competition effect is nil,  $\eta = 0$ . Therefore, the threshold  $\bar{\varphi}$  is zero (implying an infinitely elastic labor supply) and the condition for consumption crowding-in cannot be satisfied. Under Translog preferences, condition (18) reduces to

$$\frac{d\hat{C}_t^R}{d\hat{G}_t^R} > 0 \quad \text{if} \quad \varphi < \bar{\varphi} = \frac{\mu - 1}{\mu + 1}.$$

In the baseline calibration, this gives a threshold of  $\bar{\varphi} = 0.1515$ , or a minimum Frisch elasticity of 6.6. Finally, the threshold in the model with Bertrand competition is higher:  $\bar{\varphi} = 0.2773$ , implying a Frisch elasticity of around 3.6. This is because the competition effect  $\eta$  is greater under Bertrand competition than in the translog model.

These required Frisch elasticities are very high compared with existing empirical evidence

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<sup>5</sup>See also the discussion in Bilbie (2011).

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

## 4.2 Responses in Dynamic Entry Model

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

Figure 5 depicts the impulse responses of output ( $Y_t^R$ ), consumption ( $C_t^R$ ), firm entry ( $N_{E,t}$ ) and the markup ( $\mu_t$ ) to a one standard deviation shock in government spending, where  $\sigma_g = 0.01$  and the persistence of the process is set to three different values,  $\rho_g = 0.5$ ,  $\rho_g = 0.9$ , and  $\rho_g = 0.99$ . Unless indicated otherwise, we assume Bertrand competition as the prevailing market structure. Since the competition effect is highest under Bertrand competition than under a translog preference structure or monopolistic competition, this assumption give the model the biggest chance to generate a rise in the real wage and therefore a crowding-in of consumption.

[ insert Figure 5 here ]

We observe that entry rises only if government spending is highly persistent ( $\rho_g = 0.9$  or  $\rho_g = 0.99$ ), and therefore expected profits rise by a sufficiently large amount to stimulate entry. In that case, the markup moves countercyclically. However, even then the model produces a drop in consumption, which is inconsistent with the empirical evidence shown in Section 2.

The main insight from the exercise in the static model is that the Frisch elasticity needs to be implausibly high for consumption to react positively to a fiscal expansion. This finding is well known in the real business cycle literature and has spurred a substantial research effort that tries to extend the model in numerous ways so as to overcome this inconsistency. We consider two such extensions here. Both of them are relevant only in a dynamic setting,



because they affect the degree of intertemporal consumption substitution undertaken by agents. The first is the introduction of rule-of-thumb consumers as in Galí, López-Salido and Vallés (2007). The second is the utility function in Greenwood, Hercowitz and Huffman (1988) which exhibits no wealth effect on labor supply. As mentioned earlier, the negative wealth effect of a rise in government spending shifts out the labor supply curve and lowers real wages, a result which can be overturned through a mechanism that shifts out the labor demand curve such that real wages ultimately rise. A rise in real wages overturns the negative wealth effect if the substitution effect away from leisure towards consumption is strong enough. Alternatively, a rise in real wages boosts the consumption of households that have no access to a savings technology and for which consumption is mainly determined by their current labor income.

In the first model extension, we stipulate that a constant fraction  $\lambda$  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  $C_{n,t} + T_n = w_t L_{n,t}$ . 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, fiscal expansions lead to a rise in aggregate consumption. The mechanism is the following. Since prices are sticky and do not immediately increase, markups fall in response to a positive government spending shock. Markups are inversely related to real marginal costs, which in this simple setup coincide with the real wage. The labor demand curve shifts out and the real wage rises, which has a positive effect on the consumption by rule-of-thumb agents. If there are enough of those agents, total consumption increases. In Galí, López-Salido and Vallés (2007), the countercyclical movement of the markup 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.

In Figure 6, we plot the impulse response function of output, consumption ( $C_{n,t}$ ,  $C_{o,t}$  and  $C_t^R$ ) and entry for different values of the fraction of rule-of-thumb consumers:  $\lambda = 0.1$ ,  $\lambda = 0.5$ , and  $\lambda = 0.8$ . Entry costs are specified in terms of labor units,  $\alpha = 0$ . Importantly,

the persistence of the spending shock is set to  $\rho_g = 0.9$ .

[ insert Figure 6 here ]

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  $\lambda$ . The reason is that firm entry reflects an investment activity which is confined to Ricardian households. The fewer of them there are, the less investment responds to the rise in profit opportunities that accrue only in future periods. Markups increase as entry falls, which shifts inward the labor demand curve and reduces the real wage, such that consumption, by rule-of-thumb consumers and overall, falls.

To summarize, the introduction of non-Ricardian ‘rule-of-thumb’ households does not help to generate consumption crowding-in, unlike in the no-entry model of Galí, López-Salido and Vallés (2007). We carried out a number of robustness checks on this result.<sup>6</sup> First, whether we specify entry costs as labor costs ( $\alpha = 0$ ) or materials costs ( $\alpha = 1$ ) does not change the relevant impulse responses qualitatively. Second, dropping the time-to-build lag in extensive margin investment and assuming instead instantaneous entry leaves our conclusion unaltered. Third, the result is robust to the assumption of price adjustment costs à la Rotemberg (1982) as in Bilbiie, Ghironi and Melitz (2007), provided that the competition effect is present. Figure 7 shows the impulse response functions of the CES model together with the Bertrand model. The share of rule-of-thumb consumers is set to  $\lambda = 0.9$ .

[ insert Figure 7 here ]

In the CES case, 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, even though entry falls. If the competition effect is present, as in the Translog and Bertrand models, the rise in the desired markup outweighs the drop in markups due to price stickiness. As a result, the actual markup rises and consumption falls.

In a second model variant, we assume preferences with a zero wealth effect on labor supply as proposed by Greenwood, Hercovitz and Huffman (1988),

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

This form of preferences, which we refer to as GHH preferences, generates a rise in consump-

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<sup>6</sup>Results are available from the authors upon request.

tion in response to a positive government spending shock if real wages increase, as shown by Monacelli and Perotti (2008). Figure 8 shows that entry falls when the wealth effect is turned off, independently of the persistence of the shock.

[ insert Figure 8 here ]

The drop in entry raises the markup which shifts inward the labor demand curve. Real wages and consumption decline. Recall that the Frisch elasticity is set to 4 and the market structure is one of Bertrand competition. Neither the size of the Frisch elasticity, nor the specification of entry costs or the time-to-build lag are driving this finding.

It is interesting to consider the sticky-price version of the model with GHH preferences. In Figure 9, we plot the impulse response functions of the CES model together with the Bertrand model.

[ insert Figure 9 here ]

In the CES case, the competition effect is nil and the only markup variation is due to price stickiness. The countercyclical response of the markup leads to a rise in consumption, even though entry falls. If there exists a competition effect, as is the case in the Bertrand model, the drop in entry pushes up the desired markup so strongly that the actual markup increases, such that consumption falls.

## 5 Conclusion

Studies of the effects of fiscal expansions have until now neglected firm entry, which represents the extensive margin of investment and production. We believe that it is important to analyze firm entry and exit dynamics in response to such shocks. First, changes in competition can help to understand the sign and size of the fiscal multiplier on consumption. They affect the price markup, which has an effect on real wages and thus on consumption by shifting the labor demand curve. Second, firm turnover is closely related to job creation and destruction. For a government wishing to fight unemployment through a fiscal stimulus package, it is therefore useful to understand the effects of spending on firm creation.

We estimate the effects of government spending shocks in US data, using a vector autoregression analysis and a recursive identification approach. Net firm entry and consumption both rise in response to fiscal expansions. Business cycle models with endogenous entry struggle to explain this pattern. In a static entry model with full depreciation of the stock of firms each period, entry reacts positively to the shock, but consumption falls for conventional values of the Frisch elasticity of labor supply. In a dynamic entry model, the number

of firms rises only if the spending shock is sufficiently persistent. However, even in that case, consumption falls due to strong wealth effects of expected future tax increases to finance the current rise in spending.

We introduce two additional features that help to reduce the wealth effect in models with a constant number of producers. First, the presence rule-of-thumb agents who consume their entire income each period does not bring the model closer to the data. This is because such agents do not invest in new firms and therefore this model extension leads to a counterfactual drop in entry. Second, we introduce a particular preference specification which allows us to switch off the wealth effect. In the model variant with flexible prices, entry falls, such that markups rise and consumption contracts. This negative consumption response cannot be overcome through the assumption of price rigidities.

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Table 1. Data

Standard macroeconomic variables	Data Range	Source	Weblink
(1): Gross Domestic Product	1948q1-2011q2	BEA	<a href="http://research.stlouisfed.org/fred2/series/GDP">research.stlouisfed.org/fred2/series/GDP</a>
(2): Personal Cons. Expenditures: Services	1948q1-2011q2	BEA	<a href="http://research.stlouisfed.org/fred2/series/PCESV">research.stlouisfed.org/fred2/series/PCESV</a>
(3): Personal Cons. Expenditures: Nondurable Goods	1948q1-2011q2	BEA	<a href="http://research.stlouisfed.org/fred2/series/PCND">research.stlouisfed.org/fred2/series/PCND</a>
(4): Government Cons. Expenditures & Gross Investment	1948q1-2011q2	BEA	<a href="http://research.stlouisfed.org/fred2/series/GCE">research.stlouisfed.org/fred2/series/GCE</a>
(5): Government Current Receipts	1948q1-2011q2	BEA	<a href="http://research.stlouisfed.org/fred2/series/GRECPT">research.stlouisfed.org/fred2/series/GRECPT</a>
(6): Gross Private Domestic Investment	1948q1-2011q2	BEA	<a href="http://research.stlouisfed.org/fred2/series/GPDI">research.stlouisfed.org/fred2/series/GPDI</a>
(7): Private Nonresidential Fixed Investment	1948q1-2011q2	BEA	<a href="http://research.stlouisfed.org/fred2/series/PNFI">research.stlouisfed.org/fred2/series/PNFI</a>
(8): Gross Domestic Product: Implicit Price Deflator	1948q1-2011q2	BEA	<a href="http://research.stlouisfed.org/fred2/series/GDPDEF">research.stlouisfed.org/fred2/series/GDPDEF</a>
(9): Civilian Noninstitutional Population	1948q1-2011q2	BLS	<a href="http://research.stlouisfed.org/fred2/series/CNP16OV">research.stlouisfed.org/fred2/series/CNP16OV</a>
Extensive margin variables	Data Range	Source	Weblink
(10): New Incorporations	1948q1-1996q3	BEA	<a href="http://www.bea.gov/scb/pdf/NATIONAL/...">www.bea.gov/scb/pdf/NATIONAL/...</a>
(11): Net Business Formation	1948q1-1995q3	BEA	<a href="http://...BUSCYCLE/1994/1194cpgs.pdf">...BUSCYCLE/1994/1194cpgs.pdf</a> (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  $[(1)/(8)]/(9)$ . Real consumption is  $[(2+3)/(8)]/(9)$ . Real government spending is  $[(4)/(8)]/(9)$ . Real government revenues are  $[(5)/(8)]/(9)$ . Real private non-residential investment is  $[(6)-(7)/(8)]/(9)$ . As our measure of the extensive margin we use the series (10) and (11).

Table 2. Identifying Sign Restrictions

	$g_t$	$rev_t$	$y_t$	$c_t$	$inv_t$	$x_t$
Business Cycle Shock		+	+	+	+	
Fiscal Policy Shock	+					

Table 3. Summary of Static Entry Model Variants

	CES	Bertrand	Translog
Relative price ( $\rho_t$ )	1	1	$e^{-\frac{1}{2} \frac{\tilde{N}-N_t}{\tilde{\sigma} N_t}}$
Markup ( $\mu_t$ )	$\frac{\theta}{\theta-1}$	$\frac{\theta_f - (\theta_f - \theta_i) \frac{1}{N_t}}{\theta_f - (\theta_f - \theta_i) \frac{1}{N_t} - 1}$	$\frac{1 + \tilde{\sigma} N_t}{\tilde{\sigma} N_t}$
Number of firms ( $N_t$ )	$\frac{1}{\theta} \frac{L_t}{\phi}$	$\frac{1}{\theta_f - (\theta_f - \theta_i) \frac{1}{N_t}} \frac{L_t}{\phi}$	$\frac{1}{1 + \tilde{\sigma} N_t} \frac{L_t}{\phi}$



Table 4. Benchmark Calibration

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$L = 0.25$	steady state labor supply
$1/\varphi = 4$	Frisch elasticity of labor supply
$\theta = 3.8$	elasticity of substitution
$\theta_f = 6.67$	substitution elasticity across goods
$\theta_i = 1.001$	substitution elasticity across industries
$\tilde{N} = 10^9$	number of conceivable goods
$\tilde{\sigma} = 0.14177$	price-elasticity of spending share
$\phi = 0.15Y$	overhead cost
$\beta = 0.99$	discount factor
$\delta = 0.025$	firm exit rate
$\alpha = \{0, 1\}$	share of materials in entry cost

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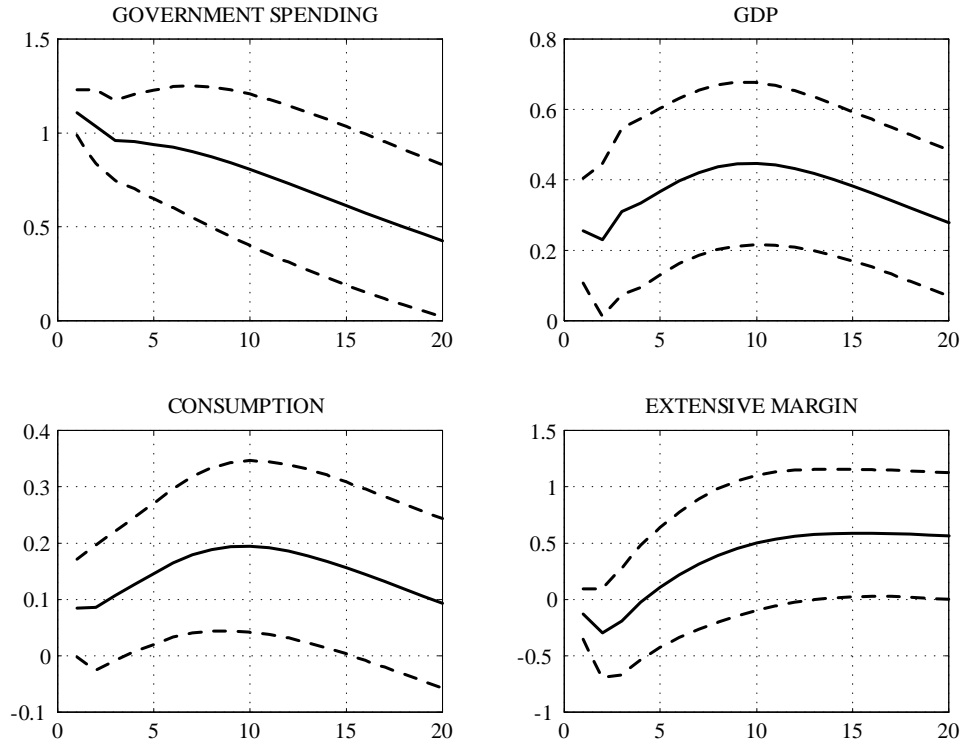


Figure 1: Recursive VAR, Entry measured as Net Business Formation

The figure shows the impulse response functions (IRFs) to a one-standard-deviation government spending shock. The shock is identified recursively as in Blanchard and Perotti (2006). Entry is measured as net business formation. The IRFs have been multiplied by 100, so as to give percentage deviations. On the horizontal axes, the horizon is given in quarters. The 90% error bands around the IRF point estimates have been computed by bootstrapping.

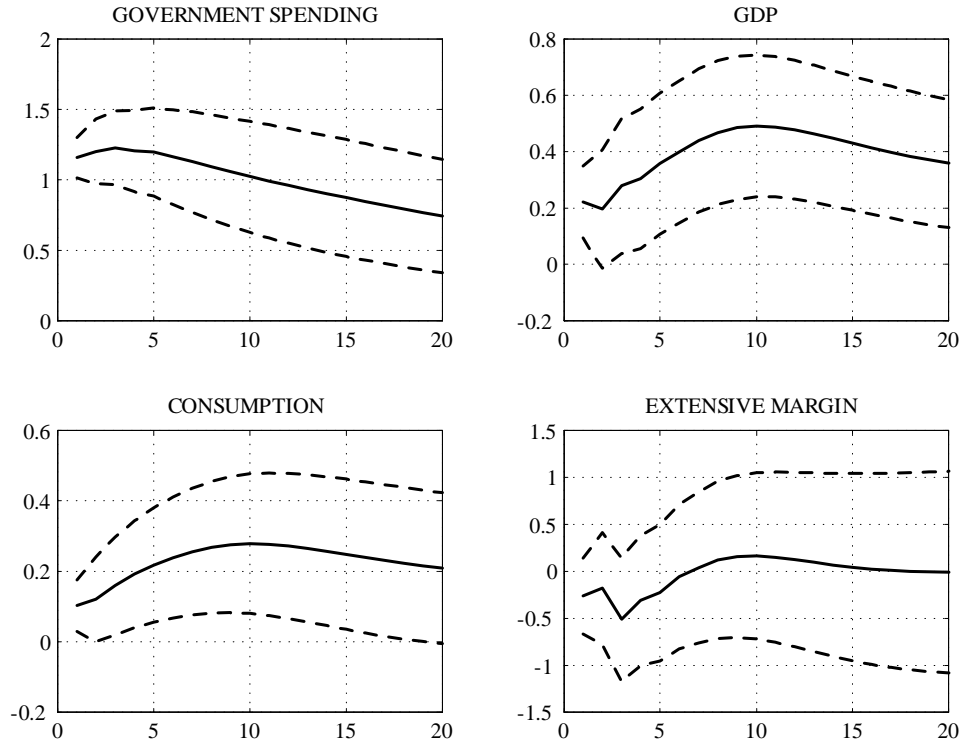


Figure 2: Recursive VAR, Entry measured as New Incorporations

The figure shows the impulse response functions (IRFs) to a one-standard-deviation government spending shock. The shock is identified recursively as in Blanchard and Perotti (2006). Entry is measured as new incorporations. The IRFs have been multiplied by 100, so as to give percentage deviations. On the horizontal axes, the horizon is given in quarters. The 90% error bands around the IRF point estimates have been computed by bootstrapping.

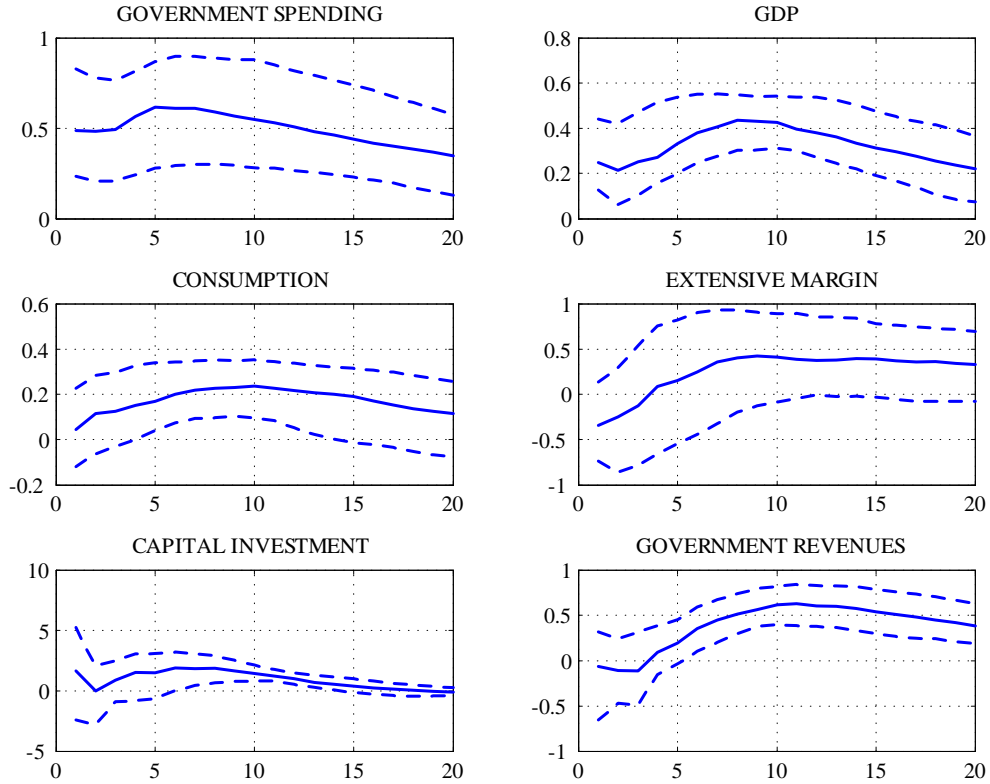
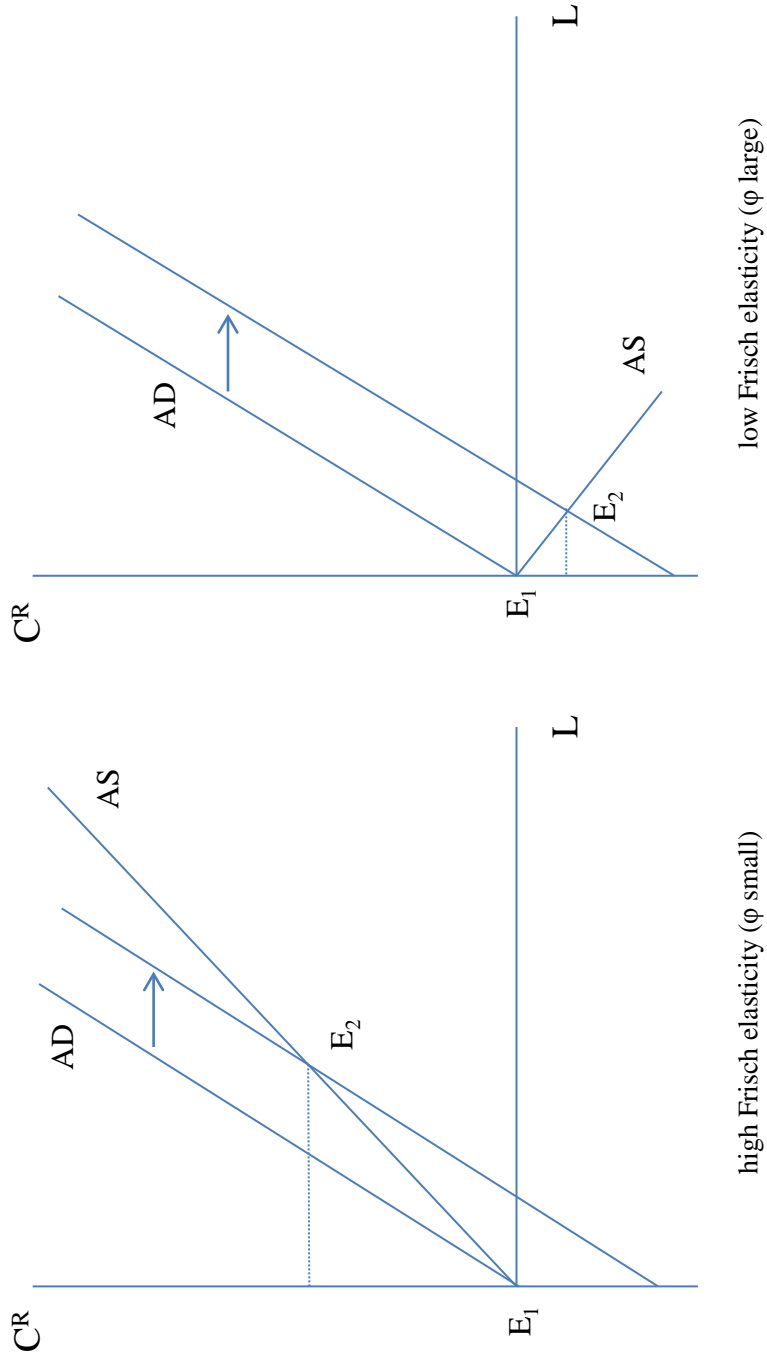


Figure 3: VAR with Sign Restrictions, Entry measured as Net Business Formation

The figure shows the impulse response functions (IRFs) to a one-standard-deviation government spending shock. The shock is identified with sign restrictions as in Mountford and Uhlig (2002), though we do not include nominal variables and we do not identify monetary policy shocks (2006). Entry is measured as net business formation. 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 4: Static Entry Model, Effects of Frisch Elasticity



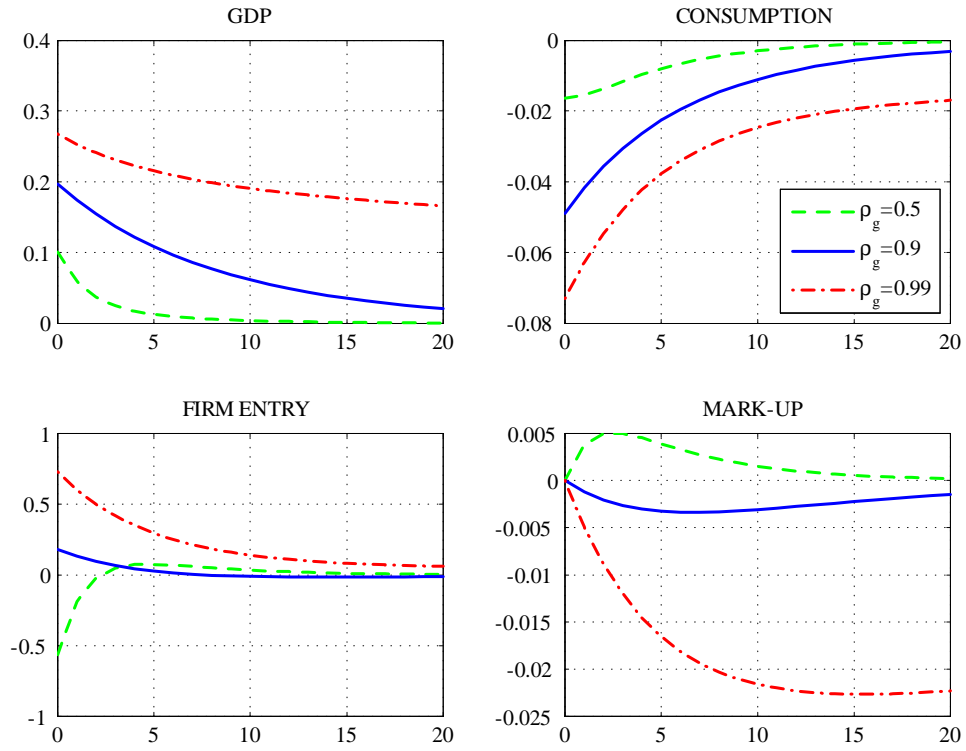


Figure 5: Benchmark Model, Effect of Shock Persistence

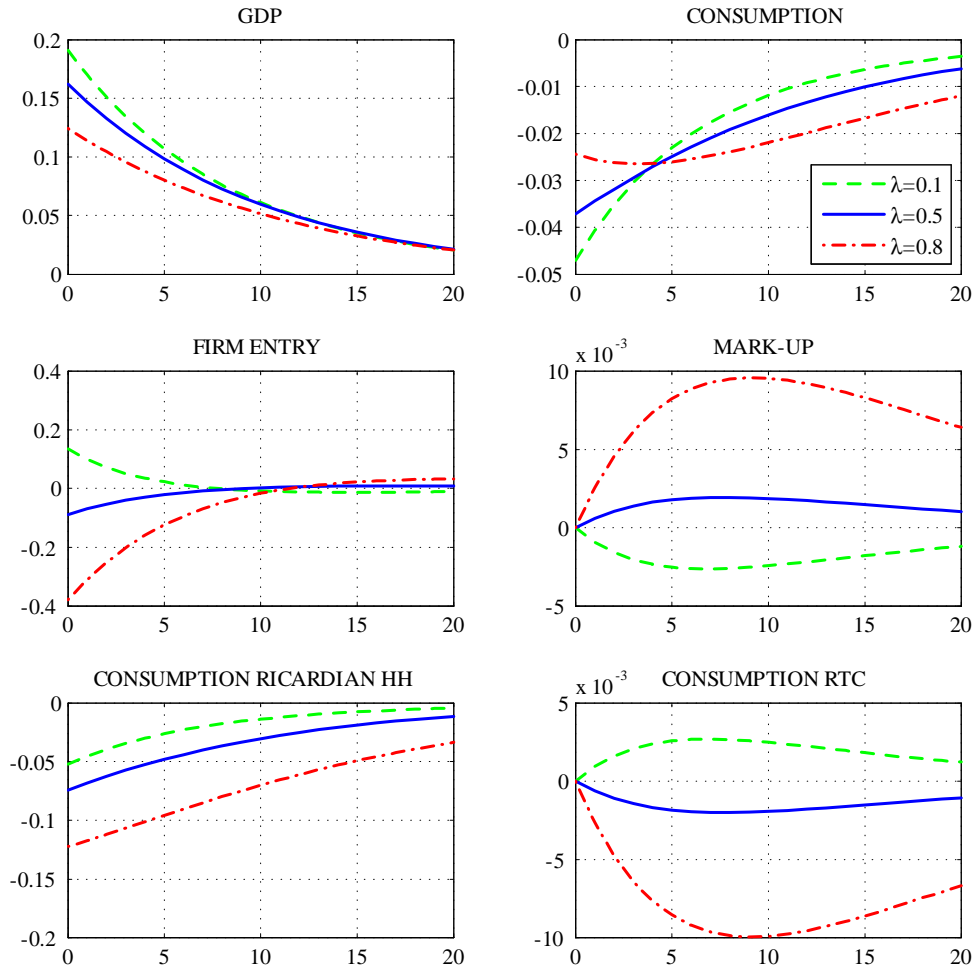


Figure 6: Model with Rule-of-Thumb Consumers and Flexible Prices

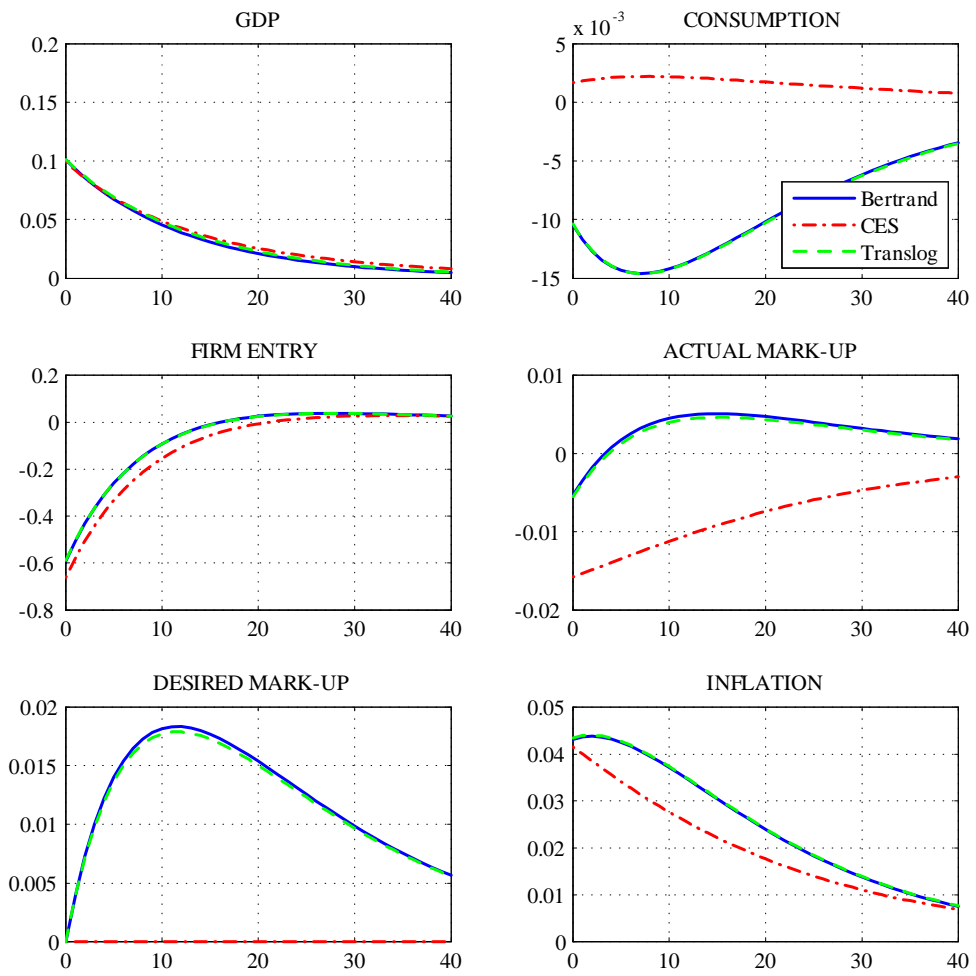


Figure 7: Model with Rule-of-Thumb Consumers and Sticky Prices



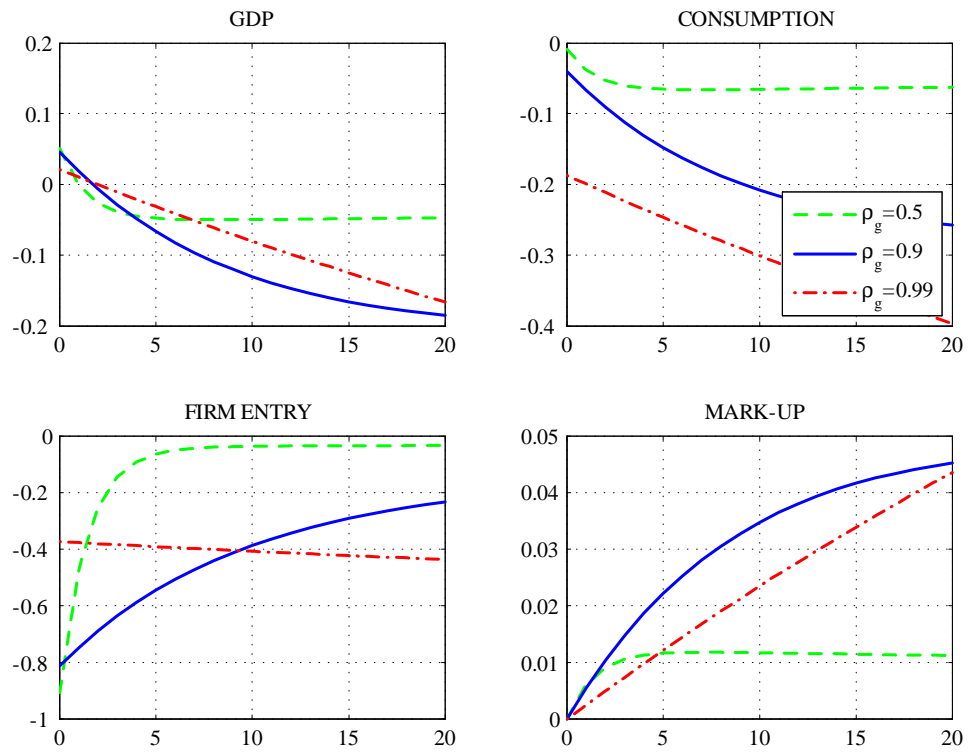


Figure 8: Model with GHH Preferences and Flexible Prices

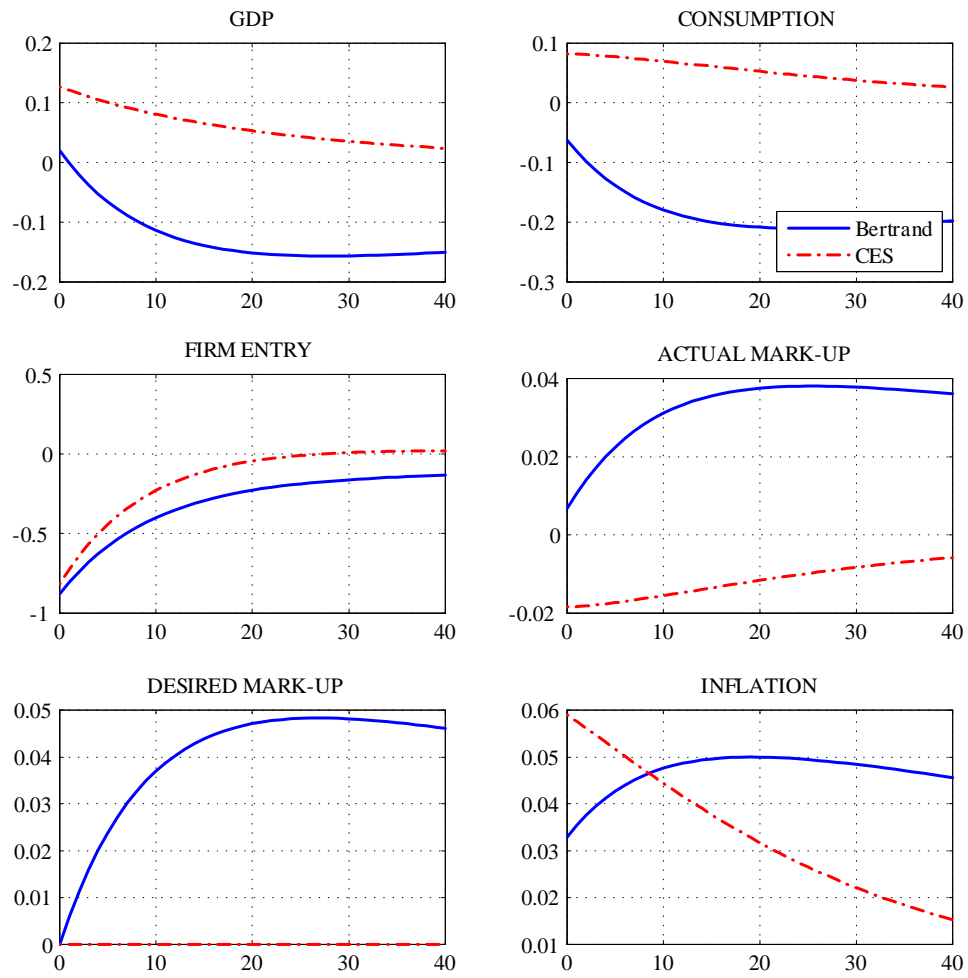


Figure 9: Model with GHH Preferences and Sticky Prices