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Economics Working Paper
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fiscal stimulus in a model with endogenous firm entry

by Alexander Totzek and Roland Winkler



Fiscal Stimulus in a Model with Endogenous Firm Entry

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Abstract

This paper explores different fiscal stimuli within a business cycle model with an endogenous number of firms. We demonstrate that a changing number of firms is a crucial dimension for evaluating fiscal policy since it accelerates the impacts of fiscal policy. In the presence of demand stimuli fiscal multipliers are small and the number of firms may decline, in particular under distortionary tax financing. Policies that disburden private agents from income taxes, on the other hand, are effective in boosting economic activity and new firm creation.

JEL classification: E62, E32, E22

Keywords: Fiscal Multipliers, Firm Entry, Product Variety

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1 Introduction

In order to fight the recessionary impacts of the current financial crisis, governments throughout the globe have passed large fiscal packages and thereby triggered a debate about the effectiveness of government spending in stimulating economic activity.

In this context Romer and Bernstein (2009) evaluate the impacts of the US fiscal package of January 2009 and find a multiplier significantly larger than one but several authors challenge this finding. Cogan et al. (2010) and Cwik and Wieland (2009) respectively employ empirically estimated models for the US and Euro economy [Smets and Wouters (2007, 2003)] and report multipliers less than one. Uhlig (2009) emphasizes the role of distortionary taxation for the effectiveness of fiscal stimuli. He shows that an increase in government consumption which is financed not only by debt but partly by distortionary labor taxes leads to a short-run boom in output but comes at the cost of an output reduction later on. Faia, Lechthaler, and Merkl (2010) and Campolmi, Faia, and Winkler (2010) demonstrate that a pure demand stimulus leads to very small (or even negative) multipliers in models with frictional labor markets. Moreover, both studies emphasize that other forms of fiscal stimuli such as hiring subsidies or income tax cuts are much more effective in boosting output and employment.

All of those contributions analyze the impacts of fiscal stimuli on standard measures of economic activity (GDP, employment, investment) but neglect their impact on the extensive margin, i.e. the number of incumbent and new products (or firms) in the market.¹ However, a recent literature emphasizes the role of an endogenous number of firms as an important propagation and amplification mechanism for business cycle fluctuations.² Bilbiie, Ghironi, and Melitz (2007a) and Bergin and Corsetti (2008) respectively demonstrate that technological innovations and shocks to monetary policy are amplified by endogenizing the extensive margin. With respect to fiscal interventions, the substantial procyclical behavior of the extensive margin may help to explain how fiscal stimuli generate large and persistent business cycle fluctuations. In particular, this amplification effect potentially give rise to larger multipliers. Furthermore, due to love of variety preferences, the number

¹Note that, as standard in the macroeconomic literature, there is a one-to-one identification between a firm and a product. We will thus use the latter expressions synonymously.

²Among others, Devereux, Head, and Lapham (1996), Bergin and Corsetti (2008), and Totzek (2009) show that GDP is highly correlated with the number of producing firms.

of products is an important factor for economic well-being.

The aim of this paper is thus twofold. First, we explore the impacts of different fiscal stimuli on product variety applying a real business cycle model with firm entry. Second, we calculate fiscal multipliers for both our baseline model with an endogenous number of firms and for the standard case of a constant extensive margin. This enables us to investigate whether a changing number of products alters the effectiveness of fiscal stimuli. Furthermore, our framework allows for a closer examination of investment decisions since we can distinguish between investments in physical capital and those in new products.

We seek to answer these questions for various fiscal packages within a variant of the model outlined in Bilbiie, Ghironi, and Melitz (2007a) with endogenous firm entry and capital in production. We consider six forms of fiscal stimuli: (i) a standard increase in government consumption³ (a pure demand stimulus), (ii) a consumption tax cut, (iii) a cut in labor income taxes, (iv) a cut in capital income taxes, (v) a cut in dividend income taxes, and (vi) a unified cut in dividend and capital taxation. Thereby, we first assume that all fiscal stimuli are financed by lump sum taxes. Thereafter, we reassess the results for the pure demand stimulus considering that the increase in government consumption is financed by different distortionary tax financing schemes.

Our main findings are as follows: First, we demonstrate that the extensive margin indeed acts as an accelerator for the impacts of fiscal stimuli. More precisely, we find that if in response to a fiscal stimuli the number of firms co-moves with GDP, fiscal multipliers are amplified. This holds in the case of positive multipliers but is also true if – due to distortionary taxation – multipliers turn negative. When the number of firms responds countercyclical the extensive margin dampens the impacts of fiscal stimuli on economic activity.

Second, a pure demand stimulus and a consumption tax cut are not the recommendable fiscal tools to boost GDP. Under lump-sum taxation the fiscal multiplier of these policies are significantly smaller than one due to large crowding out effects. Instead, a policy maker should concentrate on disburdening private agents from labor and dividend taxes since the

³As much of the literature, we assume that the government only purchases consumption goods. Alternatively, one could consider government investment as in Leeper, Walker and Yang (2010) or could follow Cavallo (2005), Gomes (2009) or Leeper, Walker and Yang (2010) by assuming that governments employ workers to produce goods used for government consumption or government investment.

multiplier of these fiscal interventions are significantly larger than one. The reason is that these fiscal interventions induce a crowding in of consumption, of investment in existing capital and in product creation which in turn leads to an increasing number of firms. Although the multiplier of a cut in capital taxes is also well above one, this policy comes at the cost of a decrease in the number of varieties.

Finally, when considering the case of an increase in government consumption financed by distortionary taxation, our analysis points out that this fiscal intervention should be financed by levying higher consumption taxes. In this case, the multiplier is positive and the number of varieties increases. If, however, an increase in government consumption is financed by raising income taxes, the fiscal multiplier turns negative, as in Uhlig (2009), and the number of varieties may decrease.

Our results are not only related to the recent literature on fiscal multipliers but also to the stream of literature that analyzes fiscal policy in business cycles model with firm entry. Lewis (2009) extends the sticky price framework of Bilbiie, Ghironi, and Melitz (2007b) to allow for government spending shocks.⁴ In her analysis, she highlights that in response to a demand stimulus the number of producers only increases for high degrees of fiscal shock persistence.⁵ The rationale is that under highly persistent shocks potential firms expect future profit opportunities which cover the entry cost and consequently enter the market. This result also holds in our flexible price framework with capital in production. Furthermore, we demonstrate that the impact of government consumption shocks on product variety is ambiguous when considering different values for the labor supply elasticity and when considering distortionary tax financing instead of lump-sum taxation. In addition, this paper analyzes fiscal stimuli beyond increases in government consumption within a business cycle model with firm entry.

The remainder of the paper is as follows. Section 2 presents the model, our baseline calibration and the policy exercises considered. Section 3 presents simulation results for the six fiscal packages financed with lump sum taxes. In Section 4, we analyze a pure demand stimulus that is financed by raising distortionary taxes. Section 5 concludes.

⁴The optimal fiscal policy in a framework with firm entry and flexible prices is derived in Chugh and Ghironi (2009).

⁵Note that this result vanishes by introducing endogenous exits as proposed by Totzek (2009).

2 The model

We apply the entry model of Bilbiie, Ghironi, and Melitz (2007a) with capital in production.⁶ The economy consists of final goods producers (or bundlers), intermediate goods producers (or manufacturing firms), new product creators, the government, and households. Each manufacturing firm employs labor and capital to produce a single differentiated intermediate good in a monopolistic competitive market under flexible prices.⁷ New product creators use labor to invent new varieties of intermediate goods. Note that new product creation is equivalent to the production of a new manufacturing firm due to the assumption of a one-to-one identification between a manufacturing firm and an intermediate good. Final goods producers bundle the intermediate goods to a homogenous final good used for private and government consumption as well as investment in physical capital. Households consume, invest in physical capital, hold government bonds and hold shares of the stock of intermediate goods producers. Moreover, households supply labor to the manufacturing and the product creation sector. Government consumption is financed by issuing bonds, by collecting lump-sum taxes, by levying taxes on consumption purchases, and by levying income taxes on labor, capital, and dividends. The model structure is depicted in Figure 1.

2.1 Final goods producers

Final goods producers buy the differentiated intermediate goods or varieties, $y_t(\omega)$, bundle them to a homogenous final good, Y_t^C , and sell it to households and to the government under perfectly competitive conditions. A final goods producer maximizes his profits,

$$Y_t^C P_t - \int_{\omega \in \Omega_t} p_t(\omega) y_t(\omega) d\omega, \text{ subjected to the following CES production function } Y_t^C \equiv$$

⁶Bilbiie, Ghironi, and Melitz (2007a) present three specifications of a model for a closed and cashless economy with endogenous firm entry: (i) the baseline model without capital, (ii) a model with capital in production, and (iii) a model with capital in production and in product creation. Of course, the model specifications with capital perform better by fitting the empirically observed second moments. However, the model with capital in both production and in product creation requires a highly implausible calibration including a 50% depreciation rate to ensure stability and non-oscillating impulse responses. We therefore restrict our analysis to the second model specification, i.e. a model with endogenous firm entry and capital in production.

⁷Bilbiie, Ghironi, and Melitz (2007b) extend the framework of Bilbiie, Ghironi, and Melitz (2007a) with labor as the only input factor by introducing sticky prices. Since we want to discuss the real effects of pure fiscal policy instead of the interdependency between fiscal and monetary interventions, we apply the pure RBC version.

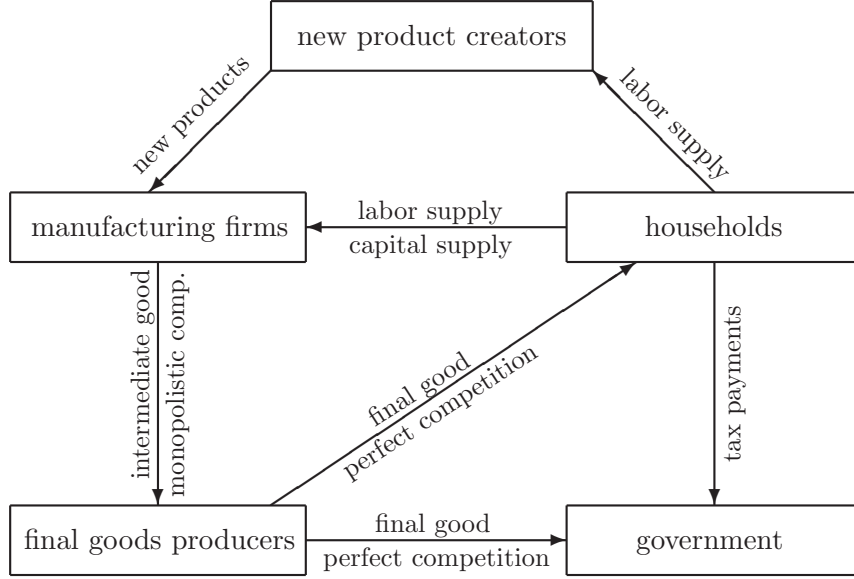


Figure 1: Model structure

$\left(\int_{\omega \in \Omega_t} y_t(\omega)^{\zeta-1/\zeta} d\omega\right)^{\zeta/(\zeta-1)}$, where P_t is the price of the final good, $p_t(\omega)$, is the price of variety ω , ζ is the elasticity between the intermediate goods, and Ω_t is the bounded set of goods available at time t .⁸ The first-order condition for profit maximization yields the demand function for variety ω which is given by $y_t(\omega) = \rho_t(\omega)^{-\zeta} Y_t^C$, where $\rho_t(\omega) \equiv p_t(\omega)/P_t$ is the relative price of variety ω and $P_t = \left(\int_{\omega \in \Omega_t} p_t(\omega)^{1-\zeta} d\omega\right)^{1/(1-\zeta)}$ is the resulting price index.

Since there is no heterogeneity in this framework, we refer to symmetry across firms, implying $y_t(\omega) = y_t$, $p_t(\omega) = p_t$, $\rho_t(\omega) = \rho_t$. Let N_t denote the number of manufacturing firms in the economy. The aggregate amount of intermediate goods (or: aggregate demand) is obtained by solving the CES technology considering that in equilibrium there exist N_t homogenous firms:

$$Y_t^C = N_t^{\frac{\zeta}{\zeta-1}} y_t \quad (1)$$

The price index can be written as $P_t = N_t^{1/(1-\zeta)} p_t$ or $\rho_t = N_t^{1/(\zeta-1)}$.

⁸Note that Bilbiie, Ghironi, and Melitz (2007a) alternatively present a translog aggregation. However, this alternative leaves our results totally unchanged. Moreover, our results are also robust to the assumption of oligopolistic competition in the goods market as in Faia (2009).

2.2 Intermediate goods producers

Each intermediate goods producer is a monopolistic supplier of product $\omega \in \Omega_t$. Firm ω uses the amount l_t of labor, the amount k_{t-1} of physical capital and the constant returns to scale technology

$$y_t = l_t^\alpha k_{t-1}^{1-\alpha} \quad (2)$$

to produce the intermediate good, y_t . The firm takes as given the factor prices w_t and r_t^K . The marginal costs, $mc_t = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}w_t^\alpha(r_t^K)^{1-\alpha}$, are identical for all firms implying a symmetric equilibrium.

The firm chooses the real price, ρ_t , in order to maximize profits, $d_t = (\rho_t - mc_t)y_t$, subjected to the demand function $y_t = \rho_t^{-\zeta} Y_t^C$. The optimization yields

$$\rho_t = \frac{\zeta}{\zeta - 1} mc_t. \quad (3)$$

Under monopolistic competition, the real price, ρ_t , is thus set as a constant mark-up over real marginal cost.

Factor demands are obtained by cost minimization and read as

$$w_t = \alpha mc_t \frac{y_t}{l_t} = \alpha \frac{\zeta - 1}{\zeta} \frac{Y_t^C}{L_t^C}, \quad (4)$$

$$r_t^K = (1 - \alpha) mc_t \frac{y_t}{k_{t-1}} = (1 - \alpha) \frac{\zeta - 1}{\zeta} \frac{Y_t^C}{K_{t-1}}, \quad (5)$$

where $L_t^C = N_t l_t$ are hours worked in the manufacturing sector and $K_{t-1} = N_t k_{t-1}$ is aggregate demand for capital.

Using (3) and $\rho_t = N_t^{1/(\zeta-1)}$, the profits of a firm can be expressed as

$$d_t = \left(1 - \frac{\zeta - 1}{\zeta}\right) \frac{Y_t^C}{N_t}. \quad (6)$$

2.3 New product creators

Firms in this perfectly competitive sector create new products, $N_{E,t}$, by using labor, L_t^E , and the technology $N_{E,t} = L_t^E / f_E$ in order to maximize their profits $v_t N_{E,t} - w_t L_t^E$. v_t

denotes the real value of an operating firm in the intermediate goods sector which is equal to the discounted sum of all current and future profits. $1/f_E$ denotes a productivity shifter such that f_E can also be interpreted as a fixed entry cost. The first-order condition for profit-maximization yields the free entry condition $v_t = w_t f_E$.

To capture the empirical finding that firm entries do not take place contemporaneously with GDP [see Devereux, Head, and Lapham (1996)], we assume a time-to-build lag in new product creation. As Bilbiie, Ghironi, and Melitz (2007a), we assume, for the sake of simplicity, that the firm's death rate is exogenous.⁹ The recursive law of motion of the extensive margin is then given by

$$N_t = (1 - \delta)(N_{t-1} + N_{E,t-1}), \quad (7)$$

where δ denotes the exogenous probability of exiting the market. Equation (7) states that a fraction, δ , of incumbent and new firms is hit by an exogenous death shock at the very end of any period. The timing assumption implies that some entrants must leave the market before they actually have started producing.

2.4 Households

The economy is made up by a continuum of homogenous households distributed over the unit interval. The representative household determines the amount of the final good for consumption, C_t , and for investment, I_t , its one-period real bond holdings, B_t , its share holdings, x_{t+1} , and its supply of hours worked, L_t , in order to maximize its expected lifetime utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1 - \sigma} C_t^{1-\sigma} - \frac{\chi}{1 + \eta} L_t^{1+\eta} \right), \quad (8)$$

where β is the discount factor, $\sigma > 0$ is the inverse of the intertemporal elasticity of substitution, $\eta > 0$ is the inverse of the labor supply elasticity, and $\chi > 0$. The maximization

⁹See Totzek (2009) for a New Keynesian framework also considering endogenous exits.

of (8) is subjected to the household's period-by-period budget constraint

$$B_t - (1 + r_{t-1})B_{t-1} + v_t(N_t + N_{E,t})x_{t+1} + (1 + \tau_t^C)C_t + I_t + \tau_t = (v_t + (1 - \tau_t^d)d_t)x_t N_t + (1 - \tau_t^L)w_t L_t + (1 - \tau_t^K)(r_t^K - \delta^K)K_{t-1} + \delta^K K_{t-1}, \quad (9)$$

the capital accumulation equation

$$K_t = (1 - \delta^K)K_{t-1} + I_t, \quad (10)$$

and the dynamics of firm's entry and exit described by equation (7). r_t and δ^K denote the real interest rate and the capital depreciation rate, respectively. The government collects lump-sum taxes, τ_t , and levies taxes on consumption, on labor income, $w_t L_t$, on capital income net of depreciation, $(r_t^K - \delta^K)K_{t-1}$, and on dividend income, $d_t x_t N_t$. The respective tax rates are τ_t^C , τ_t^L , τ_t^K , and τ_t^d . Note that we do not model explicitly a tax rate levied on the income from savings in government bonds but $r_{t-1}B_{t-1}$ can be interpreted as real interest payments net of taxes. The household uses its net income for consumption, investment in physical capital, investment in government bonds, and investment in shares of incumbent firms and entrants in the intermediate goods sector, $v_t(N_t + N_{E,t})x_{t+1}$.

Maximization yields the Euler equations for bond holdings, capital accumulation, and share holdings:

$$\frac{C_t^{-\sigma}}{1 + \tau_t^C} = \beta \mathbf{E}_t \left\{ \frac{C_{t+1}^{-\sigma}}{1 + \tau_{t+1}^C} (1 + r_t) \right\}, \quad (11)$$

$$\frac{C_t^{-\sigma}}{1 + \tau_t^C} = \beta \mathbf{E}_t \left\{ \frac{C_{t+1}^{-\sigma}}{1 + \tau_{t+1}^C} (1 + (1 - \tau_t^K)(r_{t+1}^K - \delta^K)) \right\}, \quad (12)$$

$$v_t = (1 - \delta)\beta \mathbf{E}_t \left\{ \frac{C_{t+1}^{-\sigma}(1 + \tau_t^C)}{C_t^{-\sigma}(1 + \tau_{t+1}^C)} (v_{t+1} + (1 - \tau_{t+1}^d)d_{t+1}) \right\}. \quad (13)$$

Households supply their labor force to manufacturing firms (intermediate goods producers) and product creators. Total hours worked are determined by the following in-

tratemporal optimality condition:

$$(1 - \tau_t^L)w_t = \chi L_t^\eta C_t^\sigma (1 + \tau_t^C). \quad (14)$$

2.5 Aggregate resource constraint and GDP

Aggregating the budget constraint across households, using the equilibrium condition $x_{t+1} = x_t = 1$, as well as the government budget constraint

$$G_t + (1 + r_{t-1})B_{t-1} = B_t + \tau_t^L w_t L_t + \tau_t^C C_t + \tau_t^d d_t N_t + \tau_t^K (r_t^K - \delta)K_{t-1} + \tau_t \quad (15)$$

yields the resource constraint

$$Y_t^C + v_t N_{E,t} = w_t L_t + N_t d_t + r_t^K K_{t-1}, \quad (16)$$

where G_t is government consumption, $Y_t^C = C_t + I_t + G_t$ denotes aggregate demand of final goods, and $v_t N_{E,t}$ is investment in new firms. Following Bilbiie, Ghironi, and Melitz (2007a), we moreover define total investment as $TI_t \equiv I_t + N_{E,t}v_t$. The gross domestic product, Y_t , is equal to

$$Y_t \equiv Y_t^C + N_{E,t}v_t. \quad (17)$$

The complete model is shown in Table 1.

2.6 RBC model

In order to generate a benchmark for our analysis, we apply a standard RBC model with a constant extensive margin. It can be obtained by setting $N_{E,t} = 0$ and normalizing the mass of firms to $N_t = N = 1$. This implies $L_t^E = 0$, $L_t = L_t^C$, $\rho_t = 1$, $Y_t = Y_t^C$, and $TI_t = I_t$.

2.7 Calibration

Our baseline calibration is as follows. The discount rate, β , is equal to 0.99 implying an annual steady state real interest rate of approximately 4 percent. The inverse of the

Description	Equation
Consumption Euler	$C_t^{-\sigma}/(1 + \tau_t^C) = \beta E_t \{C_{t+1}^{-\sigma}/(1 + \tau_{t+1}^C)(1 + r_t)\}$
Capital Euler	$C_t^{-\sigma}/(1 + \tau_t^C) = \beta E_t \{C_{t+1}^{-\sigma}/(1 + \tau_{t+1}^C)(1 + (1 - \tau_t^K)(r_{t+1}^K - \delta^K))\}$
Shares Euler	$v_t = (1 - \delta)\beta E_t \{C_{t+1}^{-\sigma}(1 + \tau_t^C)/(C_t^{-\sigma}(1 + \tau_{t+1}^C))(v_{t+1} + (1 - \tau_{t+1}^d)d_{t+1})\}$
Labor supply	$(1 - \tau_t^L)w_t = \chi L_t^\eta C_t^\sigma (1 + \tau_t^C)$
GDP	$Y_t = Y_t^C + v_t N_{E,t} = w_t L_t + N_t d_t + r_t^K K_{t-1}$
Aggregate demand	$Y_t^C = C_t + I_t + G_t$
Investment in new firms	$I_{E,t} = v_t N_{E,t}$
Total profit income	$N_t d_t = (1 - (\zeta - 1)/\zeta) Y_t^C$
Pricing	$\rho_t = \zeta/(\zeta - 1) m c_t$
Real wage	$w_t = \alpha(\zeta - 1) Y_t^C / (\zeta L_t^C)$
Rental rate	$r_t^K = (1 - \alpha)(\zeta - 1) Y_t^C / (\zeta K_{t-1})$
Labor in manufacturing	$Y_t^C = \rho_t (L_t^C)^\alpha K_{t-1}^{1-\alpha}$
Labor in entry	$L_t^E = f_E N_{E,t}$
Capital accumulation	$K_t = (1 - \delta^K) K_{t-1} + I_t$
Number of firms	$N_t = (1 - \delta)(N_{t-1} + N_{E,t-1})$
Free entry	$v_t = f_E w_t$
Real price	$\rho_t = N_t^{1/(\zeta-1)}$

Table 1: The model at a glance

intertemporal elasticity of substitution in consumption, σ , is set to 1. Calibrating $\eta = 2$ implies a labor supply elasticity with respect to the real wage of 1/2. χ is chosen such that in the steady state, 1/3 of time is devoted for work. Following Bilbiie, Ghironi, and Melitz (2007a), the value of the elasticity of substitution between intermediate goods, ζ , is set to 3.8 implying a mark-up of approximately 36 percent.

We also follow Bilbiie, Ghironi, and Melitz (2007a) by setting the firm destruction rate, δ , to 0.025 and the inverse of the total factor productivity in the creation of new products, $1/f_E$, to 1. The share of labor in the production function, α , and the quarterly capital depreciation rate, δ^K , are set to the standard values 0.67 and 0.025, respectively.

For reflecting the US economy tax system, the steady state tax rates are set to $\tau^C = 0.05$, $\tau^L = 0.28$, and $\tau^K = 0.36$ which are values calculated by Trabandt and Uhlig (2009).

The steady state tax rate on dividend income, τ^d , is equalized to the steady state tax rate on capital income. As standard in the literature, steady state government consumption is set such that $G/Y = 0.15$.

Our baseline calibration is summarized in Table 2.

Parameter	Value	Source
discount factor	$\beta = 0.99$	standard value
inverse of intertemp. elasticity of substitution	$\sigma = 2$	standard value
inverse of Frisch elasticity	$\eta = 1$	standard value
weight of labor	$\chi = 7.6$	to match $L = 1/3$
intra-temporal elasticity of substitution	$\zeta = 3.8$	Bilbiie, Ghironi, and Melitz (2007a)
firm exit rate	$\delta = 0.025$	Bilbiie, Ghironi, and Melitz (2007a)
capital depreciation rate	$\delta^K = 0.025$	standard value
labor share	$\alpha = 0.67$	standard value
stst. government consumption	$G/Y = 0.15$	standard value
stst. consumption tax rate	$\tau^C = 0.05$	Trabandt and Uhlig (2009)
stst. labor tax rate	$\tau^L = 0.28$	Trabandt and Uhlig (2009)
stst. capital/dividend income tax rate	$\tau^K = \tau^d = 0.36$	Trabandt and Uhlig (2009)

Table 2: Baseline calibration

2.8 Fiscal stimuli

In this section, we consider several fiscal stimuli which are all financed by lump sum taxation.

2.8.1 Demand stimulus

We analyze a temporary increase in government consumption given by

$$G_t = (1 - \rho)G + \rho G_{t-1} + \varepsilon_t^G, \quad (18)$$

where ε_t^G is normalized such that the cost of the demand stimulus in the implementation period amounts to 1% of GDP. The autocorrelation of government consumption is set to $\rho = 0.95$.

In a further exercise, we follow Uhlig (2009) and replicate the US fiscal package of 2009 by means of a AR(2) process for government consumption given by

$$G_t = (1 - (\xi_1 + \xi_2) + \xi_1 \xi_2)G + (\xi_1 + \xi_2)G_{t-1} - \xi_1 \xi_2 G_{t-2} + \varepsilon_t^G. \quad (19)$$

where the AR(2) coefficients, ξ_1 and ξ_2 , are set to 0.933 and 0.72.

2.8.2 Tax cuts

We consider temporary cuts in consumption, labor, capital income, and dividend income taxes, all of the following form

$$\tau_t^i = (1 - \rho_i)\tau^i + \rho_{\tau^i}\tau_{t-1}^i - \varepsilon_t^{\tau^i} \quad \text{for } i = C, L, K, d, \quad (20)$$

where the persistence of the AR(1) processes describing the evolution of the tax cuts are set to $\rho^{\tau^i} = \rho = 0.95$ for $i = C, L, K, d$. To be comparable with the pure demand stimulus, the impulses $\varepsilon_t^{\tau^i}$ are also normalized such that the cost of the fiscal stimulus in the implementation period amounts to 1% of GDP.

3 Simulation results

For each fiscal stimulus we compute a dynamic multiplier as proposed by Uhlig (2009). The value of this multiplier at time t is equal to the sum of discounted GDP changes until time t divided by the sum of discounted cost changes until time t . To highlight the role of firm entry, we compare the results in our baseline entry model with those in the standard RBC model.

3.1 Demand stimulus

Figure 2 shows impulse responses to an increase in government consumption. The negative wealth effect of a rising tax burden leads to a crowding out of private consumption and capital investment. Furthermore, it causes the households to expand their labor supply in the manufacturing as well as in the new product sector. This in turn induces a decline in real wages and an expansion of output. As the expansionary demand shock causes additional profit opportunities for firms in the intermediate goods market, new firm creation is boosted. The positive effect on the number of firms is moreover amplified by the decline in real wages which in turn leads to a decrease in entry costs. The crowding in of investment in new firms leads to a larger multiplier in the entry model compared to the RBC model

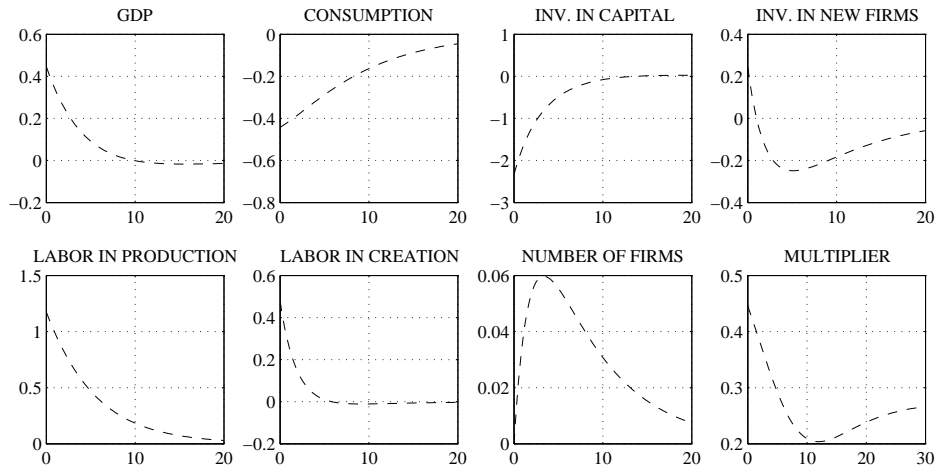


Figure 2: Impulse responses to a temporary increase in government consumption

with a fixed number of firms. This point will later be discussed in more detail.

The reaction of the extensive margin to a government spending shock is, however, ambiguous. This was already shown by Lewis (2009) within a sticky price entry model with labor as the only input factor. In her analysis, she demonstrates that the number of producers only increases for high degrees of fiscal shock persistence. The rationale is that only under highly persistent shocks the expected future profits will cover the entry costs. This result also holds in our RBC framework considering capital in production. As depicted in Figure 3, the number of firms increases for a shock persistence of 0.95, while it declines for lower values such as, for example, 0.9.¹⁰ The figure additionally indicates that the larger the degree of shock persistence the larger (and the more persistent) is the overall reaction of firms' profits.

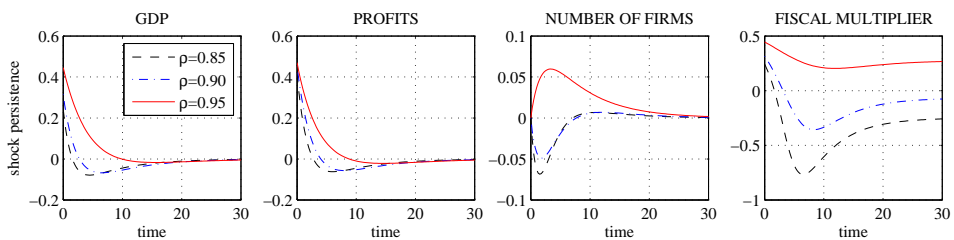


Figure 3: Impulse responses under varied shock persistence

To assess a more conclusive statement on the reaction of the number of varieties, we

¹⁰Note however that empirical studies typically estimate government spending shocks to be highly persistent [see e.g. Smets and Wouters (2007, 2003)].

simulate an increase in government consumption which captures the impacts of the US fiscal stimulus of 2009 as described in equation (19). The results, shown in Figure 4, suggest that the number of varieties increases since the estimated shock is sufficiently persistent and consequently leads to an increasing incentive for potential firms to enter the market.

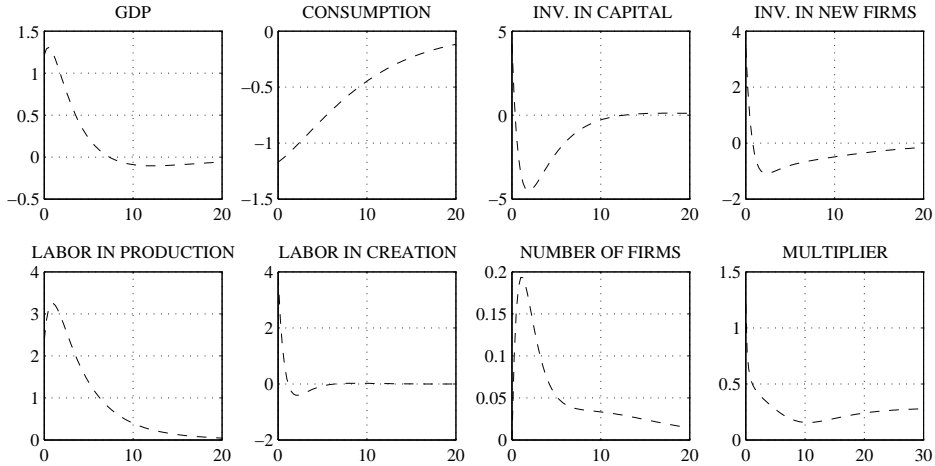


Figure 4: Impulse responses to the US fiscal package

As a further robustness check, we vary the Frisch elasticity of labor supply. For both the AR(1) process and for the US fiscal package, we find that the sign of the response of the extensive margin to an increase in government consumption also changes when varying the inverse of the Frisch elasticity of labor supply, η , within the commonly applied range 0.5-2. The impulse responses for the AR(1) process are depicted in Figure 5.

From Figure 5 it can be observed that the lower the inverse of the Frisch elasticity of labor supply the higher are the long-run profit opportunities. For $\eta = 2$, the model thus predicts a contractionary reaction of the extensive margin, while it predicts an increase in the number of varieties if $\eta \leq 1$.

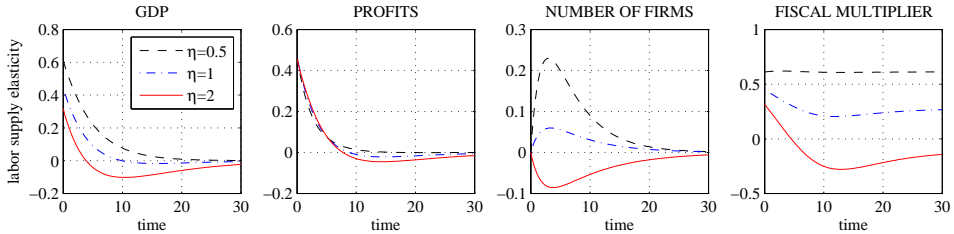


Figure 5: Impulse responses under varied labor supply elasticities

To provide further intuition why the reaction of the number of product varieties may turn negative in this case, we consider the limiting case of a totally inelastic labor supply and assume labor to be the only input factor in production. Accounting for these assumptions within a RBC model with a fixed number of producers, employment and thus output will remain unchanged after an increase in government spending. Government consumption consequently causes a total crowding out of private consumption. In the entry model, however, households can reallocate their labor force between working in the manufacturing sector and creating new products. Households are then able to dampen the drop in private consumption without reducing leisure just by increasing hours worked in the manufacturing sector in the same amount as they decrease hours devoted for product creation. Product variety consequently declines when the inverse of the labor supply elasticity, η , is large.

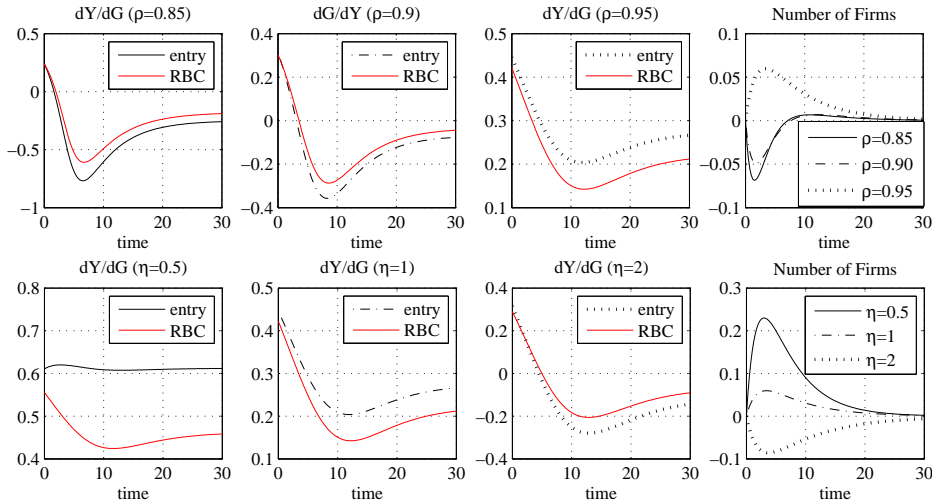


Figure 6: Fiscal multipliers and the number of firms for the endogenous entry and a standard RBC model

Figure 3 and 5 have shown that the reaction of the number of varieties to a government spending shock is ambiguous leaving the reaction of the other variables quantitatively unchanged. Note however that the reaction of the number of firms becomes a decisive factor when comparing the fiscal multipliers with those obtained by a standard RBC framework. As shown in Figure 6, the fiscal multiplier generated by the entry model exceeds that under a constant extensive margin, only if the number of firms increases. If the number of firms, however, decreases positive multiplier effects are dampened or negative

(long-run) multiplier effects are strengthened. From the aggregation of intermediate goods, it directly follows that an increase in the number of products has a positive effect on aggregate demand since $\zeta > 1$ [cf. equation (1)]. This effect is known as 'love of variety' [see Benassy (1996) or Bergin and Corsetti (2008)]. As a general rule, the number of firms acts as an accelerator for the positive (or negative) impacts of fiscal stimuli. This result is in line with the findings of Bilbiie, Ghironi, and Melitz (2007a) and Bergin and Corsetti (2008) who respectively show that technological innovations and shocks to monetary policy are amplified by endogenizing the extensive margin.

3.2 Tax cuts

After having analyzed the impacts of an increase in government consumption, we now turn to other forms of fiscal stimuli, namely tax cuts. In what follows we stick to the assumption that government spending (now in form of consumption and income tax cuts) is financed via lump-sum taxation.

Labor tax cut

Figure 7 shows the impulse responses to a labor tax cut. The cut in labor taxes induces households to increase both time spent to create new products and to work for intermediate goods firms causing a decline in the real wage and an increase in output. In contrast to the increase in government consumption, private consumption now reacts expansionary since the net wealth effect is now positive. Higher demand and lower marginal costs cause higher profit opportunities for firms in the intermediate goods market.

As new product creation becomes temporarily more profitable, investment in new firms increases. This effect is again amplified by decreasing entry costs. On the other hand, investment in existing capital decreases. All in all, total investment (not depicted here) reacts expansionary. In the RBC model investment in physical capital however increases due to the positive wealth effect. The rise in the number of firms significantly pushes the fiscal multiplier above that of the RBC model.

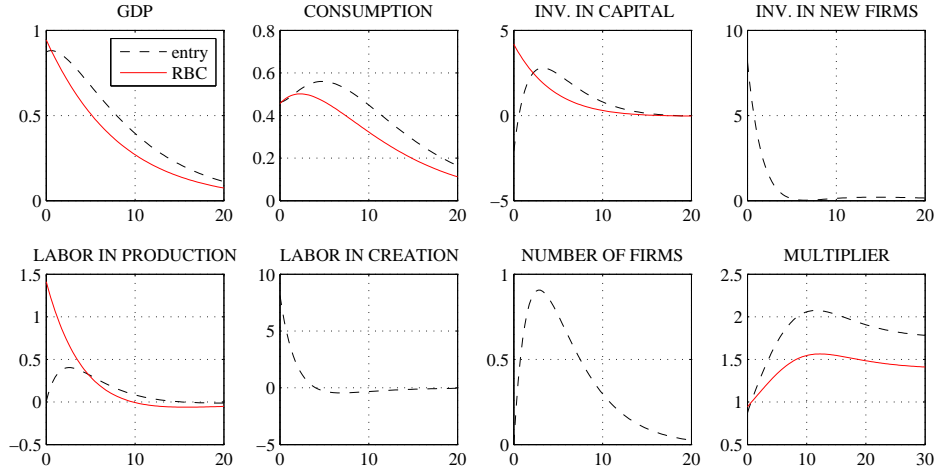


Figure 7: Impulse responses to a temporary cut in labor taxes

Capital income tax cut

Figure 8 depicts the impulse responses to a capital tax cut. In both models, the capital tax cut triggers a boom in capital investment. Since households know the tax cut to be temporary, they use their resources to finance the increase in physical capital. Households consequently lower consumption and their labor supply. In the entry model, households additionally shift labor time from product creation to the manufacturing sector in order to take advantage of the subsidized input factor which is not used for product creation. As a consequence, investment in new firms drops. In the entry model there thus exists a substitution relation between the two types of investment. The decline in new product investment causes a decrease in the number of products. According to the general rule, the multiplier is dampened in comparison to the RBC model.

Dividend income tax cut

Figure 9 shows the impulse responses to a dividend income tax cut. In the standard RBC model, this tax rate is lump-sum. Hence, it does not affect the dynamics of the economy at all. In the entry model, on the other hand, the cut in dividend taxes increases after tax profits which induces households to invest in new firms. Therefore, private agents shift labor from the manufacturing sector towards to the creation of new products. To finance the boom in product creation, capital investment is sharply reduced. Again, the model

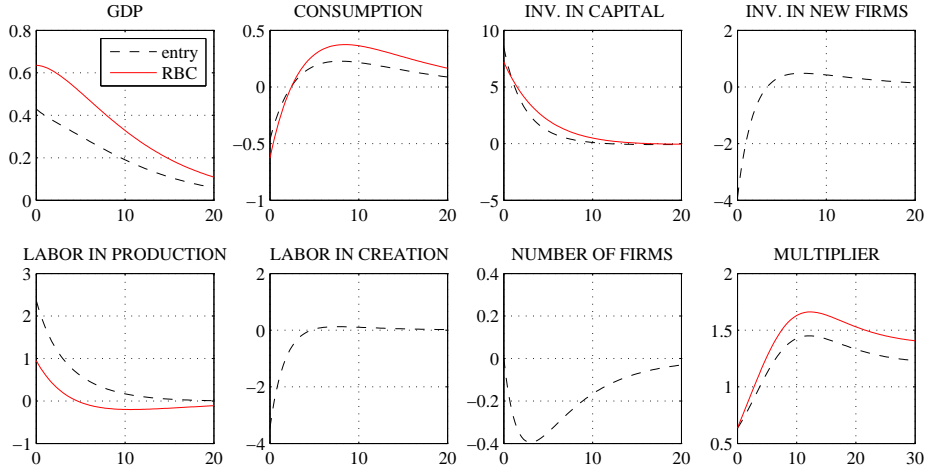


Figure 8: Impulse responses to a temporary cut in capital income taxes

depicts a substitution relation between the two types of investment. As in the case of the capital tax cut, the non-subsidized investment form drops for the sake of increasing the other one. Since the increase in investment in new firms exceeds the decline in that in physical capital total investment reacts expansionary.¹¹

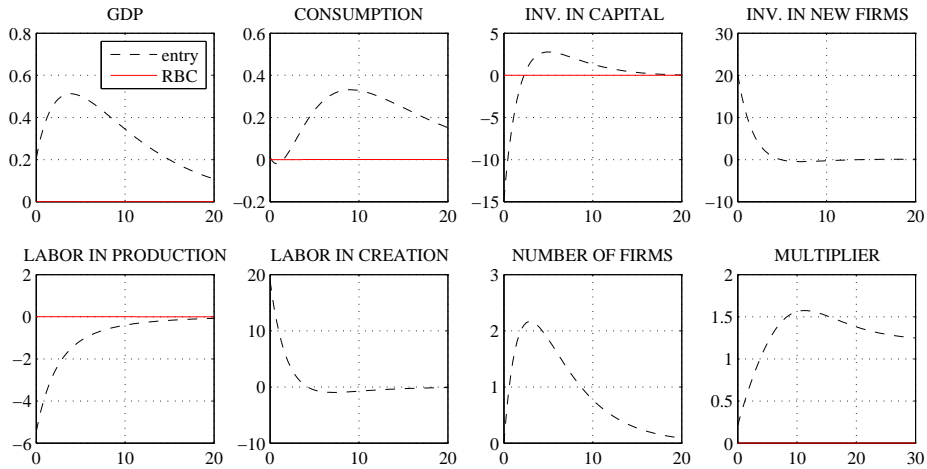


Figure 9: Impulse responses to a temporary cut in dividend income taxes

Consumption slightly decreases for the first periods. Thereafter, the reaction turns expansionary. The rationale is that the negative wealth effect resulting from the increase in lump-sum taxation at first is the dominant factor. After some periods this effect is dominated by the positive wealth effect resulting from higher labor income. As labor for

¹¹Note that the share I/TI is about 0.55 under our calibration.

product creation increases more than hours worked in the manufacturing sector decreases, total hours worked react expansionary. All in all, the dividend tax cut has an expansionary effect on GDP since it induces a crowding in of consumption, total investment, and product variety.

Capital and dividend income tax cut

Up to now we have assumed that capital income and dividend income are taxed separately. Since there exists a trade-off between investment in physical capital and investment in new firms, an isolated cut in capital income taxes leads to an increase in capital investment but comes at the cost of a decline in investment in new products. A cut in dividend income taxes, on the other hand, triggers a boom in investment in new firms and a decline in capital investment. But what happens if the government does not distinguish between the income from renting capital to firms and the profit income from holding shares of these firms? To explore this issue, we now assume that there exists a unified tax rate on capital and dividend income, i.e. $\tau_t^d = \tau_t^K$.¹²

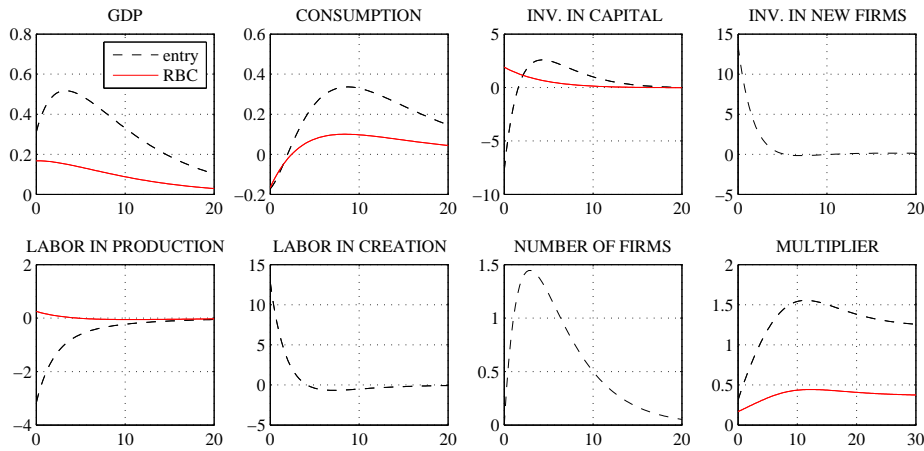


Figure 10: Impulse responses to a temporary cut in capital and dividend income taxes

Figure 10 shows impulse responses to a cut in the unified tax rate on dividend and capital income. In the entry model, the impacts of a combined dividend and capital tax cut turn out to be qualitatively identical to the ones of an isolated cut in dividend taxes. The results show a sharp decline in capital investment but a jump in investment in new

¹²Note that this fiscal package is again normalized such that the cost of the fiscal stimulus in the implementation period amounts to 1% of GDP.

firms which in turn leads to an increase in the number of varieties. This increase amplifies the fiscal multiplier significantly, when compared to the RBC model with a fixed number of firms.

In the RBC model, this fiscal package has much smaller positive effects than the isolated cut in capital taxes. The reason is that part of the package is wasted for a cut in (lump-sum) dividend taxes that is completely ineffective in stimulating economy activity if the number of firms is fixed.

Consumption tax cut

Figure 11 shows the impulse responses to a cut in consumption taxes. The temporary tax cut stimulates aggregate demand through an increase in private consumption. Otherwise, the results for a cut in consumption taxes are qualitatively equivalent to those for an increase in government consumption described above. In contrast to the standard RBC model with a constant number of producers, the consumption tax cut crowds in investment in new firms. As a result, the extensive margin increases. This in turn amplifies the multiplier effects compared to the RBC model. However, caused by the rather small reaction of product variety, the adjustment time-paths generated by the two models do not differ significantly.

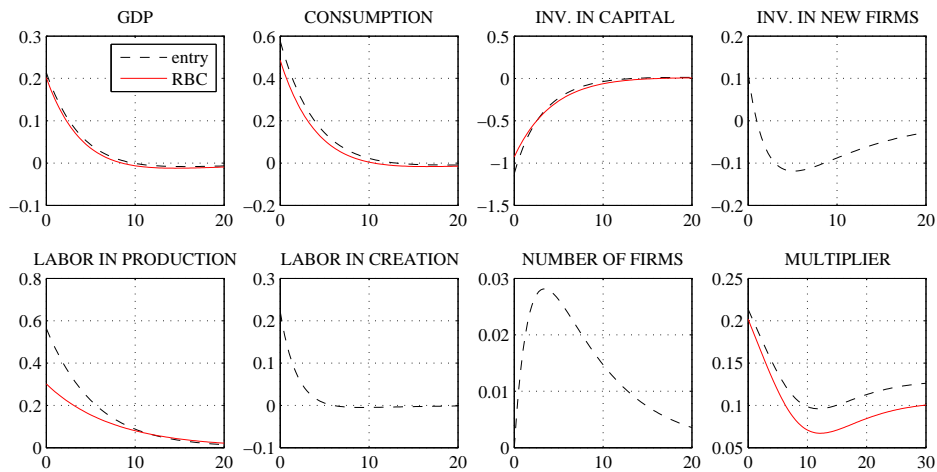


Figure 11: Impulse responses to a temporary cut in consumption taxes

Compared to an increase in government consumption, the multipliers for both the RBC

and entry model are much smaller. The rationale is that the induced increase in labor supply is smaller which dampens the boom in output.

Robustness checks

We have demonstrated that the sign of the response of the number of varieties to an increase in government consumption is ambiguous when varying the labor supply elasticity, η , and the shock persistence, ρ . In line with these findings, Table 3 shows that we obtain the same result for a consumption tax cut. This is not surprising since we already pointed out that the qualitative results for a cut in consumption taxes are equivalent to those for an increase in government consumption.

However, when looking at isolated labor, capital, and dividend income tax cuts results change. Under these fiscal stimuli, the sign of the reaction of the number of varieties is unambiguous. The extensive margin always reacts expansionary in the case of a cut in labor and dividend income taxes whereas it always decreases when considering a cut in capital taxation. Only when capital and dividend income taxes are not distinguishable, some degree of autocorrelation is necessary to ensure that the positive impact of the dividend tax cut dominates the contractionary impact of the cut in capital income taxes. Under our baseline calibration a degree of autocorrelation of $\rho \geq 0.2$ is sufficient to obtain an increasing number of varieties.

Stimulus	$\eta = 2$	$\eta = 0.5$	$\rho = 0$	$\rho = 0.95$
τ^C	↓	↑	↓	↑
τ^L	↑	↑	↑	↑
τ^K	↓	↓	↓	↓
τ^d	↑	↑	↑	↑
$\tau^K = \tau^d$	↑	↑	↓	↑

Table 3: Response of the number of varieties

3.3 The different stimuli at a glance

Table 4 shows the short- and long-run fiscal multipliers for the previously analyzed fiscal stimuli for both models and indicates the qualitative reaction of the number of varieties, N . The short-run multiplier is calculated as the change in GDP in the impact period divided by the costs of a fiscal stimulus during the impact period. The long-run multiplier

is defined as the discounted output effects divided by the discounted costs. However, as both models generate hump-shaped adjustment patterns, the short-run multipliers are rather not conclusive. Therefore, we focus on the long-run effects in the following analysis.

Stimulus	Short-Run		Long-Run		N
	Entry	RBC	Entry	RBC	
G AR(1)	0.4461	0.4422	0.2741	0.2222	↑
G AR(2)	1.2140	1.1251	0.2864	0.2429	↑
τ^L	0.8736	0.9437	1.7482	1.3878	↑
τ^C	0.2134	0.2018	0.1299	0.1053	↑
τ^K	0.6341	0.6358	1.2034	1.3679	↓
τ^d	0.2058	0	1.2118	0	↑
$\tau^K = \tau^d$	0.3114	0.1676	1.2230	0.3646	↑

Table 4: Fiscal multipliers and number of varieties, N

When disregarding the dividend income tax cut for the moment, the ranking of the analyzed fiscal stimuli remains unchanged by the introduction of entry in the model. The consumption tax cut has the lowest effect on GDP since the resulting increase in consumption is strongly mitigated by decreasing investments in physical capital. The resulting multiplier is about 0.13 (0.11) in the entry (RBC) model. The pure demand stimulus also generates a multiplier significantly below one, since the increase in government consumption causes a crowding out of both private consumption and investment in physical capital. The net effect is rather small 0.27 (0.22).

In the RBC model both the labor and the capital tax cut perform quantitatively equivalent since both factors just represent input factors for manufacturing provided by private households. In the entry model, on the other hand, labor is also needed to invent new products and is thus relatively the more important factor. By decreasing the labor tax, investment in new firms thus amplifies the results. This is also the reason why the number of firms declines in the case of the capital tax cut since the households substitute labor with capital supply leading to a decrease in new product investments. The capital tax cut has also strong multiplier effects, although the shock causes a crowding out of the extensive margin. The resulting multiplier is consequently smaller than in the standard RBC model. However, it is still larger than one. In all cases where product variety increases, the resulting multiplier generated by the entry model exceeds that of the standard RBC model.

As already mentioned, the dividend income tax rate is lump-sum in the RBC model and thus does not yield to any fluctuations at all. In the entry model, on the other hand,

this tax cut has strong effects (1.21) since it causes all components of GDP to increase over the cycle.

The unified cut in capital and dividend income taxes also leads to large multipliers in the endogenous entry model (1.22). Note that this effect is even stronger than both separated cuts in dividend and capital taxes. However, when the number of firms is fixed, the multiplier is quite small (0.3646). The rationale is the lump-sum nature of dividend taxes under these circumstances and the resulting partly non-effectiveness of the fiscal package.

Our results imply that in line with the findings of Campolmi, Faia, and Winkler (2010) and Faia, Lechthaler, and Merkl (2010), a pure demand stimulus leads to rather small real effects. Disburdening private agents from labor, dividend, or capital income taxes is much more effective. Moreover, these stimuli even generate fiscal multiplier significantly larger than one. The labor tax cut is thereby the most effective fiscal tool since it induces a crowding in of consumption, investment, and the extensive margin. Also in the case of a constant number of products, this intervention is the most successful tool.

4 Distortionary taxation

Up to now we have assumed that a demand stimulus through an increase in government consumption is financed by raising lump-sum taxes. Now, we will look at the effects of distortionary taxation for government spending multipliers and the number of firms. We follow Uhlig (2009) and assume that an increase in government consumption is financed partly by raising distortionary taxes on labor income and partly by issuing debt. The adjustment of distortionary taxes can be analyzed by introducing the following tax rule

$$\tau_t^L \omega_t L_t = \phi_g (G_t + (1 + r_{t-1})B_{t-1} - \tau_t^C C_t - \tau_t^d d_t N_t - \tau_t^K (r_t^K - \delta)K_{t-1} - \tau_t), \quad (21)$$

where ϕ_g denotes the share of lump-sum taxation or debt financing. $\phi_g = 0$ is then equivalent to pure lump sum taxation. We assume that all taxes, other than the labor income tax, stick to their steady state values, i.e., $\tau_t = \tau$, $\tau_t^C = \tau^C$, $\tau_t^K = \tau^K$, $\tau_t^d = \tau^d$.

In contrast to Uhlig (2009), we furthermore want to explore the effects of an increase

in government consumption financed by raising taxes on consumption purchases as well as on capital and dividend income. We therefore introduce the following variants of the tax rule described above:

$$\tau_t^C C_t = \phi_g (G_t + (1 + r_{t-1})B_{t-1} - \tau_t^L w_t L_t - \tau_t^d d_t N_t - \tau_t^K (r_t^K - \delta)K_{t-1} - \tau_t), \quad (22)$$

where $\tau_t^L = \tau^L$, $\tau_t = \tau$, $\tau_t^K = \tau^K$, $\tau_t^d = \tau^d$,

$$\tau_t^d d_t N_t = \phi_g (G_t + (1 + r_{t-1})B_{t-1} - \tau_t^C C_t - \tau_t^L w_t L_t - \tau_t^K (r_t^K - \delta)K_{t-1} - \tau_t), \quad (23)$$

where $\tau_t^C = \tau^C$, $\tau_t^L = \tau^L$, $\tau_t = \tau$, $\tau_t^K = \tau^K$, and

$$\tau_t^K (r_t^K - \delta)K_{t-1} = \phi_g (G_t + (1 + r_{t-1})B_{t-1} - \tau_t^C C_t - \tau_t^L w_t L_t - \tau_t^d d_t N_t - \tau_t) \quad (24)$$

where $\tau_t^C = \tau^C$, $\tau_t^L = \tau^L$, $\tau_t = \tau$, $\tau_t^d = \tau^d$.

For ϕ_g we consider two alternative values: $\phi_g = 0.5$ and $\phi_g = 1$.¹³ Table 5 shows the resulting multipliers and indicates the qualitative reaction of the extensive margin.

Taxation	$\phi_g = 0.5$					$\phi_g = 1$				
	Short-Run		Long-Run		N	Short-Run		Long-Run		N
	Entry	RBC	Entry	RBC		Entry	RBC	Entry	RBC	
τ^L	0.5484	0.3498	-2.0122	-1.5599	↓	-0.4870	-0.8429	-2.2574	-1.7025	↓
τ^C	0.2522	0.2399	0.1187	0.0945	↑	0.2436	0.2291	0.1462	0.1172	↑
τ^K	-0.2081	-0.2607	-1.2619	-1.7153	↑	-0.2309	-0.3033	-1.1325	-1.5781	↑
τ^d	0.3144	0.4222	-2.1856	0.2222	↓	0.3011	0.4222	-1.9978	0.2222	↓
$\tau^K = \tau^d$	0.1396	0.2736	-1.8859	-0.1629	↓	0.1246	0.2634	-1.7120	-0.1396	↓

Table 5: Government spending multipliers and number of varieties, N , under distortionary taxation

Three results are worth mentioning. First, as in Uhlig (2009) distortionary income taxation leads to negative long-run multipliers. Only if the increase in government consumption is financed through an increase in consumption taxes, the long-run fiscal multiplier remains slightly positive.

Second, when focusing on the long-run multiplier and disregarding dividend tax cuts, we find that a procyclical reaction of the number of firms amplifies the fiscal multiplier when compared to the standard RBC model with a fixed number of firms. In the case

¹³The results for $\phi_g = 0$ are obviously those shown in Table 4.

of capital tax financing, the number of firms reacts countercyclical which dampens the negative multiplier effects.

Note that the lump-sum nature of dividend taxes in the standard RBC model prohibits a reasonable comparison of dividend tax financing with and without an endogenous number of firms.¹⁴

Finally, the size of the response of the number of varieties crucially depends on the way an increase in government consumption is financed. Whereas under our baseline calibration and lump-sum taxation the number of varieties increases, it decreases when financed by raising distortionary labor and dividend income taxes. In these cases the negative impact of the rise in taxes (described above) dominates the positive impact of the increase in government consumption. When the demand stimulus is financed through an increase in consumption taxes, however, the number of varieties increases. Hence, the negative impacts of the consumption tax cut are dominated by the rise in government consumption. This result is intuitive since an isolated consumption tax cut has very small effects [cf. Table 4].

A rise in capital taxes leads to an increase in the number of firms due to the substitution between investment in new firms and investment in existing capital. In this case, the number of firms increases since both effects on the extensive margin – the rise in capital taxes and the increase in government consumption – run into the same direction.

5 Conclusion

Since recent theoretical contributions analyze the impacts of fiscal stimuli on standard economic measures of economic activity (GDP, employment, investment) but neglect their impact on the extensive margin, this paper analyzes different fiscal stimuli in a model with endogenous product creation.

We demonstrate that the extensive margin is a crucial dimension for evaluating fiscal policy since it accelerates the impacts of fiscal stimulus. More precisely, we find that in response to a fiscal stimuli the number of firms co-moves with GDP, fiscal multipliers are amplified. If, however, the number of firms responds countercyclical the extensive margin

¹⁴Obviously, the RBC multipliers are identical to those depicted in Table 4.

dampens the impact on economic activity.

We show that a pure demand stimulus and a consumption tax cut are not the recommendable fiscal tools to boost GDP. Instead, a policy maker should concentrate on disburdening private agents from labor and dividend taxes since these fiscal interventions both induce a crowding in of consumption, of investment in existing capital, and of investment in new product creation. The latter effect in turn leads to an increase in the number of product varieties.

Considering the case that an increase in government consumption is financed by distortionary taxation, our findings suggest higher consumption taxes. The reason is that a rise in income taxes causes fiscal multipliers to turn negative which may be even amplified by a decreasing number of varieties. Only if the demand stimulus is financed with consumption taxes, the fiscal multiplier remains positive and the number of varieties increases.

To highlight the role of an endogenous number of firms for the impacts of different fiscal packages on economic activity, we employ a real business cycle model with firm entry. Thus, our framework does not allow for any role of monetary policy which, however, plays an important role as a policy response to economic downturns. The interplay of monetary and fiscal policy in a model with firm entry may thus be a promising area for future research.

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