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Totzek, Alexander and Winkler, Roland C.

Christian-Albrechts University of Kiel, Goethe University Frankfurt

7 April 2010

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Alexander Totzek[‡]

Christian-Albrechts-University Kiel

Roland C. Winkler[§]

Goethe University Frankfurt

First draft: April 2010

This draft: November 2010

Abstract

This paper explores different fiscal stimuli within a business cycle model with an endogenous mass of firms which we estimate for the U.S. economy using Bayesian techniques. We demonstrate that a changing mass of firms is a crucial dimension for evaluating fiscal policy since it can both accelerate and decelerate the impacts of fiscal stimuli. When fiscal interventions cause the mass of firms to decline, an additional crowding-out effect of investment in new firms results in a multiplier below that of the standard RBC model. In the presence of demand stimuli, fiscal multipliers are small and the mass of firms may decline. This holds in particular under distortionary tax financing. By contrast, policies that disburden private agents from income taxes are effective in boosting economic activity and product creation.

JEL classification: E62, E32, E22

Keywords: Fiscal Multipliers, Firm Entry, Product Variety

[‡] *Address*: Department of Economics, Christian-Albrechts-University Kiel, Olshausenstr. 40, 24098 Kiel, Germany. *Phone*: ++49-431-880-1447, *E-mail*: totzek@economics.uni-kiel.de

[§] *Address*: Department of Money and Macroeconomics, Goethe University Frankfurt, Grüneburgplatz 1, House of Finance, 60323 Frankfurt am Main, Germany. *Phone*: ++49-69-798-33800, *E-mail*: winkler@hof.uni-frankfurt.de

1 Introduction

In order to fight the recessionary impacts of the recent 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 U.S. fiscal package of January 2009 and find a multiplier significantly larger than one. However, several authors challenge this finding. Cogan et al. (2010) and Cwik and Wieland (2009) respectively employ empirically estimated models for the U.S. and Euro economy [Smets and Wouters (2007, 2003)] and report multipliers less than one.[1] Uhlig (2010) 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 these 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 mass of incumbent and new products (or: firms) in the market.[2] However, a recent literature highlights the role of an endogenous mass of firms as an important propagation and amplification mechanism for business cycle fluctuations.[3] 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, a substantial pro-cyclical behavior of the mass of firms may help to explain how fiscal stimuli generate large and persistent business cycle fluctuations. In particular, this amplification effect potentially give rise to

[1] Note that Cogan et al. (2010) also incorporate rule-of-thumb consumers.

[2] Remark: 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.

[3] Among others, Devereux, Head, and Lapham (1996), Bergin and Corsetti (2008), and Totzek (2010) show that GDP is highly correlated with the number of producing firms.

larger multipliers.

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 which we estimate for the U.S. using Bayesian techniques. Second, we calculate fiscal multipliers for both our baseline model with an endogenous mass of firms and for the standard case of a constant extensive margin. This enables us to investigate whether a changing mass of firms alters the effectiveness of fiscal stimuli. Our framework moreover allows for a closer examination of investment decisions – and crowding-out/in effects of fiscal interventions – since we can distinguish between investments in physical capital and those in new products. A further advantage of this kind of models is that profit taxation is not lump-sum. This allows a broader base for fiscal policy analysis.

Note that the aim of this paper is however not to calculate fiscal multipliers of the ARRA stimulus package as we do not apply a large scale DSGE model with several nominal and real frictions. Instead, we apply a rather simple framework and focus on the qualitative and quantitative differences to the standard RBC model. More precisely, we apply 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 consumption[4] (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 taxes. 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 schemes of distortionary tax financing.

Our main findings are as follows. We demonstrate that the extensive margin can indeed act as an accelerator for the impacts of fiscal stimuli. More precisely, we find that if in response to a fiscal intervention the mass of firms increases, fiscal multipliers are amplified. In this case, two expansionary effects arise. First, an increasing extensive margin has a positive impact on goods production. Second, households have to invest in start-ups to

[4] As 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.

create new firms. Additional investments in turn boost GDP. When compared to the standard RBC model – with a constant extensive margin – the multipliers are significantly larger. If, by contrast, the mass of firms decreases, the extensive margin dampens the impacts of fiscal stimuli on economic activity. The drop in new firm investment then represents an additional crowding-out effect. In comparison with the standard RBC model, the resulting multipliers are then significantly smaller.

With respect to the different fiscal packages, our analysis shows that the reaction of the extensive margin in response to an increase in government consumption turns out to be ambiguous. This result finds also support in the data as our estimation depicts an insignificant impact reaction of investment in new firms and of the mass of firms.[5] In line with this finding, Lewis (2009) points out that the mass of firms only reacts expansionary if the fiscal demand shock is sufficiently persistent.[6] The economic rationale is that only under highly persistent shocks potential firms expect future profit opportunities which cover the entry cost and consequently enter the market.

We extend this analysis by demonstrating that the ambiguous impact of government consumption shocks on product variety is not only driven by the shock persistence but by the combination of the latter with the labor supply elasticity. Furthermore, we show that the source of government financing is a crucial dimension, too. The economic intuition why the reaction of the mass of product varieties may turn negative when the labor supply elasticity is low is as follows. Suppose labor is the only input in production and is supplied totally inelastic. In an RBC model with a fixed mass of producers, an increase in consumption consequently causes a complete 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.[7] Households are then able to dampen the drop in private consumption by increasing hours worked in the manufacturing sector and decrease hours worked for product creation. Product variety consequently declines when labor supply is sufficiently inelastic.

[5] For the remaining shocks considered in the estimation process (shock to the price mark-up, entry costs, labor supply, and technology) the reactions are however significant.

[6] Lewis (2009) extends the sticky price framework of Bilbiie, Ghironi, and Melitz (2007b) to allow for government spending shocks. The optimal fiscal policy in a framework with firm entry and flexible prices is derived in Chugh and Ghironi (2009).

[7] Remark: As in amongst others Bilbiie, Ghironi, and Melitz (2007b), we assume that labor is needed to create new products.

The impulse response functions, based on the estimated mean of the parameters, show a decrease in the mass of firms in response to increase in government consumption. The additional crowding-out effect pushes the multiplier below that of the RBC model with a constant mass of firms. This is particularly true when considering the case of an increase in government consumption financed by distortionary income taxation. In line with the findings of Uhlig (2010) the long-run fiscal multipliers then become significantly negative. Similar results are found for the case of a demand stimulus through a cut in consumption taxes.

Due to the fact that fiscal demand stimuli may cause a crowding-out not only of investment in physical capital and consumption but also of investment in new firms, we conclude that these policies are not the recommendable tools to boost economic activity. Instead, a policy maker should concentrate on disburdening private agents from labor and dividend taxes since the multipliers of these interventions are significantly larger. The reason is that in these cases we find a crowding-in of private consumption, of investment in existing capital, and of investment in product creation. The latter effect in turn leads to an increasing mass of firms. Although the multiplier of a cut in capital taxes is also close to one, this policy comes at the cost of a crowding-out in new firm investment and thus of a decrease in the mass of firms.

Finally, this study is – to the best of our knowledge – the first that conducts a Bayesian estimation of a DSGE model with firm entry incorporating several structural shocks. In a complementary study, Lewis and Poilly (2010) estimate a DSGE model with firm entry by using a VAR minimum distance approach. They apply a framework with several nominal and real frictions but focus on a single shock to monetary policy.

The remainder of the paper is as follows. Section 2 presents the model. In Section 3, the results of the Bayesian estimation are presented. In Section 4, we discuss the estimated responses to an increase in government consumption. The fiscal multipliers of six fiscal packages, all financed with lump-sum taxes, are discussed in Section 5. In Section 6, we analyze a pure demand stimulus that is financed by raising distortionary taxes. Section 7 concludes.

2 The model

We apply the entry model of Bilbiie, Ghironi, and Melitz (2007a) with capital in production.[8] 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.[9] New product creators use labor to invent new varieties of intermediate goods. Notice that new product creation is equivalent to the production of a new manufacturing firm due to the common 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 fiscal consumption as well as for 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, $Y_t^C P_t - \int_0^{N_t} p_t(\omega) y_t(\omega) d\omega$, subjected to the following CES production function $Y_t^C \equiv \left(\int_0^{N_t} y_t(\omega)^{(\zeta_t - 1)/\zeta_t} d\omega \right)^{\zeta_t/(\zeta_t - 1)}$, where P_t is the price of the final good, $p_t(\omega)$, is the

[8] Bilbiie, 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.

[9] Bilbiie, Ghironi, and Melitz (2007b) extend the framework of Bilbiie, Ghironi, and Melitz (2007a) by introducing sticky prices. Since we do not want to discuss the interdependency between fiscal and monetary interventions, we apply the pure RBC version.

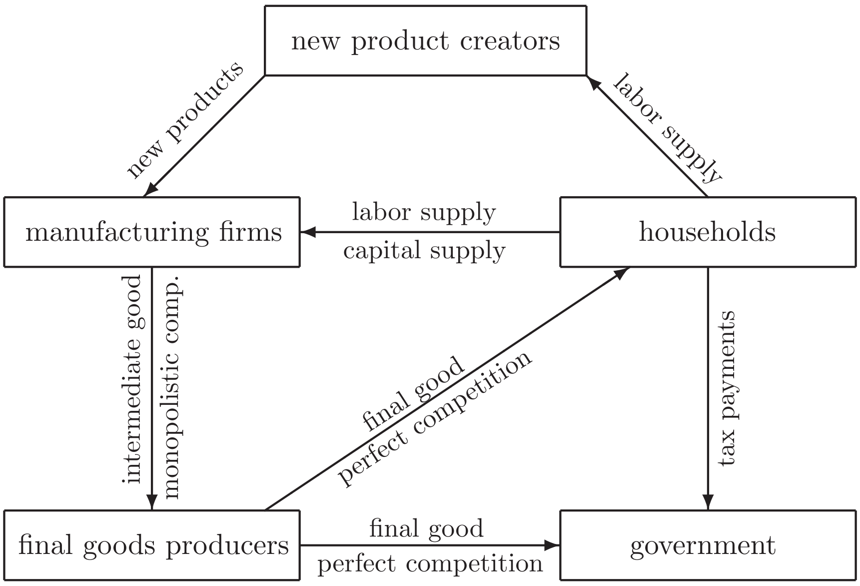

Figure 1: Model structure

price of variety ω, and ζ_t is the time-varying elasticity between the intermediate goods.[10] The latter follows an exogenous AR(1) process: $\log \zeta_t = (1-\rho_\zeta)\log\zeta + \rho_\zeta \log\zeta_{t-1} + \varepsilon_t^\zeta$, where ε_t^ζ is white noise.[11] N_t denotes the non-stationary mass of goods available at time t. The first-order condition for profit maximization yields the demand function for variety ω which is given by $y_t(\omega) = \rho_t(\omega)^{-\zeta_t} Y_t^C$, where $\rho_t(\omega) \equiv p_t(\omega)/P_t$ is the relative price of variety ω and $P_t = \left(\int_0^{N_t} p_t(\omega)^{1-\zeta_t} d\omega\right)^{1/(1-\zeta_t)}$ is the resulting price index.

Since there is no heterogeneity in this framework, we refer to symmetry across firms, implying $y_t(\omega) = y_t$, $p_t(\omega) = p_t$, $\rho_t(\omega) = \rho_t$. The aggregate amount of intermediate goods (or: aggregate demand) is obtained by solving the CES technology:

$$Y_t^C = N_t^{\frac{\zeta_t}{\zeta_t - 1}} y_t. \tag{1}$$

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

[10] Remark: Bilbiie, Ghironi, and Melitz (2007a) alternatively present a translog aggregation. However, our results remain robust with respect to this assumption since the generated mark-up movements are quantitatively very small.

[11] In the following, a variable without a time index denotes the respective steady state value.

2.2 Intermediate goods producers

Each intermediate goods producer is a monopolistic supplier of product ω.[12] A firm uses the amount l_t of labor, the amount k_{t-1} of physical capital and the constant returns to scale technology

$$y_t = z_t l_t^{\alpha} k_{t-1}^{1-\alpha} \tag{2}$$

to produce the intermediate good, y_t. z_t is total factor productivity which follows the process: $\log z_t = (1-\rho_z)\log z + \rho_z \log z_{t-1} + \varepsilon_t^z$, where ε_t^z is white noise. $\alpha \in (0,1)$ denotes the share of labor in production. The firm takes the factor prices w_t and r_t^K as given. 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 $y_t = \rho_t^{-\zeta_t} Y_t^C$. The optimization yields

$$\rho_t = \frac{\zeta_t}{\zeta_t - 1} mc_t \,. \tag{3}$$

In the absence of shocks to the intratemporal elasticity between intermediate goods, the real price is set as a constant mark-up over real marginal costs.

Factor demands are obtained by cost minimization and read as

$$w_t = \alpha mc_t \frac{y_t}{l_t} = \alpha \frac{\zeta_t - 1}{\zeta_t} \frac{Y_t^C}{L_t^C} \,, \tag{4}$$

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

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

$$d_t = \left(1 - \frac{\zeta_t - 1}{\zeta_t}\right) \frac{Y_t^C}{N_t} \,. \tag{6}$$

[12] See Faia (2009) for a New Keynesian model with firm entry and oligopolistic competition on the goods market. However, our results are robust with respect to this assumption since the generated counter-cyclical mark-up movements are rather small.

2.3 New product creators

Firms in this perfectly competitive sector create new products amounting to, $N_{E,t}$, by using labor, L_t^E, and the technology $N_{E,t} = L_t^E / f_{E,t}$ in order to maximize their profits $v_t N_{E,t} - w_t/z_t L_t^E$. 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. $1/f_{E,t}$ denotes a productivity shifter such that $f_{E,t}$ can also be interpreted as a time-varying entry cost that follows the exogenous AR(1) process: $\log f_{E,t} = (1 - \rho_{f_E}) \log f_E + \rho_{f_E} \log f_{E,t-1} + \varepsilon_t^{f_E}$, where $\varepsilon_t^{f_E}$ is white noise. The first-order condition for profit-maximization yields the free entry condition $v_t = w_t/z_t f_{E,t}$.

To capture the empirical finding that firm entries do not take place contemporaneously with GDP [see amongst others Devereux, Head, and Lapham (1996)], we assume a time-to-build lag in new product creation. As in Bilbiie, Ghironi, and Melitz (2007a), we assume, for the sake of simplicity, that the firm's death rate is exogenous.[13] The recursive law of motion of the extensive margin is then given by

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

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

[13] See Totzek (2010) for a New Keynesian framework simultaneously considering endogenous entries and exits.

utility

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\log C_t - \frac{\chi_t}{1+\eta} L_t^{1+\eta} \right) , \tag{8}$$

where β is the discount factor, $\eta > 0$ is the inverse of the labor supply elasticity, and $\chi_t > 0$ is a shock to the labor supply that follows an AR(1) process: $\log \chi_t = (1-\rho_\chi)\log\chi + \rho_\chi \log\chi_{t-1} + \varepsilon_t^\chi$, where ε_t^χ is white noise. The maximization of (8) is subjected to the household's period-by-period budget constraint

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

the capital accumulation equation

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

and the dynamics of firm 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.[14] 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, $v_t(N_t + N_{E,t})x_{t+1}$.

The first-order conditions for utility maximization are given by

$$\lambda_t = \beta\,\mathrm{E}_t \left\{ \lambda_{t+1}(1+r_t) \right\} , \tag{11}$$

$$\lambda_t = \beta\,\mathrm{E}_t \left\{ \lambda_{t+1}\big(1 + (1-\tau_t^K)(r_{t+1}^K - \delta^K)\big) \right\} , \tag{12}$$

$$v_t = (1-\delta)\beta\,\mathrm{E}_t \left\{ \frac{\lambda_{t+1}}{\lambda_t}\big(v_{t+1} + (1-\tau_{t+1}^d)d_{t+1}\big) \right\} . \tag{13}$$

$$\lambda_t = C_t^{-1}\left(1+\tau_t^C\right)^{-1} \tag{14}$$

[14] 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.

where λ_t denotes the Lagrange multiplier for the budget constraint.

Households supply their labor force to manufacturing firms (or: intermediate goods producers) and product creators. Total hours worked are determined by the following intratemporal optimality condition:

$$(1-\tau_t^L)w_t = \chi_t L_t^\eta C_t(1+\tau_t^C)\,. \tag{15}$$

The optimal labor supply equation implies that both a decrease in labor and in consumption taxes leads ceteris paribus to an increase in total hours worked and consumption.

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

$$G_t + (1+r_{t-1})B_{t-1} = B_t + \tau_t^L w_t L_t + \tau_t^C C_t + \tau_t^d d_t N_t + \tau_t^K (r_t^K - \delta)K_{t-1} + \tau_t \tag{16}$$

yields the overall resource constraint

$$Y_t^C + v_t N_{E,t} = w_t L_t + N_t d_t + r_t^K K_{t-1}\,, \tag{17}$$

where $Y_t^C = C_t + I_t + G_t$ denotes aggregate demand of final goods and $v_t N_{E,t}$ is investment in new firms. G_t is government consumption which is described by the AR(1) process: $G_t = (1-\rho_g)G + \rho_g G_{t-1} + \varepsilon_t^G$, where ε_t^G is white noise. Following Bilbiie, Ghironi, and Melitz (2007a), we define total investment as $TI_t \equiv I_t + N_{E,t}v_t$. The gross domestic product, Y_t, is equal to $Y_t \equiv Y_t^C + N_{E,t}v_t$.[15]

2.6 The 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 $TI_t = I_t$.

[15] The complete model at a glance can be found in Appendix B.

3 Parameter estimates

In this section, we estimate the structural entry model using Bayesian techniques. The estimation is based on U.S. data for the quarterly growth rates of real GDP, real consumption, hours worked, the real wage, and net business formation over the sample period 1964Q2 to 1995Q3.[16] All series are demeaned prior to estimation. In order to generate data-consistent time series from the model, we divide the real model variables C_t, Y_t, and w_t by the relative price ρ_t.[17] The measurement equations then read as follows:

$$\text{data\_GDP}_t = \left(\frac{Y_t/\rho_t}{Y_{t-1}/\rho_{t-1}} - 1\right) 100\,, \qquad \text{data\_WAGE}_t = \left(\frac{w_t/\rho_t}{w_{t-1}/\rho_{t-1}} - 1\right) 100\,,$$

$$\text{data\_CONS}_t = \left(\frac{C_t/\rho_t}{C_{t-1}/\rho_{t-1}} - 1\right) 100\,, \qquad \text{data\_HOURS}_t = \left(\frac{L_t}{L_{t-1}} - 1\right) 100\,,$$

$$\text{data\_NBF}_t = \left(\frac{N_t}{N_{t-1}} - 1\right) 100\,.$$

The application of five data series requires at least five exogenous disturbances. Therefore, we estimate the baseline model including shocks to government consumption, ε_t^g, to total factor productivity, ε_t^z, to entry costs, $\varepsilon_t^{f_E}$, to labor supply, ε_t^χ, and to the price mark-up, ε_t^ζ.

The following parameters are kept fixed in the estimation procedure. The discount rate, β, is fixed equal to 0.99 implying an annual steady state real interest rate of approximately 4 percent. The quarterly capital depreciation rate, δ^K, is set to the standard value 0.025. The share of labor in the production function, α, is set to 0.8 which is the value estimated by Smets and Wouters (2007). Following Bilbiie, Ghironi, and Melitz (2007a, 2007b) and Lewis (2009), the value of the elasticity of substitution between intermediate goods, ζ, is set to 3.8.[18] For reflecting the U.S. economy, the steady state tax rates and steady state government consumption are set to $\tau^C = 0.05$, $\tau^L = 0.28$, $\tau^K = 0.36$, and $G/Y = 0.18$ 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. Throughout

[16] A full description of the data is given in the Appendix A. The sample period is limited through the lack of data on net business formation.

[17] Bilbiie, Ghironi, and Melitz (2007a) point out that for data-consistency real model variables should be deflated by p_t instead of P_t.

[18] Although this value seems to be rather small, Lewis and Poilly (2010) estimate the elasticity of substitution between intermediate goods to be even smaller (3.31) in a model with firm entry.

Parameters		Prior distribution			Posterior distribution		
		Type	Mean	Std. Dev.	Mode	Mean	Confid. Interval
Inv. of Frisch elasticity	η	Normal	1	0.75	2.9899	3.1761	[2.3784 – 4.0188]
Firm exit rate	δ	Beta	0.025	0.01	0.0966	0.0944	[0.0810 – 0.1073]
Entry cost	f_E	Normal	1	0.5	0.3398	0.3535	[0.2866 – 0.4165]
Persistence of g shock	ρ_g	Beta	0.5	0.2	0.9287	0.8879	[0.8125 – 0.9714]
Persistence of z shock	ρ_z	Beta	0.5	0.2	0.9990	0.9984	[0.9970 – 0.9998]
Persistence of f_E shock	ρ_{f_E}	Beta	0.5	0.2	0.9758	0.9604	[0.9319 – 0.9908]
Persistence of ζ shock	ρ_ζ	Beta	0.5	0.2	0.1943	0.1948	[0.1190 – 0.2733]
Persistence of χ shock	ρ_χ	Beta	0.5	0.2	0.9838	0.9819	[0.9694 – 0.9948]
Std. dev. g shock	ε_t^g	Inv. Gam.	0.01	2	0.0536	0.0709	[0.0384 – 0.0997]
Std. dev. z shock	ε_t^z	Inv. Gam.	0.01	2	0.0148	0.0154	[0.0132 – 0.0176]
Std. dev. f_E shock	$\varepsilon_t^{f_E}$	Inv. Gam.	0.01	2	0.0177	0.0164	[0.0128 – 0.0197]
Std. dev. ζ shock	ε_t^ζ	Inv. Gam.	0.01	2	0.0852	0.0876	[0.0757 – 0.0992]
Std. dev. χ shock	ε_t^χ	Inv. Gam.	0.01	2	0.0258	0.0274	[0.0211 – 0.0334]

Table 1: Results from the Bayesian estimation including prior distribution and confidence intervals

the estimation process, χ is computed endogenously such that in the steady state 1/3 of time is devoted to work. The steady state value of total factor productivity, z, is normalized to 1.

For the remaining parameters we choose priors for the Bayesian estimation following previous literature, in particular Smets and Wouters (2007). Table 1 shows the prior distribution, alongside with the estimated parameters as modes of the posterior distribution and the 95 percent confidence intervals obtained by the Metropolis-Hastings algorithm. The standard deviations of shocks are assumed to be inverse-gamma distributed with a mean of 0.01. The prior means for the autoregressive parameters are beta distributed with prior means of 0.5 and standard deviations of 0.2. We assume a normal distribution for the inverse of the Frisch elasticity of labor supply, η. The prior mean of 1 and the standard deviation is chosen to cover a wide range of parameter values typical used in calibration exercises. The entry cost, f_E, is assumed to be normal distributed with a prior mean of 1 and a standard deviation of 0.5.[19] Finally, the firm exit rate, δ, is beta distributed with a mean of 0.025 which is the calibrated value used by Bilbiie, Ghironi, and Melitz (2007a) which they choose to match the average annualized job destruction rate in the U.S..

The results of the Bayesian estimation are shown in Table 1. It depicts that the pro-

[19] Remark: Bilbiie, Ghironi, and Melitz (2007a) log-linearize their model and conclude that the steady state of the entry costs cancels out and thus does not affect the resulting dynamics, at all. By contrast, we apply the non-linear representation. Hence, the steady state of the entry costs now plays a crucial role by determining the steady state value of v_t and thus influences the dynamics of the whole entry mechanism.

cesses for government spending, total factor productivity, entry costs, and for the labor supply shock are highly persistent with an AR(1) coefficient of 0.92, 0.99, 0.98, and 0.98, respectively. The persistence of the price mark-up shock is quite low. These results are consistent with studies such as Smets and Wouters (2007). The point estimate of the inverse of the Frisch elasticity of labor supply, η, is approximately 3 with a 95 percent confidence interval from 2.4 to 4. The confidence interval for the entry cost ranges from 0.29 to 0.42 with a point estimate of around 1/3. Finally, our estimation delivers a firm exit rate of about 10 percent. This high value is more in line with the findings of Broda and Weinstein (2010) who report a product turnover rate of about of 6.25 percent than with the calibrated 2.5 percent used by Bilbiie, Ghironi, and Melitz (2007a). Notice that – as pointed out in Lewis and Poilly (2010) and Bilbiie, Ghironi, and Melitz (2007a) – a higher value of δ implies less persistent dynamics. Remarkably, the data seems to speak in favor of a high value (less persistent dynamics) although we are estimating a rather simple model without features that generates additional persistence such as habit persistence or capital adjustment costs. This finding suggests that the entry mechanism per se leads to sufficiently persistent dynamics.

4 Estimated responses to a government consumption shock

In this section, we analyze the effects of an increase in government consumption, G_t, financed by lump-sum taxation. We use the estimated model to analyze the impulse responses and to discuss the ambiguous reaction of investment in new firms and consequently of the mass of firms.

Figure 2 displays the estimated impulse responses to an increase in government consumption.[20] The solid lines are the means of the distribution of impulse response functions, the grey shaded areas depict the 90 percent highest probability density intervals. Figure 2 shows that in response to an increase in government consumption, private consumption, and investment in physical capital decline significantly. The reason is the negative wealth effect of a rising tax burden [see Baxter and King (1993)]. The wealth effect also causes households to expand their total labor supply which in turn induces a decline in real wages

[20]The number of years are on the abscissa. However, we interpret periods as quarters.

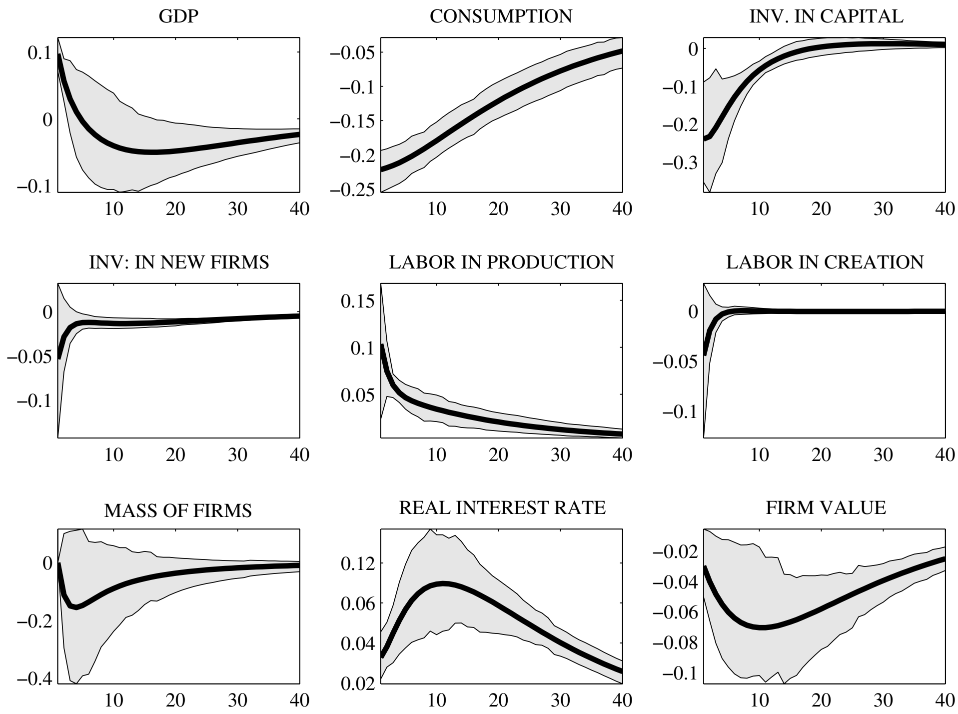

Figure 2: Impulse responses to a temporary increase in government consumption

and a significant expansion of output.

The insignificant reaction of hours worked in the new product sector, of investment in new firms, and of the total mass of firms suggest that the reaction of the extensive margin in response to a government spending shock is ambiguous.[21] This was already mentioned by Lewis (2009) within a calibrated firm entry model with sticky prices and labor as the only input factor. Lewis (2009) points out that the mass of producers only increases for sufficiently high degrees of fiscal shock persistence, ρ_g. The rationale is that only under highly persistent shocks, the expected future profits will cover the entry costs such that new firm creation is boosted. This result also holds in our estimated RBC model considering capital in production.

Notably, we find that the response of the mass of firms does not only depend on the shock persistence but also on the combination of the latter with the labor supply elasticity, $1/\eta$. In the following exercise, we focus on investment in new firms which will be important for the analysis of the effectiveness of fiscal policy because it affects GDP via two channels.

[21] Remark: In the longer-run the contractionary reactions of investment in new firms and of the mass of firms become significant.

The following equation for GDP, Y_t, reveals these two channels:

$$Y_t \equiv v_t N_{E,t} + \underbrace{N_t^{\frac{\zeta}{\zeta-1}} y_t}_{Y_t^C} \tag{18}$$

First, investment in new firms, $v_t N_{E,t}$, is naturally a component of GDP. Second, investment in new firms changes the mass of firms, N_t, which in turn has an impact on the overall production of final goods. Analytically, the latter effect follows from the aggregation of intermediate goods since an increase in the mass of products has ceteris paribus a positive effect on aggregate demand since $\zeta > 1$. This effect is known as 'love of variety' [see Benassy (1996) or Bergin and Corsetti (2008)]. Notice that a decrease in investment in new firms represents an additional crowding-out effect of fiscal policy that is absent in a model with a constant extensive margin.

In order to analyze how firm entry depends on ρ_g and η, we simulate the model under a range of parameter values for $\rho_g = [0, 1)$ and $\eta = [1, 4]$ keeping the remaining parameters fixed to the estimated means shown in Table 1.

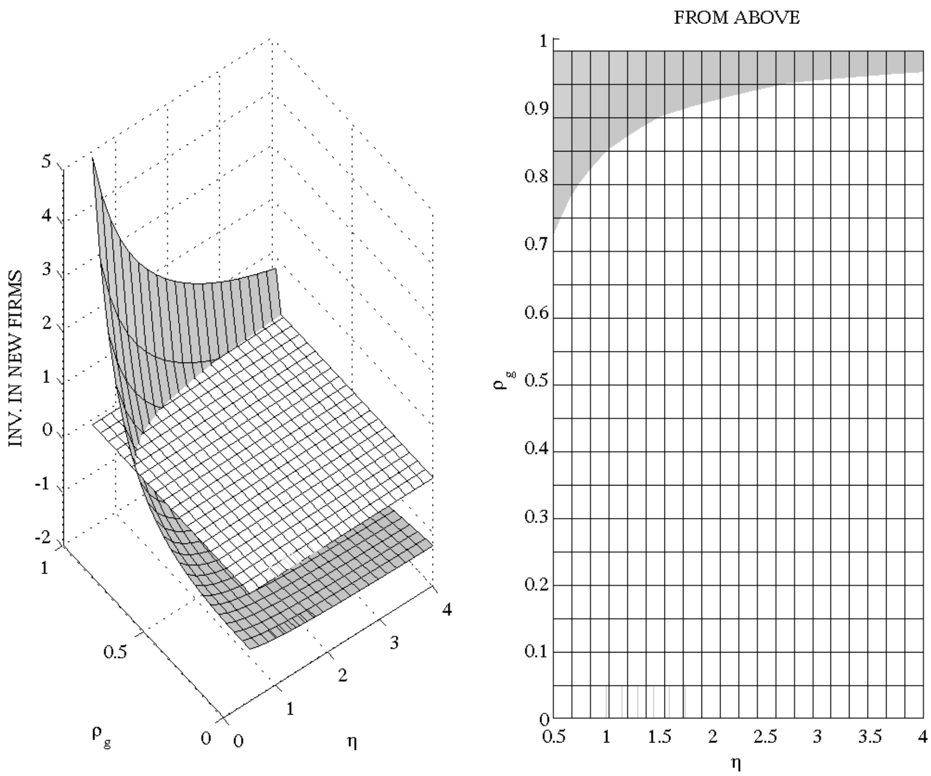

Figure 3: On the ambiguous reaction of investment in new firms

Figure 3 shows investment in new firms (grey area) and the zero plane (white shaded area) from two different lines of sight. Figure 3 indicates that the development of this type of investment and thus of the extensive margin is unambiguously expansionary for a high shock persistence. Moreover, the model also generates an expansionary reaction of this type of investment for lower degrees of shock persistence if the Frisch elasticity of labor supply, $1/\eta$, is sufficiently large. By contrast, the reaction turns negative if the shock persistence is low and the labor supply is sufficiently inelastic.

The economic intuition why the reaction of the mass of firms may turn negative when the labor supply elasticity is low is straightforward. Therefore, let us conduct the following thought experiment and consider the limiting case of a totally inelastic labor supply. Let us moreover abstract from capital such that labor is the only input factor in production. Accounting for these assumptions within an RBC model with a fixed mass of producers, employment and thus output will remain unchanged after an increase in government spending. Government consumption consequently causes a complete 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 to product creation. Product variety consequently declines when the inverse of the labor supply elasticity, η, is large.

All in all, Figure 3 depicts that the qualitative reaction of investment in new firms and thus of the extensive margin is ambiguous. By contrast, Bilbiie, Ghironi, and Melitz (2007a) and Bergin and Corsetti (2008) respectively show that technological innovations and shocks to monetary policy are unambiguously amplified by endogenizing the extensive margin. In line with these findings, it is worth mentioning that the estimated response of the mass of firms to the other shocks under consideration are unambiguous. Figure 4 shows that in response to an increase in total factor productivity, firm entry is boosted significantly. By contrast, a cost-push shock, a utility shock, and an increase in entry costs lead to a significant fall in the mass of firms.

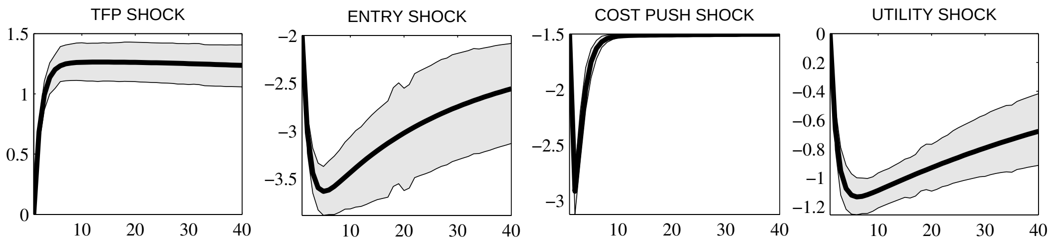

Figure 4: Impulse responses of the mass of firms to different shocks

5 Multiplier analysis

After having analyzed the impulse responses to an increase in government consumption, we now investigate the return of a fiscal stimulus, the fiscal multiplier. Thereby, we do not focus only on a pure demand stimulus, but also consider other fiscal stimuli in form of income or consumption tax cuts. For the purpose of comparability, we normalize the corresponding innovations such that the cost of each fiscal package amounts to 1% of GDP in the implementation period.

For each fiscal intervention, we compute a dynamic multiplier as proposed by Uhlig (2010). 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

$$\text{dynamic multiplier}_t = \frac{\sum_{s=0}^{t} \beta^s \mathrm{d}Y_s}{\sum_{s=0}^{t} \beta^s \mathrm{d}G_s}. \tag{19}$$

By setting $t = 4$ and $t \to \infty$, we obtain a short-run and the long-run multiplier, respectively. The short-run multiplier is thus defined as the discounted change in GDP in the first year divided by the discounted costs of a fiscal stimulus during the first year. The long-run multiplier is defined as the discounted overall output effects divided by the discounted overall costs.

To highlight the role of firm entry, we compare the results in our baseline entry model with those in the standard RBC model sketched in Section 2.6.

5.1 The pure demand stimulus

The evaluation of the pure demand stimulus yields a short-run and a long-run multiplier amounting to 0.09 and -0.30, respectively. Thereby, the reaction of the mass of firms becomes a decisive factor when comparing the fiscal multipliers with those obtained by a standard RBC framework. In comparison with the standard RBC model, the short-run multiplier remains approximately unchanged while the long-run multiplier is about 36% smaller.[22] The reason is that investment in new firms and consequently the mass of firms decline as shown in Figure 4. This additional crowding-out effect pushes down the effectiveness of an increase in government consumption.

Figure 5 shows that the fiscal multiplier generated by the entry model exceeds that under a constant extensive margin only if the mass of firms increases. Figure 5 is based on simulations of the model for different values of the Frisch elasticity of labor supply and the shock persistence, keeping the remaining calibration unchanged. More precisely, the figure shows dynamic fiscal multipliers for both the entry model and the standard RBC model with a constant mass of firms for the boundaries of the estimated confidence intervals of $\rho_g = \{0.81, 0.97\}$ and $\eta = \{2.38, 4.02\}$.[23] The left panel shows the fiscal multiplier for the case of a high shock persistence and a relatively elastic labor supply ($\rho_g = 0.97$, $\eta = 2.38$). This parameter set leads to an increase in the mass of firms which in turn pushes the dynamic multiplier above that of the RBC model with a constant extensive margin. The right panel is based on the opposite case of a low shock persistence and a more inelastic supply of labor ($\rho_g = 0.81$, $\eta = 4.02$) which leads to decrease in the mass of firms and thus yields a smaller multiplier compared to the standard RBC model.

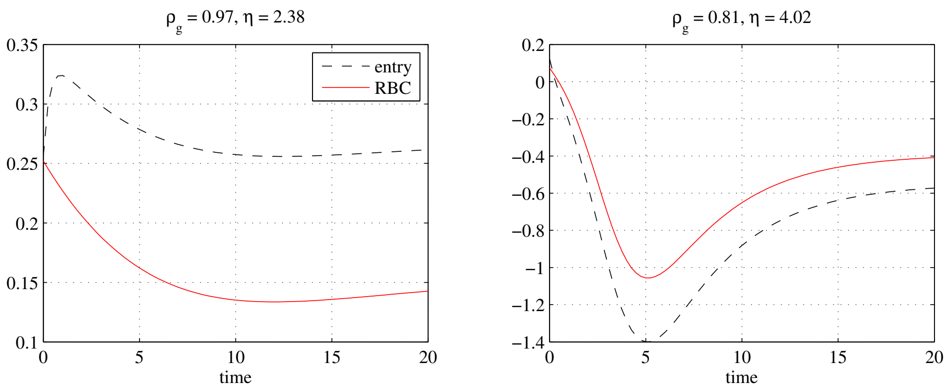

Figure 5: Fiscal multipliers for the endogenous entry and a standard RBC model

As a general rule, the mass of firms acts as an accelerator for the positive impacts

[22] Remark: Consequently, the long-run multiplier is also negative in the standard RBC model applying our estimated parameters.

[23] A detailed graphical analysis of the fiscal multiplier and the mass of firms for different parameter sets of ρ_g and η can be found in Appendix C.

of fiscal stimuli if the mass of firms increase while it acts as a decelerator if the mass of firms decreases. As will be shown later, this result also holds in the case of other fiscal interventions such as tax cuts or demand stimuli under distortionary taxation.

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

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

where the persistence of the AR(1) processes describing the evolution of the tax cuts are set to $\rho_{\tau^i} = \rho_g$ for $i = C, L, K, d$.

The aim of this exercise is twofold. First, we want to compare the effectiveness of different forms of fiscal stimuli. Second, we want to check the robustness of our finding that firm entry can accelerate and decelerate the multiplier effects.

5.2.1 The labor tax cut

Figure 6 shows the impulse responses to a labor tax cut for the firm entry model and the standard RBC model as well as the resulting dynamic multipliers. The cut in labor taxes induces households to increase both time spent to create new products and to work for intermediate good producers 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 positive.

Higher goods demand and lower marginal costs result in 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 in turn amplified by decreasing entry costs. By contrast, investment in existing capital decreases on impact. Thereafter, the reaction turns positive. All in all, total investment (not depicted here)

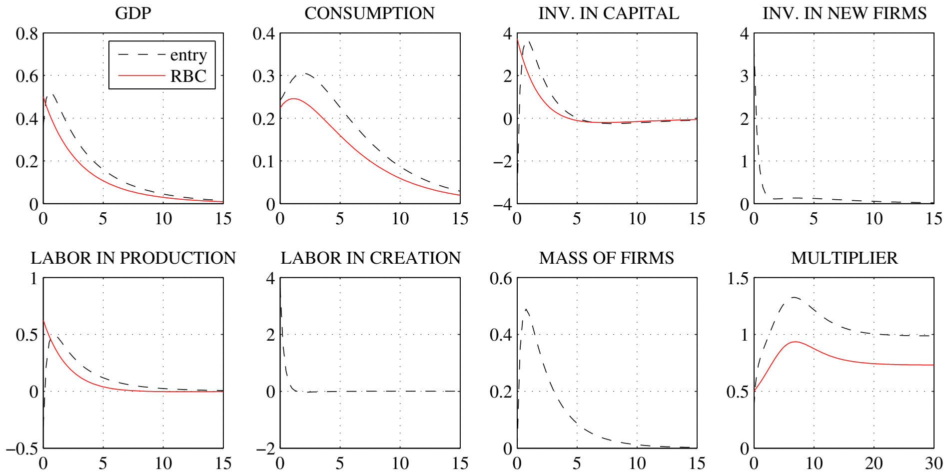

Figure 6: Impulse responses to a temporary cut in labor taxes

reacts expansionary. In the RBC model investment in physical capital increases due to the positive wealth effect. The rise in the mass of firms results in a fiscal multiplier above that of the RBC model by about 8% in the short-run and 36% in the long-run.

5.2.2 The capital income tax cut

Figure 7 depicts the impulse responses to a capital tax cut and the resulting multipliers. 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 increase 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 mass of products.

The substitution relation between new firm investment and capital investment can analytically be shown by substituting (12) in (13):

$$v_t = \frac{(1-\delta)(v_{t+1} + (1-\tau_{t+1}^d)d_{t+1})}{1+(1-\tau_t^K)(r_{t+1}^K - \delta^K)}. \tag{21}$$

From (21) it directly follows that a drop in capital income tax causes the real value of an

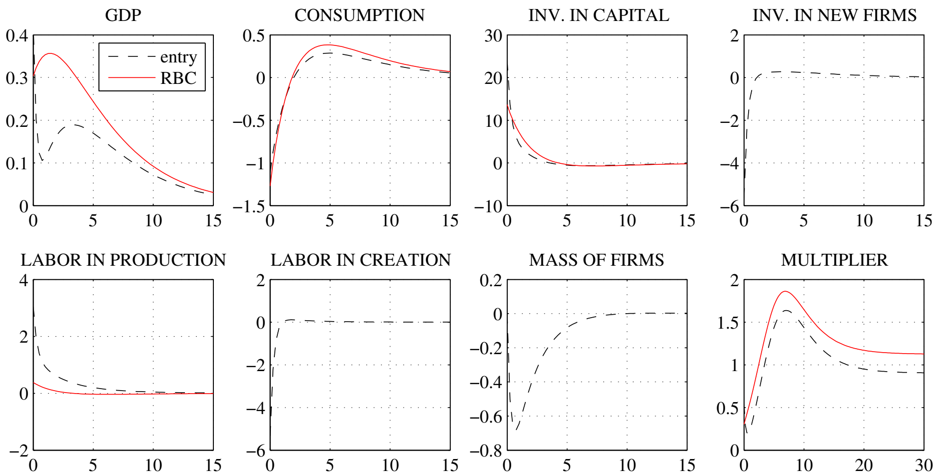

Figure 7: Impulse responses to a temporary cut in capital income taxes

operating firm in the intermediate goods sector, v_t, to decrease. This in turn induces a contractionary reaction of investment in new firms.

When compared to the RBC model, the firm entry model generates significantly smaller multipliers – 22% smaller in the short-run and 20% smaller in the long-run – caused by the additional crowding-out of new firm investment.

5.2.3 The dividend income tax cut

Figure 8 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, however, 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 the creation of new products. To finance the boom in product creation, capital investment is sharply reduced on impact. Again, the model depicts the 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.

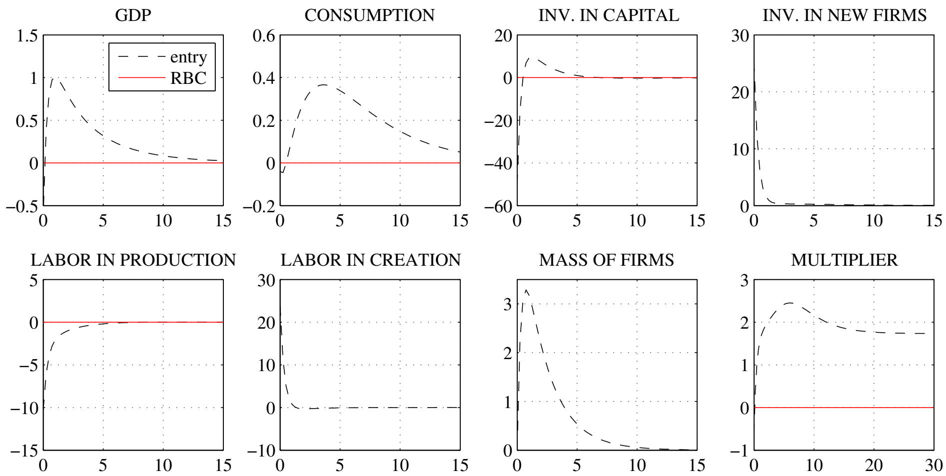

Figure 8: Impulse responses to a temporary cut in dividend income taxes

Analytically, the substitution relation can be shown by re-arranging (21):

$$r_{t+1}^K = \frac{(1-\delta)(v_{t+1} + (1-\tau_{t+1}^d)d_{t+1}) - v_t}{(1-\tau_t^K)v_t} + \delta^K. \tag{22}$$

It follows that a dividend tax cut increases, in isolation, the rental rate of physical capital which equals the marginal product of capital. An increase in the marginal product of capital requires a decrease in physical capital and thus a drop in capital investment.

Figure 8 depicts that consumption increases due to the positive wealth effect resulting from higher labor income. Since labor used for product creation rises more than hours worked in the manufacturing sector decreases, total hours worked also react expansionary. All in all, the dividend tax cut has an expansionary effect on GDP since it induces a crowding-in of private consumption, total investment, and product variety which in turn leads to a larger multiplier when compared to a cut in capital taxes.

5.2.4 The 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, on the one hand, 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. In reality, governments however do not distinguish between the income from renting capital to firms and the profit income from holding shares of these firms. Therefore, we now assume that there exists a unified tax rate on capital and dividend income, i.e. $\tau_t^d = \tau_t^K$.[24]

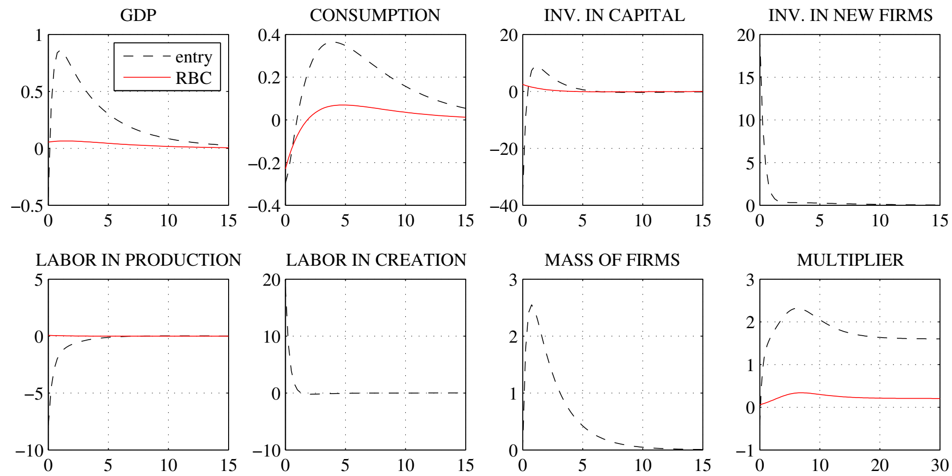

Figure 9: Impulse responses to a temporary cut in capital and dividend income taxes

Figure 9 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 equivalent to those of an isolated cut in dividend taxes. The results show a sharp initial decline in capital investment but a jump in investment in new firms which in turn leads to an increase in the mass of varieties. This increase amplifies the fiscal multiplier significantly by about seven times, when compared to the RBC model with a fixed mass of firms.

The rationale is that in the RBC model, this fiscal package has much smaller positive effects since part of the package is 'wasted' for a cut in dividend taxes which is completely lump-sum and thus ineffective in stimulating economy activity if the mass of firms is constant.

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

5.2.5 The consumption tax cut

Figure 10 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 in response to an increase in government consumption described above. This is a plausible result since both fiscal interventions are expansionary shocks to goods demand. In contrast to the standard RBC model with a constant mass of producers, the consumption tax cut crowds out investment in new firms. As a result, the extensive margin decreases. This in turn dampens the long-run multiplier effects compared to the RBC model by about 33%. As in the case of a pure demand stimulus, the short-run multiplier remains however unaffected.

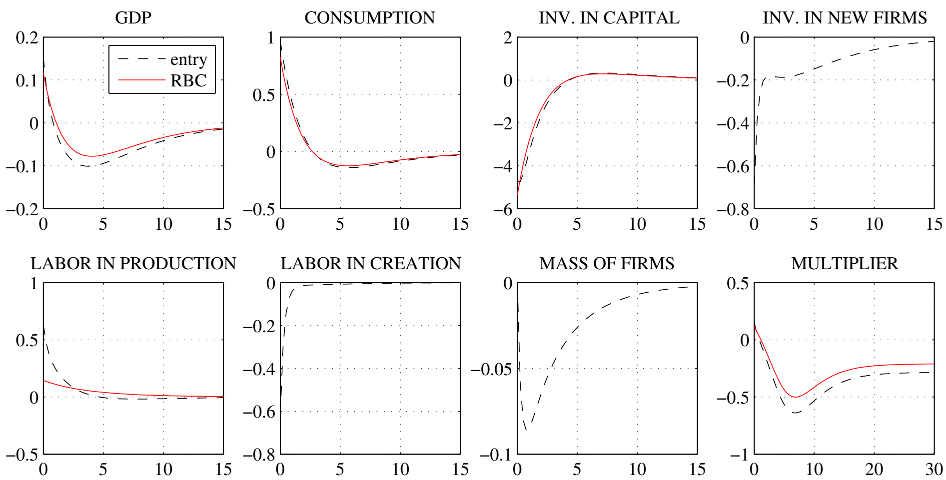

Figure 10: Impulse responses to a temporary cut in consumption taxes

5.2.6 Robustness checks

We have demonstrated that the sign of the response of the mass of varieties to an increase in government consumption is ambiguous when varying the labor supply elasticity, η, and the shock persistence, ρ_g. In line with these findings, Table 2 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 regarding isolated labor, capital, and dividend income tax cuts, results

Stimulus	$\eta = 4.02$	$\eta = 3.17$	$\eta = 1$	$\rho_g = 0$	$\rho_g = 0.89$	$\rho_g = 0.97$
τ^C	$-$	$-$	$+$	$-$	$-$	$+$
τ^L	$+$	$+$	$+$	$+$	$+$	$+$
τ^K	$-$	$-$	$-$	$-$	$-$	$-$
τ^d	$+$	$+$	$+$	$+$	$+$	$+$
$\tau^K = \tau^d$	$+$	$+$	$+$	$-$*	$+$	$+$

* A degree of autocorrelation of $\rho \geq 0.08$ is however sufficient to obtain an increasing mass of varieties.

Table 2: Response of the mass of varieties [$+$: expansionary reaction of the mass of firms, $-$: contractionary reaction of the mass of firms]

change. Under these fiscal stimuli, the sign of the reaction of the mass 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 if 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 amounting to $\rho_g \geq 0.08$ is sufficient to obtain an increasing mass of varieties.

5.3 The different stimuli at a glance

Table 3 shows the short- and long-run fiscal multipliers for the previously analyzed fiscal stimuli in both models and indicates the qualitative reaction of the mass of firms, N.

Stimulus	Short-Run Multiplier	% dev. of RBC	Long-Run Multiplier	% dev. of RBC	N
G	0.09	0%	- 0.30	- 36%	$-$
τ^L	0.56	8%	0.99	36%	$+$
τ^C	0.09	0%	- 0.28	- 33%	$-$
τ^K	0.32	- 22%	0.90	- 20%	$-$
τ^d	0.45	n.a.*	1.73	n.a.*	$+$
$\tau^K = \tau^d$	0.44	529%	1.60	700%	$+$

*The dividend tax cut is lump-sum in the RBC model and thus does not yield to any fluctuations, at all.

Table 3: Fiscal multipliers and mass of varieties, N [$+$: expansionary reaction of the mass of firms, $-$: contractionary reaction of the mass of firms]

The pure demand stimulus generates small short- and long-run multipliers, since the increase in government consumption causes a crowding-out of private consumption, investment in physical capital, and investment in new firms. As in the RBC model, the long-run multiplier becomes even negative, -0.30. As already mentioned, the cut in consumption tax yields qualitatively the same results as the increase in government consumption. Table

3 moreover shows that both interventions also perform quantitatively equivalent. The decline in the extensive margin leads to a long-run multiplier which is 33% lower than in the RBC model.

In both the RBC and the firm entry model, the cuts in labor and capital taxes perform quite well. However, the cut in capital tax, in particular, generates a long-run multiplier slightly larger than one in the RBC model. By contrast, this is not the case in the entry model where the labor tax cut has a stronger impact than the capital tax cut. Since the capital tax cut comes at the cost of a crowding-out of investment in new firms, the multiplier is significantly dampened when compared to the RBC model. However, the capital tax cut still result in a positive long-run multiplier close to one. The labor tax cut results in a crowding-in of private consumption, investment in physical capital and in new firms. As a result, the multiplier becomes significantly amplified.

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, however, this tax cut has strong effects (1.73) since it causes all components of GDP to increase over the cycle. This policy intervention is thus more effective than for instance the cut in capital taxes. The unified cut in capital and dividend income taxes also leads to large multipliers in the endogenous entry model (1.60). However, when the mass of firms is fixed, the multiplier is very small but positive. The rationale is the lump-sum nature of dividend taxes under these circumstances and the resulting non-effectiveness of a part of the fiscal package.

Table 3 moreover depicts our general result since in all cases where product variety increases, the multipliers generated by the entry model exceed those of the standard RBC model. Additionally, 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. The dividend tax cut is thereby the most effective fiscal tool since it induces a crowding-in of consumption, investment, and the extensive margin.

6 Distortionary taxation

Up to now, we have assumed that fiscal interventions are financed by raising lump-sum taxes. In the following, we investigate the effects of distortionary taxation for government spending multipliers and the mass of firms. We follow Uhlig (2010) and assume that an increase in government consumption is financed partly by raising distortionary taxes on labor income and partly by issuing debt.[25] The adjustment of distortionary taxes can be analyzed by introducing the following tax rule

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

where ϕ_g denotes the share of distortionary taxation. $\phi_g = 0$ is consequently 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 (2010), we furthermore want to explore the effects of an increase in government consumption financed by raising the tax on consumption purchases as well as the unified tax on capital and dividend income. We therefore introduce the following variants of the tax rule described above:

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

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

$$\begin{aligned} &\tau_t^d (d_t N_t + (r_t^K - \delta)K_{t-1}) \\ &\quad = \phi_g\big(G_t + (1 + r_{t-1})B_{t-1} - \tau_t^C C_t - \tau_t^L w_t L_t - \tau_t^K (r_t^K - \delta)K_{t-1} - \tau_t\big)\,, \qquad (25) \end{aligned}$$

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

We set $\phi_g = 0.5$ implying that half of the increase in government consumption is financed by distortionary taxation. Table 4 shows the resulting short- and long-run multipliers and indicates the qualitative reaction of the extensive margin. The results for $\phi_g = 0$ are obviously those shown in Table 3.

[25] Remark: Then, Ricardian equivalence naturally does not hold anymore.

Stimulus	Short-Run Multiplier	% dev. of RBC	Long-Run Multiplier	% dev. of RBC	N
τ^L	- 0.35	- 6%	- 1.67	- 45%	–
τ^C	- 0.05	- 67%	- 0.06	- 20%	–
$\tau^K = \tau^d$	- 0.53	- 430%	- 6.43	- 1210%	–

Table 4: Government spending multipliers and mass of varieties, N, under distortionary taxation ($\phi_g = 0.5$)

Three results are worth mentioning. First, as in Uhlig (2010), distortionary taxation of labor income leads to a strong negative long-run multiplier. This result also holds when considering distortionary taxes on the unified tax on capital and dividend income. If the increase in government consumption is however financed through an increase in consumption taxes, the short- and long-run fiscal multipliers are approximately zero in both models.[26]

Second, the quantitative response of the extensive margin does not only depend on the fiscal shock persistence and on the labor supply elasticity but also on the way an increase in government consumption is financed. Table 4 shows that in all cases of financing, the fiscal intervention leads to a decline in the mass of firms.

Finally, when comparing the multipliers of the entry model with those of the RBC model with a fixed mass of firms, we again find strong evidence for an additional crowding-out effect of the extensive margin. In all cases, the mass of firms reacts contractionary leading to smaller multipliers. Consequently, when assuming an endogenous mass of firms and fiscal policy financed with distortionary taxation, the short- and long-run multipliers become significantly smaller, i.e. more negative.

We obtain the strongest decelerating effects in the case of the unified tax to capital and dividend income since dividend taxation is lump-sum in the RBC model such that part of the fiscal package is ineffective. Moreover, Table 3 reports that the unified change in this tax rate has in isolation stronger effects than the pure fiscal demand stimulus.

7 Conclusion

Since recent theoretical contributions analyze the impacts of fiscal stimuli only 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 an estimated

[26] This result becomes even stronger in the case $\phi_g = 1$. Then, fiscal policy has no effects, at all.

model with endogenous product creation.

We demonstrate that the extensive margin is a crucial dimension for evaluating fiscal policy since it can accelerate and decelerate the impacts of fiscal stimuli. More precisely, we find that if in response to a fiscal stimulus the mass of firms increases, fiscal multipliers are amplified. If, however, the mass of firms declines, the reaction of the extensive margin dampens the impact on economic activity. This result remains robust to different fiscal interventions such as tax cuts and fiscal packages financed by distortionary taxation.

We show that a pure demand stimulus and a consumption tax cut are not the recommendable fiscal tools to boost GDP since these interventions result in an additional crowding-out effect of investment in new firms. A policy maker should instead 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 a further amplification via an increase in the mass of products.

Considering the case that the increase in government consumption is financed by distortionary income taxation, we find that the tax hike causes fiscal multipliers to become strongly negative which is even amplified by a decreasing mass of varieties. This result echoes the findings of Uhlig (2010) in the case of distortionary labor taxation. If the demand stimulus is financed with higher consumption taxes, the fiscal multiplier is approximately zero.

To highlight the role of an endogenous mass of firms for the impacts of different fiscal packages on real 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. Moreover, the simplicity of our model precludes a thorough quantitative examination of the impacts of the ARRA fiscal stimulus packages. Future research should be to conduct a Bayesian estimation of a DSGE model with several nominal and real frictions as well as endogenous firm entry to quantify the fiscal accelerator discussed in the paper at hand.

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Appendix A

Definition of data variables

Demeaned growth rates

data_GDP= (output/output(-1)-mean(output/output(-1)))*100

data_CONS=(consumption/consumption(-1)-mean(consumption/consumption(-1)))*100

data_HOURS= (hours/hours(-1)-mean(hours/hours(-1)))*100

data_WAGE=(real wage/real wage(-1)-mean(real wage/real wage(-1)))*100

data_NBF=(NBF/NBF(-1)-mean(NBF/NBF(-1)))*100

Absolute values

consumption = (PCEC / GDPDEF) / LNSindex

output = (GDPC96 / LNSindex)

hours = (PRS85006023 * CE16OV /100) / LNSindex

real wage = (PRS85006103 / GDPDEF)

Source of the original data

GDPC96 : Real Gross Domestic Product - Billions of Chained 1996 Dollars, Seasonally Adjusted Annual Rate

Source: U.S. Department of Commerce, Bureau of Economic Analysis

GDPDEF : Gross Domestic Product - Implicit Price Deflator - 1996=100, Seasonally Adjusted

Source: U.S. Department of Commerce, Bureau of Economic Analysis

PCEC : Personal Consumption Expenditures - Billions of Dollars, Seasonally Adjusted Annual Rate

Source: U.S. Department of Commerce, Bureau of Economic Analysis

CE16OV : Civilian Employment: Sixteen Years & Over, Thousands, Seasonally Adjusted

Source: U.S. Department of Labor: Bureau of Labor Statistics

CE16OV index : CE16OV (1992:3)=1

LNS10000000 : Labor Force Status : Civilian noninstitutional population - Age : 16 years and over - Seasonally Adjusted - Number in thousands

(Before 1976: LFU800000000 : Population level - 16 Years and Older)

Source: U.S. Bureau of Labor Statistics

LNSindex : LNS10000000(1992:3)=1 PRS85006023 - Nonfarm Business, All Persons, Average Weekly Hours Duration : index, 1992 = 100, Seasonally Adjusted

Source : U.S. Department of Labor

PRS85006103 - Nonfarm Business, All Persons, Hourly Compensation Duration : index, 1992 = 100, Seasonally Adjusted

Source : U.S. Department of Labor

NBF: Net Business Formation: index, 1967=100

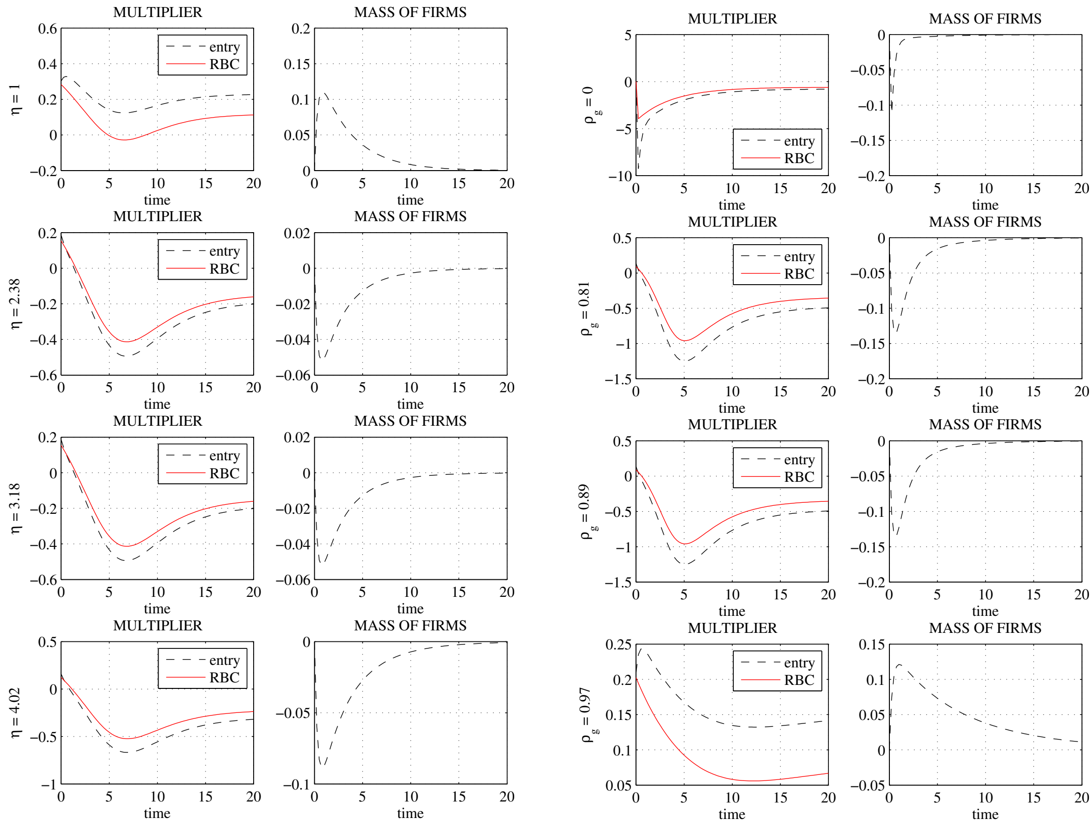
Source: Survey of Current Business available at Fraser St. Louis Fed

Appendix B

Description	Equation
Consumption Euler	$C_t^{-\sigma}/(1+\tau_t^C) = \beta\,\mathrm{E}_t\left\{C_{t+1}^{-\sigma}/(1+\tau_{t+1}^C)(1+r_t)\right\}$
Capital Euler	$C_t^{-\sigma}/(1+\tau_t^C) = \beta\,\mathrm{E}_t\left\{C_{t+1}^{-\sigma}/(1+\tau_{t+1}^C)\big(1+(1-\tau_t^K)(r_{t+1}^K-\delta^K)\big)\right\}$
Shares Euler	$v_t = (1-\delta)\beta\,\mathrm{E}_t\left\{C_{t+1}^{-\sigma}(1+\tau_t^C)/\big(C_t^{-\sigma}(1+\tau_{t+1}^C)\big)\big(v_{t+1}+(1-\tau_{t+1}^d)d_{t+1}\big)\right\}$
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	$N_t d_t = (1-(\zeta_t-1)/\zeta_t)\,Y_t^C$
Pricing	$\rho_t = \zeta_t/(\zeta_t-1)mc_t$
Real wage	$w_t = \alpha(\zeta_t-1)Y_t^C/(\zeta L_t^C)$
Rental rate	$r_t^K = (1-\alpha)(\zeta-1)Y_t^C/(\zeta_t K_{t-1})$
Labor in manufacturing	$Y_t^C = \rho_t z_t (L_t^C)^\alpha K_{t-1}^{1-\alpha}$
Labor in entry	$L_t^E = f_{E,t}/z_t N_{E,t}$
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	$v_t = f_{E,t}/z_t w_t$
Real price	$\rho_t = N_t^{1/(\zeta_t-1)}$

Table 5: The model at a glance

Appendix C


MULTIPLIER
MASS OF FIRMS
entry
RBC
time
η = 1
η = 2.38
η = 3.18
η = 4.02
ρ_g = 0
ρ_g = 0.81
ρ_g = 0.89
ρ_g = 0.97