Online Appendix: Firm Dynamics, Markup Variations, and the Business Cycle

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A Dynamic Version of the Entry/Exit Model

The baseline model assumes that entry is completely static – the entry decision depends only on the current period's profits. In what follows we will present a richer, dynamic model in which the entry decision is forward-looking.[1] We have tried to keep the setup as close as possible to the static entry/exit model that we use in the main part of the paper. Most importantly, we still have the exact same setup with a final, sectoral and differentiated good. Now, however, there is a sunk entry cost, ψ. The potential entrant weighs this cost of entry against expected future profits. Specifically, the equilibrium equates the upfront entry cost to the present discounted value of future profits (using the appropriate stochastic discount factor). In this model, the number of firms becomes a state variable. There are now two types of investment: investments in the capital stock that is used to produce the existing goods and investments in new firms or production lines.

The simplifying assumption of static entry decisions has been made to ensure almost closed form solutions and the derivation of easily interpretable expressions. This no longer holds in the dynamic case. We can, however, simulate the economy, draw impulse response functions and report the volatility of key variables over the cycle. Using the exact same process for the exogenous productivity shock, we find that the dynamic entry model with time-varying markups increases the volatility of output by 43 percent over the benchmark RBC model. The static entry model achieves an increase of 93 percent. That is, the results are somewhat mitigated compared to the baseline model, but the key magnification mechanism is still quantitatively significant. The simplifying assumption of static entry is critical for the tractability of our model, but it turns out that our empirical results are robust to that modification.

A.1 Setup of the Model

A.1.1 Laws of Motion for the State Variables

We will look at the entry decision in more detail below, but note, for now, that the number of firms that enter in period t is given by N_t^E. Each period a fraction δ of firms exits exogenously. There is no time to build assumption for entering firms – an entering firm starts producing in the same period. The state variables in period t are

[1] The setup of the model is similar to the on in Bilbiie, Ghironi and Melitz (2006a).

thus given by N_{t-1} and K_t. The law of motion for the capital stock is standard.

$$
\begin{aligned}
N_t &= (1-\delta)N_{t-1} + N_t^E && (1) \\
K_{t+1} &= (1-\delta_t^k)K_t + I_t && (2)
\end{aligned}
$$

A.1.2 Production

The setup is very similar to the version without entry cost. Once a firm has entered it produces with the same technology as in the main paper and again pays a fixed cost of production ϕ in terms of output goods. As before we will use an aggregation that eliminates the *variety effect*. Final goods are given by the CRS aggregation of sectoral goods which in turn are a CES aggregation of a finite number of differentiated goods within each sector. Those differentiated goods are produced using a Cobb-Douglas production function in capital and labor.

$$
\begin{aligned}
Y_t &= \left[\int_0^1 Q_t(j)^\omega dj\right]^{\frac{1}{\omega}} \\
Q_t(j) &= N_t^{1-\frac{1}{\tau}}\left[\sum_{i=1}^{N_t} x_t(j,i)^\tau\right]^{\frac{1}{\tau}} \\
x_t(j,i) &= z_t\,(k_t(j,i))^\alpha\,(h_t(j,i))^{1-\alpha} - \phi
\end{aligned}
$$

In the symmetric equilibrium total production of the final good is given by the following aggregation of total labor and capital used in the final good sector, $H = Nh$ and $K = Nk$ respectively.

$$
\begin{aligned}
Y_t &= N_t^{1-\frac{1}{\tau}}\left[\sum_{i=1}^{N_t} x_t^\tau\right]^{\frac{1}{\tau}} \\
&= N_t x_t && (3) \\
&= z_t K_t^\alpha H_t^{1-\alpha} - N_t\phi && (4)
\end{aligned}
$$

Producers of differentiated goods solve the standard cost minimization problem.

Dropping the (j, i) subscripts, the resulting first order conditions are given by

$$(1-\alpha)\frac{z_t k_t^{\alpha} h_t^{1-\alpha}}{h_t}\frac{p_t}{\mu_t} = w_t \tag{5}$$

$$\alpha\frac{z_t k_t^{\alpha} h_t^{1-\alpha}}{k_t}\frac{p_t}{\mu_t} = r_t^k \tag{6}$$

Profits of an individual firm are then given as follows. We use p_t as the numeraire which simplifies the expression.

$$\begin{aligned}
\pi_t &= p_t x_t - w_t l_t - r_t^k k_t \\
&= p_t \frac{Y_t}{N_t} - \frac{p_t}{\mu_t}\frac{z_t K_t^{\alpha} H_t^{1-\alpha}}{N_t} \\
&= \frac{1}{N_t}\left[Y_t - \frac{z_t K_t^{\alpha} H_t^{1-\alpha}}{\mu_t}\right] \\
&= \frac{1}{N_t}\left[Y_t - \frac{Y_t + N_t\phi}{\mu_t}\right] \\
&= \left(\frac{\mu_t - 1}{\mu_t}\right)\frac{Y_t}{N_t} - \frac{\phi}{\mu_t} \qquad (7)
\end{aligned}$$

As shown in the main part of the paper, the markup will now depend on the number of active firms in the market, i.e. on the degree of competition.

$$\begin{aligned}
\mu_t &= \mu(N_t) \\
&= \frac{(1-\omega)N_t - (\tau - \omega)}{\tau(1-\omega)N_t - (\tau - \omega)} \qquad (8)
\end{aligned}$$

A.1.3 Households

The state variables are K_t and N_{t-1}. The representative household choses a sequence of consumption, labor supply, investments in capital and firms to maximize lifetime utility,

$$\max_{\{C_t, H_t, K_{t+1}, N_t\}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\log(C_t) - \theta\frac{H_t^{1+\chi}}{1+\chi}\right)\right]$$

subject to a sequential budget constraint $\forall t$:

$$C_t + K_{t+1} + v_t N_t \leq w_t H_t + (1 - \delta^k + r_t^k) K_t + \pi_t N_t + v_t (1 - \delta) N_{t-1},$$

where v the value of one firm. Note that the household receives income from labor services, capital that the firm rents, dividends and capital gains from their equity holdings. Denoting the Lagrange multiplier by λ, optimization yields five first order conditions

$$\begin{aligned}
\lambda_t &= \beta^t C_t^{-1} \\
\lambda_t w_t &= \beta^t \theta H_t^{\chi} \\
\lambda_t &= \mathbb{E}_t \left[(1 - \delta^k + r_{t+1}^k) \lambda_{t+1} \right] \\
\lambda_t (v_t - \pi_t) &= \mathbb{E}_t \left[\lambda_{t+1} (1 - \delta) v_{t+1} \right]
\end{aligned}$$

These can be simplified to yield three optimality conditions, an IntraEuler condition, an InterEuler conditions as well as an asset pricing equation.

$$w_t = C_t \theta H_t^{\chi} \tag{9}$$

$$1 = \beta \mathbb{E}_t \left[\frac{C_t}{C_{t+1}} (1 - \delta^k + r_{t+1}^k) \right] \tag{10}$$

$$v_t = \pi_t + \beta (1 - \delta) \mathbb{E}_t \left[\frac{C_t}{C_{t+1}} v_{t+1} \right] \tag{11}$$

We can thus rewrite the budget constraint in a way that gives rise to a very nice interpretation. Capital income, labor income and profits on the right hand side are used to finance consumption and investment, i.e. investments in capital and in new firms, on the left hand side. We will call this the aggregation equation.

$$C_t + I_t + v_t N_t^E = r_t^k K_t + w_t H_t + \pi_t N_t \tag{12}$$

A.1.4 Entry

Entry decisions are made by a large group of potential entrepreneurs. To found a new firm, an entrepreneur pays an entry cost ψ in terms of output units. The entrepreneur subsequently sells the firm to the household for the present discounted value of future profits (using the appropriate stochastic discount factor). This price v_t is defined in

(11). Hence, the optimal level of entry is determined by the following entry condition.

$$v_t = \psi \tag{13}$$

A.1.5 Resource Constraints and Stochastic Process

The final good can be used for consumption, investment in capital goods and the sunk entry costs.

$$Y_t = C_t + I_t + \psi_t N_t^E \tag{14}$$

$$\log(z_t) = \rho \log(z_{t-1}) + \epsilon_t \tag{15}$$

A.2 Total Factor Productivity

We have shown that the Solow residual – as it is traditionally used – is an upward biased estimator of the technology shock in the context of our baseline model. We will now look at TFP in the dynamic entry model to see whether this finding still holds. From that equation (7) we can find the following expression for the total amount of resources spent on the fixed cost of production.

$$N_t \phi = (\mu_t - 1) Y_t - \mu_t N_t \pi_t$$

We can plug this into (4) to get an expression for output:

$$Y_t = \frac{z_t K_t^\alpha H_t^{1-\alpha}}{\mu_t} + N_t \pi_t \tag{16}$$

TFP can then be calculated as:

$$\begin{aligned} TFP_t &= \frac{Y_t}{K_t^\alpha H_t^{1-\alpha}} \\ &= \frac{z_t}{\mu_t} + \frac{N_t \pi_t}{K_t^\alpha H_t^{1-\alpha}} \\ &= \frac{z_t}{\mu_t} + \frac{z_t N_t \pi_t}{Y_t + N_t \phi_t} \\ &= \frac{z_t}{\mu_t} \left[1 + (\mu_t - 1) \frac{\pi_t}{\pi_t + \phi} \right] \end{aligned} \tag{17}$$

In the main part of the paper measured TFP was given by the ratio of the exogenous productivity process z_t and the endogenous markup μ_t. Let's return to the case with zero entry costs using the model presented in this appendix. In the static case, firms enter until current profits are equal to zero in each period. Instead of equation (7) we would thus have

$$N_t\phi = (\mu_t - 1)Y_t.$$

It is then easy to derive expressions for output and TFP. It turns out, that the results from the main part of the paper still hold.

$$\begin{aligned} Y_t &= z_t K_t^{\alpha} H_t^{1-\alpha} - N_t\phi \\ &= z_t K_t^{\alpha} H_t^{1-\alpha} - (\mu_t - 1)Y_t \\ &= \frac{z_t K_t^{\alpha} H_t^{1-\alpha}}{\mu_t} \\ TFP_t^{static} &= \frac{z_t}{\mu_t} \end{aligned}$$

Let $\hat{z}_t$, $\hat{\mu}_t$ and $\hat{\pi}_t$ denote the percentage deviations from the steady state of technology, the markup and profits respectively. Log linearization of (17) allows us to better understand the dynamics of measured TFP over the cycle.

$$\widehat{TFP}_t = \hat{z}_t + \hat{\mu}_t \left(\frac{-\phi}{\phi + \mu^* \pi^*} \right) + \hat{\pi}_t \left(\frac{(\mu^* - 1)\pi^*\phi}{(\mu^*\pi^* + \phi)(\pi^* + \phi)} \right) \tag{18}$$

Note that the coefficient on $\hat{\mu}_t$ is negative. This again introduces an upward bias when the Solow residual is used as an estimator for the level of technology as markups are countercyclical. Now, however, the size of the coefficient is smaller than before when we found a coefficient of -1. The third term, $\hat{\pi}_t$, has a positive coeficient. As profits are procyclical both in the data and in the model, this reinforces the upward bias of the estimator. To quantify the effect, we will turn to simulations.

A.3 Simulations

In this section we will present our calibration, solve for the steady state and summarize the model's equation.

A.3.1 Calibration

We stay as close as possible to the calibration in the paper and thus set the steady state markup to 30 percent. The sunk entry cost ψ are pinned down by our assumptions on the steady state markup and the elasticities of substitution within, $\frac{1}{1-\tau}$, and across sectors, $\frac{1}{1-\omega}$. These values are again taken from the baseline calibration in the main part of the paper.

The fixed cost of production ϕ are set such that they make up for a given share fc of total sales in the steady state. In our baseline calibration we set the share of fixed costs to 15 percent.

$$\frac{\phi}{x} = fc \tag{19}$$

A.3.2 Steady State

We can now solve for the steady state values. Assume that all variables are constant in the steady state. The InterEuler condition implies that

$$r^k - \delta^k = \frac{1}{\beta} - 1. \tag{20}$$

Calibrate μ, τ and ω to the numbers given by Table 1. We can then back out the steady state number of firms by inverting (8).[2]

$$N = \frac{(\tau - \omega)(\mu - 1)}{(1 - \omega)(\mu\tau - 1)} \tag{21}$$

We can then use the asset pricing equation to find the entry cost ψ that makes this an equilibrium.

$$\begin{aligned} v &= \pi + \beta(1 - \delta))v \\ \psi &= \left(\frac{1 + r^k - \delta^k}{r^k - \delta^k + \delta}\right)\pi \end{aligned}$$

[2]Again calibrate μ. Take N and ψ as given by the time varying markup case above. Set $\tau = \frac{1}{\mu}$ and $\omega = \tau$. Everything else goes through as in the varying markup case.

From the production function:

$$\begin{aligned}
Y &= Nx \\
&= \left(\frac{K}{H}\right)^{\alpha} H - N\phi \\
&= \left(\frac{K}{H}\right)^{\alpha} H - fcNx \\
&= \frac{1}{1+fc}\left(\frac{K}{H}\right)^{\alpha} H
\end{aligned} \tag{22}$$

Profits in the steady state are given by (7):

$$\begin{aligned}
\pi &= \left(\frac{\mu-1}{\mu}\right)\frac{Y}{N} - \frac{\phi}{\mu} \\
\pi &= \left(\frac{\mu-1}{\mu}\right)\frac{Y}{N} - \frac{fc}{\mu}\frac{Y}{N} \\
\pi &= \left(\frac{\mu-1-fc}{\mu}\right)\frac{Y}{N}
\end{aligned} \tag{23}$$

This gives us the steady state level of output as we can find the capital labor ratio from the expression for the rental rate of capital:

$$\begin{aligned}
r^k &= \alpha\left(\frac{K}{H}\right)^{\alpha-1}\frac{1}{\mu} \\
\frac{K}{H} &= \left(\frac{\alpha}{r^k\mu}\right)^{\frac{1}{1-\alpha}}
\end{aligned} \tag{24}$$

It's not hard to find the remaining values:

$$N^e = \delta N \tag{25}$$

$$I = \delta^k K \tag{26}$$

$$C = Y - I - vN^e \tag{27}$$

$$w = (1-\alpha)\left(\frac{K}{H}\right)^{\alpha}\frac{1}{\mu} \tag{28}$$

$$\theta = \frac{w}{CH^{\chi}} \tag{29}$$

A.3.3 Dynamic System

The model of this section is characterized by the following system of equations.

$$
\begin{aligned}
\mu_t &= \frac{(1-\omega)N_t - (\tau - \omega)}{\tau(1-\omega)N_t - (\tau - \omega)} \\
\mu_t &= \frac{1}{\tau} \quad \text{[with constant markups]} \\
\pi_t &= \left(\frac{\mu_t - 1}{\mu_t}\right)\frac{Y_t}{N_t} - \frac{\phi}{\mu_t} \\
\psi &= \pi_t + \beta(1-\delta)\mathbb{E}_t\left[\frac{C_t}{C_{t+1}}\psi\right] \\
1 &= \beta\mathbb{E}_t\left[\frac{C_t}{C_{t+1}}(1-\delta^k + r_{t+1}^k)\right] \\
r_t^k &= \alpha z_t\left(\frac{K_t}{H_t}\right)^{\alpha-1}\frac{1}{\mu_t} \\
w_t &= (1-\alpha)z_t\left(\frac{K_t}{H_t}\right)^{\alpha}\frac{1}{\mu_t} \\
w_t &= C_t\theta L_t^{\chi} \\
Y_t &= C_t + I_t + v_t N_t^E \\
Y_t &= z_t K_t^{\alpha} H_t^{1-\alpha} - \phi N_t \\
K_{t+1} &= \left(1-\delta^k\right)K_t + I_t \\
N_t &= (1-\delta)\,N_{t-1} + N_t^E \\
\log(z_t) &= \rho\log(z_{t-1}) + \epsilon_t
\end{aligned}
$$

A.4 Results

This section contains the results of our simulations. First, we will briefly describe the dynamic responses of various key variables to a technology shock. Second, we will look at the magnification mechanism embedded in this version of the entry and exit model.

Figure 1 at the end of this letter illustrates the impulse response functions for the most interesting variables. The exogenous shock is a one percentage shock to the level of technology, z_t. We can see that this shock leads to a spike in firm entry, which increases by more than 5% before quickly falling back to its steady state level. The number of active firms increases a quarter of a percent and slowly converges back to the steady state as firms exogenously exit. During the boom, the markup falls by a quarter of a percent – this is obviously inversely related to the number of active firms – before converging back to the steady state. Each firm's profits shoot up by almost 1% and fall back within about 10 quarters. The remaining impulse responses are standard. Output and investment increase by almost 2% and 7% respectively before converging back to the steady state. The response of consumption is hump-shaped, while hours increase by about 1% before falling back down.

Interestingly, we still find the Solow residual – as conventionally measured – to be an upward biased estimator of the level of technology as can be seen in the top left panel of Figure 1. Measured TFP overshoots by about 20%, but it shows qualitatively the same response as the level of technology. This effect is smaller than the effect we find in the static entry model – where we find an overshoot of more than 40 percent – but still quantitatively strong.

Table 2 summarizes the results of our simulation. We have simulated each model using the same process for the exogenous technology shock with $\rho = 0.94$ and $\sigma_\epsilon = 0.01$. Each column refers to a different model. The first presents the results for the benchmark, perfect competition RBC model. The next two columns refer to the dynamic entry and exit model of this appendix for the two cases of a constant ($\tau = \omega$) and time-varying ($\tau > \omega$) markup. The last column restates the results of the baseline model that we use in the main part of the paper. For each model, we list the ratio of the volatility of output in the current model to the volatility of output in the benchmark RBC model. In the dynamic entry/exit model with constant markups, output volatility increases only slightly. However, in the dynamic entry/exit with time-varying markups it increases by a notable 43%. As a comparison, this effect is larger in the static entry model with an increase of 93%. Hence, while the magnification is somewhat mitigated when compared to the static entry case, the mechanism is still at work and achieves an economically significant effect. However, the model does not endogenously increase the persistence of shocks.[3]

[3]It is important to note that this magnification mechanism does not depend on unrealistic fluctuations in the markup. In our simulation over 1000 periods, the markup is above 32.5% or below 27.5% in only 3 percent of the observations.

B Alternative Model with Cournot Setup

In the benchmark model, each monopolistic producer produces a differentiated good. The sectoral good is an aggregation of these. In what follows, we analyze the model under the assumption that all the N_t firms within a specific sector j produce a homogenous good. That is, we concentrate on the Cournot equilibrium.

Denoting the cost function of producer i in sector j by $C^m(w, r, x)$, the maximization problem can be written as

$$\max_{x(j,i)} \quad x(j,i)P\left(Y\right)^{1-\rho}\left[x(j,i) + x(j,-i)\right]^{\rho-1} - C^m(w, r, x(j,i)) \tag{30}$$

where $x(j, -i)$ is the output of the remaining producers in the sector j. In a symmetric equilibrium, the resulting price elasticity of demand is

$$\eta_{x(j,i),p(j)} = \frac{N}{\omega - 1} \tag{31}$$

which implies that the markup expression is

$$\mu(N) = \frac{N}{N + \omega - 1} \tag{32}$$

and that

$$\frac{d\mu}{dN} = \frac{\omega - 1}{(N + \omega - 1)^2} < 0 \tag{33}$$

As in the benchmark model, the markup is a decreasing function of the number of intermediate producers. It is easy to show that the model is otherwise characterized by the exact same equations as before. This implies that the key element for endogenous TFP movement and for the internal magnification mechanism is the interaction between firms' entry/exit and competition, not the specific type of game that one assumes.

B.1 Connection between Output and Markups in the Cournot Setup

Using equation (32) and the expression $N_t = \left(\frac{\mu_t - 1}{\phi}\right) Y_t$ from the paper, one can show that in this model the elasticity of the markup with respect to the number of firms is given by

$$\widehat{\mu}_t = \left(\frac{1-\mu^*}{1+\mu^*}\right)\widehat{y}_t. \tag{34}$$

As the Cournot version uses a setup with homogeneous goods, τ does not exist in such a model. It can be seen from equation (34), that ω has no effect on the elasticity of the markup with respect to output. This supports the earlier claim that our results are robust to the calibration we undertake in Section 4.2 of the paper. As we will show in the next paragraph, the main results of the Cournot model are very similar to what we find using the benchmark entry/exit model.

B.2 Simulation Results for Cournot Model

Following the same steps as in Section 4.2, one can then recover the *adjusted* time series of technology shocks from the observable data using (34),

$$\widehat{z}_t = \left(\widehat{y}_t - s_k\widehat{k}_t - s_H\widehat{h}_t\right) + \widehat{\mu}_t \tag{35}$$

$$= \left(\frac{2}{1+\mu^*}\right)\widehat{y}_t - s_k\widehat{k}_t - s_H\widehat{h}_t \tag{36}$$

The simulation results for this model are included in the main paper in Table 4 of the main paper. The reported moments of the adjusted technology time series show that, relative to the RBC model, the incorporation of firm entry and exit into the Cournot setup leads to smaller estimates of technology shocks' volatility. Simulating the entry/exit model in the Cournot setup, we find that it generates output, hours, investment and consumption volatilities that are almost identical to those of the RBC model which uses a much more volatile exogenous technology process. The model's generated output volatility is similar to that of the RBC model with a much lower exogenous volatility of the technology process.

C Fixed Markup Case

In this version of the model monopolistic producers continue to enter and exit until a zero-profits equilibrium is reached. As stated in the Section 4.1, assume that each monopolistic producer is now of measure zero within a specific sector.

$$Q_t(j) = N_t^{1-\frac{1}{\tau}} \left[\int_{i=0}^{N_t} x_t(j,i)^{\tau} di \right]^{\frac{1}{\tau}} .$$

In this case the price elasticity of demand faced by the monopolistic producer is constant and given by $\frac{1}{\tau-1}$, implying a constant markup rule $\frac{1}{\tau}$.

From the zero-profit condition we can immediately solve for each firm's level of production.

$$\begin{aligned} p_t x_t &= MC_t \left(x_t + \phi \right) \\ x_t &= \frac{\phi}{\mu - 1} \end{aligned} \tag{37}$$

Thus, since the markup is now a constant parameter, the actual production per-firm does not vary over the cycle. All the changes in aggregate output are due to the extensive margin, i.e., the entry/exit of firms.

As before, in a symmetric equilibrium, the production function of the monopolistic producer is

$$x_t = z_t k_t^{\alpha} h_t^{1-\alpha} - \phi. \tag{38}$$

These two last expressions for x_t allow us to derive to equations for the number firms and aggregate output.

$$N_t = \frac{(\mu - 1)}{\mu \phi} z_t K_t^{\alpha} H_t^{1-\alpha} \tag{39}$$

$$Y_t = N_t x_t = z_t K_t^{\alpha} H_t^{1-\alpha} - N_t \phi, \tag{40}$$

We can now loglinearize (39) and (40) to find

$$\begin{aligned} \hat{N}_t &= \hat{z}_t + \alpha \hat{k}_t + (1-\alpha)\hat{h}, \\ \hat{Y}_t &= \left(\frac{zK^{\alpha}H^{1-\alpha}}{Y} \right) \left(\hat{z}_t + \alpha \hat{k}_t + (1-\alpha)\hat{h}_t \right) - \frac{N\phi}{Y} \hat{N}_t, \end{aligned}$$

which we can combine to find

$$\hat{Y}_t = \left(\frac{zK^{\alpha}H^{1-\alpha} - N\phi}{Y} \right) \left(\hat{z}_t + \alpha \hat{k}_t + (1-\alpha)\hat{h}_t \right).$$

However, from equation (40) it follows that

$$\frac{zK^{\alpha}H^{1-\alpha} - N\phi}{Y} = 1.$$

Thus, the expression simplifies to yield the standard result. The Solow residual, $\hat{Y}_t - \alpha\hat{k}_t - (1-\alpha)\hat{h}_t$, is in this case equal to $\hat{z}_t$. The mere presence of monopoly power and fixed costs of operation does not impart a bias in the measurement of the Solow residual. Entry/exit of firms in the presence of constant markups assures that equation (37) holds at any point in time which implies a constant ratio of the fixed cost of operation to sales. Hence, in the case of constant markups with entry and exit there are no movement in measured TFP that are not directly attributable to exogenous technology shocks.

Table 1: Calibration

	Parameter	Calibrated To
$\mu^* - 1$	Markup in steady state	30%
τ	Elasticity within sector	0.949
ω	Elasticity across sectors	0.001
ψ	Sunk entry cost	Implied by μ^*, τ and ω
ϕ	Fixed production cost	15% of total sales
α	Capital share	0.30
H^*	Time spent working	0.30
β	Time discount factor	0.99
ρ	Persistence of shocks	0.94
σ	Volatility of innovations	0.01

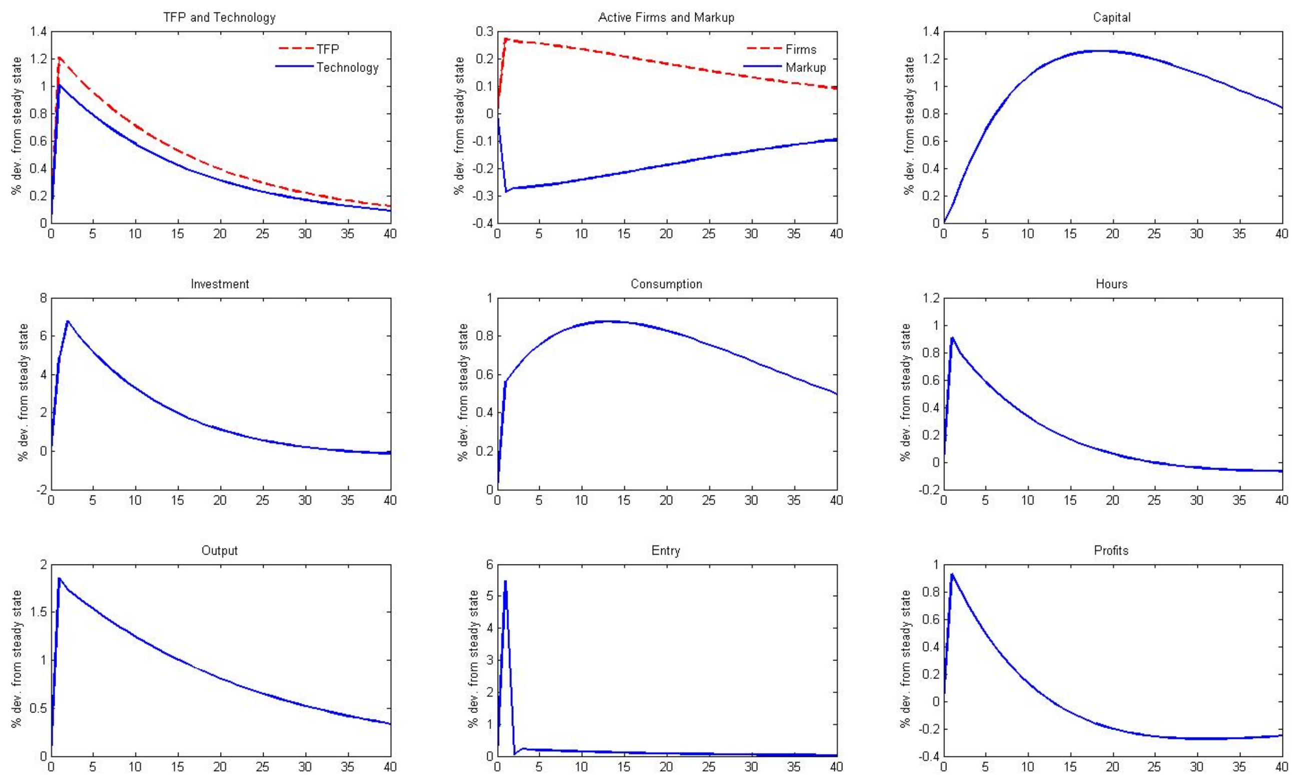
Note: Most parameters are taken from the baseline model in the paper. The fixed cost parameter ϕ has been calibrated such that the total amount of resources spent on the fixed cost $N\phi$ is equal 15% of total sales Y in steady state. The sunk entry cost ψ follows from our assumptions on μ^*, τ and ω.

Table 2: Magnification Ratios in the Dynamic Model

		Dynamic Entry/Exit		
	Perfect Competition	Constant Markup	Varying Markup	Static Entry/Exit
$\sigma_Y^2/\sigma_{Y,RBC}^2$	1.00	1.02	1.43	1.93

Note: We do not re-estimate the technology shocks, but simply simulate each model using the same exogenous process for technology with $\rho = 0.94$ and $\sigma_\epsilon = 0.01$. The moments are calculated from simulated data which is HP filtered with a smoothing parameter of 1600.

Figure 1: Impulse Response Functions



Note: The figure shows the responses of several key variables in the model in percentage deviations from the steady state as a result of a one percent shock to the level of technology. Each period refers to one quarter.