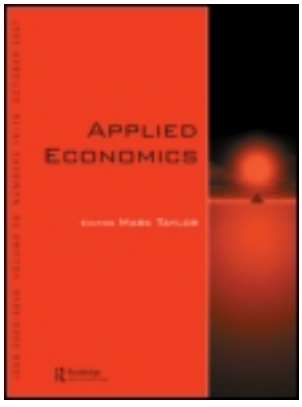

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Firm dynamics in news-driven business cycles: the role of endogenous survival rate

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Firm dynamics in news-driven business cycles: the role of endogenous survival rate

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Evidences from the structural vector-error correction model shows that the new business formation and stock prices co-moves with output under news shocks. However, simply incorporating firm dynamics into Jaimovich and Rebelo's (Jaimovich and Rebelo, 2009) model cannot explain these empirical findings. We show that this problem can be resolved by introducing endogenous survival rates for the new entrants.

Keywords: firm dynamics; aggregate co-movement; expectation-driven business cycle; news shocks

JEL Classification: E22; E32

I. Introduction

Recent empirical studies (Beaudry and Portier, 2006; Beaudry and Lucke, 2010) have found that expectations may be an important source of macroeconomic fluctuations. One natural question is whether the anticipative reactions made by forward-looking agents generate dynamic movements that resemble the business cycles. Beaudry and Portier (2006) show that it is difficult for standard real business cycle (RBC) models to produce business cycle co-movements under news shocks. Wang (2012) illustrates that this difficulty can be easily understood from a labour market perspective.[1] In standard RBC models without any real frictions, a positive future total factor productivity (TFP) shock will increase future income and therefore induce forward-looking households to raise their current consumptions. The income effect may also increase households' leisure or reduce their labour supply. As a result, equilibrium labour decreases, causing output fall as well because the capital stock is predetermined. Consequently, positive news about future TFP results in opposing movement in output and consumption.

More recently, Jaimovich and Rebelo (2009) established a full-fledged but concise RBC model with several real rigidities. Their model produces a positive co-movement of aggregate variables in response to the news shocks about TFP and investment-specific technology (IST), thus explaining the expectation-driven business cycle (EDBC) particularly well.[2] Three distinctive

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[1] In a standard RBC model, the labour demand curve denotes the relationship between wage and labour demand determined by the firm's optimal decisions. The shape of the curve thus depends on the form of the production function, while the labour supply curve reflects the relationship between wage and labour supply derived from a household's optimal labour decision. The shape of the curve is thus mainly affected by the utility function.
[2] Other papers also generate an EDBC, for example, Den Hann and Kaltenbrunner (2009), Gunn and Johri (2011), Schmitt-Grohe and Uribe (2012) and Karnizova (2010), among others.

features in Jaimovich–Rebelo's model play key roles: a utility function that yields little income effect on leisure, a dynamic adjustment cost in investment and a variable capacity utilization. With a special form of utility, their model implies that a change in income does not affect the labour supply curve, and hence it alleviates the problem of negative co-movement between consumption and labour supply. The dynamic adjustment cost smooths the investment decisions intertemporally: the current investment also increases in response to an anticipated future increase in investment. Variable capacity utilization allows firms to raise the intensity of capital usage in response to a decline in the relative price of investment. A higher capital utilization rate further increases the marginal product of labour and hence induces a higher labour supply. Consequently, the business cycle co-movement can be generated. Though Jaimovich and Rebelo (2009) are successful in explaining EDBCs, their model does not consider firm dynamics. As the literature documents,[3] the net entry in the US economy is strongly procyclical and accounts for a large fraction of employment variation. This finding suggests that firm dynamics should be considered an important aspect in EDBC modelling as well.

In this article, we first extend Beaudry and Lucke's (2010) empirical exercise by adding the new business formation (NF) into their baseline system. We find firm entry positively co-moves with output under favourable news about future TFP and that the pattern is statistically significant. To account for our empirical findings, we then incorporate endogenous firm dynamics into Jaimovich–Rebelo's model. However, simply incorporating firm entry decisions into their model cannot explain our empirical findings: the economy experiences a recession instead of a boom under a favourable future TFP shock. The model can no longer produce an EDBC because the advances in future technology make producing today relatively less profitable than producing in the future. Given this expectation, potential firms have an incentive to wait and enter the market at a later date. As a result, the total number of incumbents in the current period decreases due to a sharp fall-off in the entry rate. As the demand for labour and capital decreases, the representative household's income level decreases correspondingly. The reduction in income causes further declines in consumption. Eventually, the economy is trapped into a recession. The key reason for the failure to generate an EDBC (under good news about future TFP) is that the survival rate of new entrants is assumed to be constant.[4] As there is no marginal cost for a large change in the number of firms that enter the market, NF in the model is extremely volatile. In light of this logic, we endogenize the survival rate as a decreasing function of the entry mass. With this small modification, the Jaimovich–Rebelo model augmented by an endogenous firm entry is able to explain the positive co-movement of output, consumption, investment, hours worked, asset price and firm entry mass. The decreasing survival rate, which resembles the adjustment cost, prevents a significant increase in the number of new entrants and thus leads to relatively little competition from new entrants after the news shock is realized and, in turn, a higher value for each operating firm. To take advantage of this profitable opportunity, more forward-looking firms will enter the market immediately when expecting a positive economic future. As a result, both asset price and firm mass increase when good news about TFP hits the economy.

However, the situation changes slightly when a favourable future IST shock hits the economy. The impulse responses show that the model with an exogenous survival rate can still produce the business-cycle co-movements among output, consumption, total investment, hours worked and firm entry mass. The explanation is as follows. Distinct from the TFP case, good news about future IST decreases the future relative price of investment in units of consumption. Because of the investment adjustment cost, the marginal value of installed capital declines in the current period in accordance with the decline in the future price of investment.[5] This further induces firms to increase investments and raise their capacity utilization.[6] As a result, hours worked, output and consumption all increase. Moreover, higher aggregate demand attracts more firms to enter the economy. However, because the survival rate of new entrants is constant, the free-entry condition implies the firm value (or stock price (SP)) is always constant along the business cycle, which is definitely inconsistent with the empirical finding. Therefore, to mimic the positive co-movement between SPs and output, endogenous survival rate is still necessary when studying the effect of news shock about future IST.

The remainder of the article is organized as follows. Section II presents a structural VECM analysis on a four-variable system to investigate firm dynamics under news shocks. In Section III, a model is constructed with firm entry based on Jaimovich and Rebelo (2009). Section IV describes the model's dynamics in an environment with or without endogenous survival rate of the entrants. Section V concludes the article.

[3] See Jaimovich and Floetotto (2008) and Wang and Wen (2011), among others.
[4] To the best of our knowledge, the literature often assumes the failure rate of new entrants is constant or zero, for example, Jaimovich (2007)and Bilbiie, Ghironi and Melitz (2008).
[5] This is because the marginal value of installed capital becomes persistent when there is the investment adjustment cost.
[6] A favourable future neutral TFP shock would have little effect on the current relative price of investment.

II. Empirical Evidence from US Data

We now investigate the dynamic effects of news shocks on firm entry by analysing the US macroeconomic data. The variables of interest are TFP, which describes the exogenous process of technology[7]; SP,which contains the information about the future; real GDP (Y), which captures the macroeconomic condition; and NF, which represents the number of firms that enter the market. All of the variables are transformed into per-capita variables using the total US population count between the ages of 16 to 64. The last three series are presented in logs. Data are quarterly, running from 1955Q1 to 2009Q4. The "Appendix" section provides further details of our data.

To identify the news shock, we employ the Beaudry–Lucke identification strategy. We first arrange the order of structural shocks such that the first is a surprise technology shock, the second is a news shock about TFP and the last two are short-run shocks (e.g. demand shocks). The econometric model we use is a four-variable structural vector error correction model (SVECM). Specifically, as in Beaudry and Lucke (2010), we consider an environment where a four-dimensional vector of X_t (ordered as $[\mathrm{TSP}; \mathrm{SP}; \mathrm{Y}; \mathrm{NF}]$ is integrated of order one,[8] and can be represented as a vector autoregressive (VAR) p rocess of order $p < \infty$. Allowing for $r_0 < 4$ cointegration vectors, the error-correction representation of the process X_t takes the form

$$\Delta X_t = ab^{'} X_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta X_{t-j} + u_t \tag{1}$$

where a and b are $4 \times r_0$ matrices of loading coefficients and cointegrating vectors, respectively; the $\{\Gamma_j\}_j^{p-1}$ are 4×4 coefficient matrices; and u_t are the nonorthogonal error terms. Our exercise aims to identify a vector of orthogonal/structural shocks, ε_t satisfying $u_t = B\varepsilon_t$ where B is a nonsingular impact matrix. In particular, we assume the ordering in the vector ε_t is TFP shock, news shock about TFP and two short-run shocks. By applying the Granger representation theorem, process (1) can be expressed as (see Lütkepohl (2005))

$$X_t = X^0 + \sum_{j=1}^{\infty} \Xi_j B\varepsilon_{t-j} + L\sum_{j=1}^{t-1} \varepsilon_j + B\varepsilon_t \tag{2}$$

where X^0 is a vector of initial conditions, the matrices $\{\Xi_j\}_j^{\infty}$ are absolutely summable $(\lim_{j\to\infty} \Xi_j = 0)$, L is the long-run multiplier matrix of the structural shocks ε_t and B is the corresponding short-run impact matrix.

To jointly identify matrices L and B we must impose six restrictions on their elements. Specifically, we assume that the news shock (the second shock in ε_t) has no impact on today's TFP but can affect today's SP. That is, the (1,2) element in the B matrix is zero.[9] Regarding two short-run shocks (the third and fourth shocks in ε_t), we assume that they are independent of the exogenous TFP process and have no long-run effects on TFP. This assumption means the (1,3) and (1,4) elements in both B and L are set at zero. Finally, to distinguish two short-run shocks, we force the (3,4) element in B to be zero. With these aforementioned six restrictions, all of the structural shocks are fully identified. To summarize, the impact matrix B and the long-run matrix L can be shown explicitly as

$$B = \begin{bmatrix} * & 0 & 0 & 0 \\ * & * & * & * \\ * & * & * & 0 \\ * & * & * & * \end{bmatrix}, L = \begin{bmatrix} * & * & 0 & 0 \\ * & * & * & * \\ * & * & * & * \\ * & * & * & * \end{bmatrix} \tag{3}$$

To study the dynamic responses to the new shocks, we first estimate a SVECM for the four-variable system (TFP, SP, Y, NF). We use three criteria to determine the appropriate lag length. Specifically, the Akaike Information Criterion and the Final Prediction Error Criterion suggest four lags in levels, that is, $p = 3$ in the representation (1), while the Schwarz Criterion suggests three lags in levels. Therefore, we estimate the system with four lags in levels.[10]

We now turn to the cointegration properties. As shown in Table 1, the Johansen trace test significantly rejects one cointegration relationships $(r_0 = 1)$ at the 5% level and marginally rejects two cointegration relationships $(r_0 = 2)$ at the 5% level. Since in our SVECM there is only one explicit trend for the TFP series, a natural assumption on cointegration rank is three, that is, rejecting two cointegration relationships in the Johansen test. Taking this into account, as in Beaudry and Portier (2006), we conservatively choose three cointegration relationships instead of two. Our results are robust to the value of the cointegration rank.

Figure 1 presents the responses of TFP, SPs, output and NF to a one-SD of positive news shock. The top left panel shows that under a positive news shock, TFP initially

[7] Ideally, the IST series should also be added to the system to identify news shocks about IST. However, as there is no such variable (like TFP) that can capture the exogenous changes in IST, we only study the news about TFP.
[8] The ADF test shows that all of four series are $I(1)$ processes.
[9] As the news shock has the ability to predict the TFP in the long run, the (1,2) element in the long-run matrix L is not necessarily zero.
[10] We also estimate the system with three lags in levels for the robustness check. The main results in our article change little.

Table 1. Results in Johansen trace test

Cointegration rank: r_0	0	1	2	3
p-Value	0.0000	0.0194	0.0503	0.2610

Notes: Four lags (in levels) and one intercept are included. The test is implemented in JMulTi.

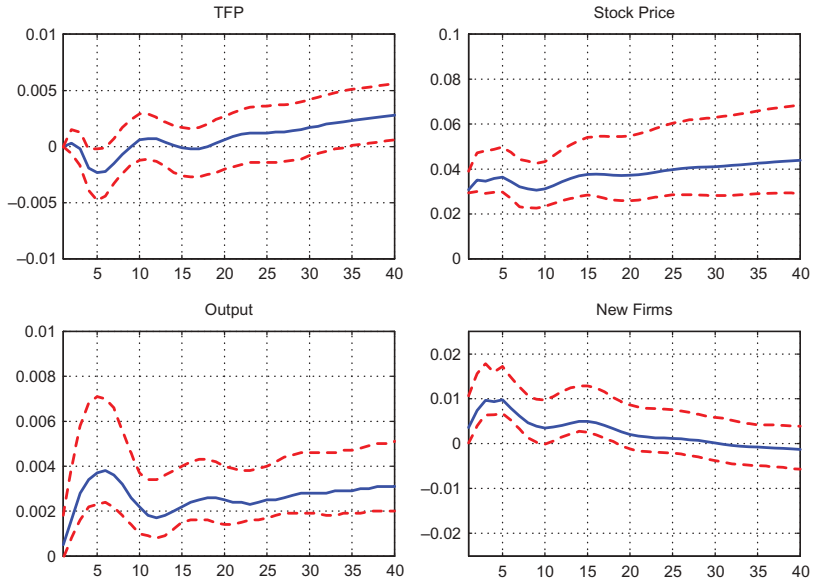

Fig. 1. Responses to news shock in the four-variable SVECM system
Notes: The figure shows percentage responses (0.01 corresponds to 1%). The horizontal axes indicate quarters. In each panel, the blue solid line represents the impulse response. The red dashed lines are 95% bootstrapped confidence interval computed (200 replications) by Hall's percentile interval. All the estimations are conducted in the software JMulTi.

decreases and after approximately 1.5 years, it reverses and gradually increases. The dynamics of TFP share similar patterns to those found in Beaudry and Lucke (2010), thus suggesting that our SVECM system, despite the variables being considered, contains as much information as does the Beaudry–Lucke system to recover the news about TFP. Moreover, other panels in Fig. 1 show that there are statistically significant positive effects of a news shock about future TFP on output, SP and NF. Furthermore, the responses of these three variables present a similar hump shape. In particular, they increase in the first five quarters and gradually decrease thereafter, finally tending to flatten out 15 quarters later. Overall, the dynamics of output and SP, as in Beaudry and Lucke (2010), highly co-move with the news shock about future TFP. The novel finding in our exercise is that the firm entry appears to demonstrate a similar pattern of co-movement.

Intuitively, the phenomenon in which positive news induces more new business incorporations is mainly due to the potential firms' expectation that their firm value will increase in the future due to the higher level of productivity. This point is well reflected by the significant co-movement relationship between firm entry and SP. In the next section, we incorporate the firm dynamics into the Jaimovich–Rebelo model and provide the theoretical rationale for our previous empirical findings.

III. The Model

Consider a closed economy, which is characterized by a representative household, a representative firm producing final goods and a continuum of differentiated monopolistically competitive intermediate firms. The mass of intermediate firms is endogenously determined by their entry and exit decisions.

Final goods firms

The final goods firms maximize their period-by-period profit with the technology constraint, which is a CES aggregation of a continuum of intermediate goods indexed by i:

$$Y_t = \left(\int_0^{N_t} \left(y_t^i \right)^{\sigma} \mathrm{d}i \right)^{1/\sigma} \tag{4}$$

where y_t^i is the production of the intermediate firm i, N_t is the mass of the intermediate firms and $\sigma \in (0,1)$ governs the elasticity of substitution across intermediate goods.

The final goods producers' profit maximization yields

$$y_t^i = \left(p_t^i\right)^{\frac{1}{\sigma-1}} Y_t \tag{5}$$

and the price index function is

$$P_t = \left(\int_0^{N_t} \left(p_t^i\right)^{\frac{\sigma}{\sigma-1}} \mathrm{d}i\right)^{\frac{\sigma-1}{\sigma}} \tag{6}$$

where p_t^i is the optimal price set by the intermediate firm i and P_t denotes the aggregate price index hereafter normalized to one.

Incumbent intermediate firms

We first consider a typical incumbent firm. Each intermediate good, y_t^i, is produced by the firm i using the efficient capital, $u_t^i k_t^i$, and the labour, l_t^i, with the Cobb–Douglas production function:

$$y_t^i = A_t (u_t^i k_t^i)^{\alpha} (l_t^i)^{1-\alpha} \tag{7}$$

where A_t denotes the aggregate technology and u_t^i is a variable rate of capital utilization. The rate of capital utilization determines the intensity of the use of capital, which affect the rate of capital depreciation. We let $\delta(u_t^i)$ represent the rate of capital depreciation and assume that depreciation is convex to the rate of utilization: $\delta'(\cdot) > 0$, $\delta''(\cdot) > 0$. The total cost to produce y_t^i can be obtained by

$$\min r_t u_t^i k_t^i + w_t l_t^i$$

$$s.t. A_t \left(u_t^i k_t^i\right)^{\alpha} \left(l_t^i\right)^{1-\alpha} \geq y_t^i \tag{8}$$

where r_t represents the rental rents per unit of efficient capital, w_t is the real wage and let ϕ_t^i be the marginal cost. We then have the following:

$$r_t = \alpha \phi_t^i \frac{y_t^i}{u_t^i k_t^i}, w_t = (1-\alpha)\phi_t^i \frac{y_t^i}{l_t^i} \tag{9}$$

Using the aforementioned two equations, we can derive that in a symmetric equilibrium the marginal cost ϕ_t^i is

$$\phi_t^i = \frac{1}{A_t} \left(\frac{w_t}{1-\alpha}\right)^{1-\alpha} \left(\frac{r_t}{\alpha}\right)^{\alpha} \tag{10}$$

Each intermediate firm i maximizes its static period operating profits:

$$\pi_t^i = \left(p_t^i - \phi_t^i\right) y_t^i \tag{11}$$

The previous expression yields that optimal price and profit at each period are

$$p_t^i = \phi_t^i / \sigma, \pi_t^i = (1-\sigma) p_t^i y_t^i \tag{12}$$

Because the intermediate firms' technology is symmetric with respect to all inputs, we focus hereafter on the symmetric equilibrium: $u_t^i = u_t$, $k_t^i = k_t$, $l_t^i = l_t$, $y_t^i = y_t$, $r_t^i = r_t$, $\phi_t^i = \phi_t$ and $\pi_t^i = \pi_t$. The representative household provides labour, L_t and capital, K_t, to firms for production activities. In a symmetric equilibrium, the resource constraint on the labour and capital markets implies $L_t = N_t l_t$ and $K_t = N_t k_t$. The aggregate price index from Equation 6 implies $p_t = N_t^{\frac{1-\sigma}{\sigma}}$. Also, the technology of producing the final goods implies $y_t = N_t^{\frac{1-\sigma}{\sigma}} y_t$. Finally, the aggregate final output, the equilibrium rental rate and wage, and the intermediate firm's operating profit are given by

$$y_t = A_t N_t^{\frac{1}{\sigma}-1} (u_t K_t)^{\alpha} L_t^{1-\alpha} \tag{13}$$

$$w_t = (1-\alpha)\sigma \frac{Y_t}{L_t} \tag{14}$$

$$r_t = \alpha\sigma \frac{Y_t}{u_t K_t} \tag{15}$$

$$\pi_t = (1-\sigma) Y_t / N_t \tag{16}$$

Potential entrants

In order to enter the market, the potential entrants have to pay f_e units of final goods as the cost of entry. We assume that a start-up becomes a functioning new firm, acting as a product monopoly with an endogenous probability q_t. The empirical literature provides fruitful evidence that the survival rate of new entries is negatively correlated with the level of industrial density. Mata and Portugal (1994) investigate the Portuguese manufacturing data and find the new firm failure varies positively with the extent of entry into the industry; Audretsch, *et al.* (2000) find a similar pattern using the Netherlands entry data; Hannan *et al.* (1995), using Belgium, France, Germany and Italy data, find that during the mature stage of the industry the survival rate is negatively affected by the density of entry due to

the competition effect. Taking this correlation into account, we assume q_t is a decreasing function of the entry rate $\frac{n_t}{N_{t-1}}$ [11]:

$$q_t = q\left(\frac{n_t}{N_{t-1}}\right) \tag{17}$$

where n_t denotes the mass of potential entrants and the elasticity of q_t at steady state, $\frac{q'\frac{n}{N}}{q}$, is in $[-1,0]$ This specification is a generalized version of that used in Beaudry *et al*. (2011). They assume that n_t start-ups compete to secure the $\varepsilon_t N_{t-1}$ (ε_t is an exogenous shock) new monopoly positions. This is to say, the survival rate q_t has a form of $\frac{\varepsilon_t N_t - 1}{n_t}$. The exogenous ε_t is assumed to be an increasing function of the entry rate: $g\left(\frac{n_t}{N_t - 1}\right)$, with $0 \leq \frac{g'\frac{n}{N}}{g} \leq 1$. The increasing feature of $g(.)$ indicates that the more start-ups there are, the more vacancies will be generated. This is equivalent to $\frac{q'\frac{n}{N}}{q} \in -1, 0]$.

Each incumbent firm faces a natural death rate δ_N. Thus, only a proportion $1 - \delta_N$ of existing firms will survive into the next period. We also assume that the period-t entrants produce in the current period, that is, there is no time-to-build.[12] Therefore, the law of motion for the total mass implies

$$N_t = (1 - \delta_N)N_{t-1} + q_t n_t \tag{18}$$

Finally, the free-entry condition implies that the potential firms are willing to enter as long as the expected value for the start-up is higher than the cost of entry. Therefore, in the equilibrium, we have

$$f_e = q_t V_t \tag{19}$$

where V_t denotes the present discounted value of expected profits for the incumbent firm, which corresponds to the SP in the real world. Note that the free-entry condition is crucial to understand the dynamics of SP (V_t). With an exogenous survival rate (q_t is a constant), the SP does not respond to any exogenous shocks. Therefore, in order to capture the cyclicity in SP as observed from the SVECM exercise, it is necessary to endogenize the survival rate q_t.

Households

The household side is similar to what is presented in Jaimovich and Rebelo (2009). The representative household has preferences over random stream of consumption C_t and labour L_t with the following lifetime utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(C_t - \psi L_t^{\theta} X_t\right)^{1-\xi} - 1}{1 - \xi} \tag{20}$$

where

$$X_t = C_t^{\gamma} X_{t-1}^{1-\gamma} \tag{21}$$

We assume that $0 < \beta < 1$, $\theta > 1$, $\psi > 0$, and $\xi > 0$ The presence of X_t means that preferences is nontime-separable in consumption and labour. When $\gamma = 1$ we obtain KPR preferences, and when $\gamma = 0$, we obtain the GHH preferences. In each period, the representative household maximizes its utility (20) subject to the following sequence of constraints:

$$\begin{aligned} C_t + I_t/Z_t + \int_0^{N_t} V_t s_t^i \mathrm{d}i \leq w_t L_t + r_t u_t K_t \\ + \int_0^{N_t} \pi_t s_t^i \mathrm{d}i + (1 - \delta_N) \int_0^{N_{t-1}} V_t s_{t-1}^i \mathrm{d}i \end{aligned} \tag{22}$$

$$K_{t+1} = (1 - \delta_t)K_t + \left(1 - \varphi\left(\frac{I_t}{I_{t-1}}\right)\right) I_t \tag{23}$$

where s_t^i denotes the share of firm i purchased by the household in period t; Z_t is the IST shock. An increase in Z_t reflects technological progress in IST. As in Jaimovich and Rebelo (2009), $\varphi'\left(\frac{I_t}{I_{t-1}}\right) I_t$ is the adjustment cost in investment such that $\varphi(1) = 0$, $\varphi'(1) = 0$ and $\varphi''(1) > 0$. The first-order conditions for $\{C, X, L, u, I, K, S\}$ are

$$\lambda_t = \left(C_t - \psi L_t^{\theta} X_t\right)^{-\xi} + \mu_t \gamma C_t^{\gamma - 1} X_{t-1}^{1-\gamma} \tag{24}$$

$$\begin{aligned} \mu_t = \beta E_t\left[(1 - \gamma)\mu_{t+1} C_{t+1}^{\gamma} X_t^{-\gamma}\right] \\ - \left(C_t - \psi L_t^{\theta} X_t\right)^{-\xi} (\psi L_t^{\theta}) \end{aligned} \tag{25}$$

$$\lambda_t w_t = \left(C_t - \psi L_t^{\theta} X_t\right)^{-\xi} \psi X_t \theta L_t^{\theta - 1} \tag{26}$$

[11] Assuming qt is a decreasing function of either $\frac{n_t}{N_{t-1}}$, $\frac{n_t}{N_t}$ or n_t does not affect our final results. This is because N_t is a stock variable that is less volatile than n_t, and thus dynamics of qt is mainly driven by n_t.

[12] The time-to-build assumption does not matter in model's dynamics, except for the response of the total mass N_t at the first period.

$$\lambda_t r_t = \eta_t \delta_t' \tag{27}$$

$$\lambda_t/Z_t = \eta_t\left[1-\phi\left(\frac{I_t}{I_{t-1}}\right)-\phi'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}\right] + \beta E_t\left[\eta_{t+1}\phi'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2\right] \tag{28}$$

$$\eta_t = \beta E_t\left[\eta_{t+1}(1-\delta_{t+1})+\lambda_{t+1}r_{t+1}u_{t+1}\right] \tag{29}$$

$$V_t = \pi_t + \beta(1-\delta_N)E_t\left(\frac{\lambda_{t+1}}{\lambda_t}V_{t+1}\right) \tag{30}$$

where μ_t, λ_t and η_t are the Lagrangian multipliers associated with Equations 21, 22 and 23, respectively. Finally, the market clearing condition implies

$$C_t + l_t/Z_t + n_t f_e = Y_t \tag{31}$$

Note that, as in Jaimovich and Rebelo (2009), the value of installed capital in units of consumption can be defined as η_t/λ_t From Equation 28, η_t/λ_t is mainly determined by the IST shock Z_t and the investment dynamics. Equation 27 implies that the optimal capacity utilization is decreasing in the value of installed capital.

IV. Exogenous Versus Endogenous Survival Rate

We now analyse how the model economy responds to a news shock about future TFP or IST when the survival rate is either constant or endogenous. As in Jaimovich and Rebelo (2009), the timing of the news shock that we consider is as follows. At time zero, the economy is in a steady state. At time one, the unanticipated news arrives. Agents learn that there will be a 1% permanent increase in A_t (or Z_t) beginning four periods later, in period five.

Table 2 presents the values assigned to the calibrated parameters. For those parameters also present in Jaimovich–Rebelo model, we simply use the same values. In particular, the time unit corresponds to one quarter. The discount factor, β, is calibrated at 0.985, which implies a steady state annual real interest rate of 6%. The value of intertemporal elasticity of substitution, ξ, is set as 1 corresponding to the logarithmic utility. The value of is γ set to 0.01 such that the preference is close to GHH specification. The value of θ chosen to be 1.4 implies that the elasticity of the labour supply is 2.5 when the preference takes the GHH form. On the production side, the share of capital α is set to 0.36, as commonly used in the literature. The steady state capital depreciation rate δ_k is calibrated at 0.025, which corresponds to the 10% annual depreciation rate found in the data. We choose the second derivative of the adjustment-cost functions evaluated at the steady state, φ'', to equal 1.3. For the elasticity $\delta''(u)u/\delta'(u)$ evaluated in the steady state, we set it to 0.15. For those parameters absent in the Jaimovich–Rebelo model, we set σ at $1/1.2$, implying that the steady state mark-up is 20%. The natural death rate of firms, δ_N is set at 0.025, which implies a 10% annual rate of exogenous exit in our model. This assumption is consistent with the empirical result that the annual job destruction rate in the United States is approximately 10%. The survival rate for new entrants at steady state, q, is set to be $1-\delta_N$. In order to make the start-ups not too many, we set the initial fixed cost, f_e, at 0.12.[13] Finally, we set the elasticity of the survival rate at steady state, $\frac{q'^{n}_{N}}{q}$, to be –0.5. Our robustness check shows the results hold over a wide range.

Table 2. Calibrated parameters

Parameter	Value	Description
β	0.985	Subjective discount factor
ξ	1	Intertemporal elasticity of substitution
θ	1.4	Corresponds to an elasticity of labour supply of 3.3 when preferences take the GHH form
γ	0.01	The extent of nontime-separable preference in consumption and labour 0 for GHH preference, 1 for KPR preference
φ''	1.3	Second derivative of investment adjustment cost function
$\delta''(u)u/\delta'(u)$	0.15	Elasticity of $\delta'(u)$ at steady state
A	0.36	Capital share in production
Σ	1/1.2	Corresponds to 20% mark-up
δ_k	0.025	Steady-state depreciation rate of capital
δ_N	0.025	Corresponds to 10% annual rate of exogenous exit
f_e	0.12	Fixed entry cost
$\frac{q'^{n}_{N}}{q}$	−0.5	Elasticity of survival rate at steady state

Before discussing the impulse responses, we briefly discuss the dynamics in the labour market under different news shocks. Consider an extreme case where $\gamma = 0$, X_t is constant, and the utility function becomes the GHH preference.[14] Equations 24 and 26 imply

$$w_t = \psi\theta L_t^{\theta-1} \tag{32}$$

[13] It is easy to show that the steady state share of the initial entry cost in output equals to $\frac{\delta_N(1-\sigma)q}{1-\beta(1-\delta_N)}$. And according to our calibration, this share equals 10.25%. However, the value of fe has no effect on our results regarding impulse responses.

[14] There exists income effect when $\gamma > 0$. The range of the value of γ is set to maintain the co-movement among the aggregate variables.

The last equation implies that a change in consumption would not affect the labour supply curve, that is, there is no income effect. Thus, from Equations 13 and 14, we have

$$w_t = A_t N_t^{\frac{1}{\sigma}-1}(u_t K_t)^{\alpha} L_t^{-\alpha} \tag{33}$$

which implies that the labour demand curve would only be affected by the change in total firm mass N_t and capacity utilization u_t. Remember that u_t largely depends on the marginal value of installed capital η_t/λ_t as shown in Equation 27. A favourable future TFP shock, compared to the IST shock, would not significantly change the value of η_t/λ_t, and thus the change in u_t is relatively small. In this case, the firm mass N_t dominates the shift of labour demand curve. Therefore, whether the model can mimic the EDBC hinges on the dynamics of the firm mass N_t,[15] while a news shock about future IST would significantly change the marginal value of installed capital and thus the capacity utilization u_t. In this case, the capacity utilization u_t dominates the shift of labour demand curve, and accordingly, it is the key variable to generate the EDBC.

Figures 2 and 3 depict the responses under a good news shock about TFP or IST with exogenous survival rates. The responses in Fig. 2 clearly illustrate the failure of the Jaimovich–Rebelo model with a constant survival rate for new entrants in generating positive co-movement under a favourable future TFP shock. In this case, the aggregate variables, including output, consumption, total investment,[16] hours worked and entry numbers, all decline in the impact period. Therefore, good news leads the economy into a recession, which is contrary to the empirical findings. The failure to generate an EDBC in this case is mainly due to the constant survival rate, which imposes no extra cost for a large shift in the number of firms entering the market; therefore, the potential firms have an incentive to enter the economy at the news-realized period. According to the previous analysis on the labour market, the decline in total firm mass causes the model to fail to generate an EDBC. As shown in Fig. 2, the entry number decreases sharply in the first period, which induces less demand in labour and capital and thus reduces total income. As a result, consumption goes down, and thus the economy is trapped in a recession because the Jaimovich–Rebelo specifications (variable capacity utilization, investment adjustment, preference with lower income effect) cause the other aggregate variables to positively co-move with consumption. In addition, according to the free entry condition, the asset price (V_t) in this case is constant, which is highly inconsistent with the empirical findings. Figure 3 reports the responses under a favourable

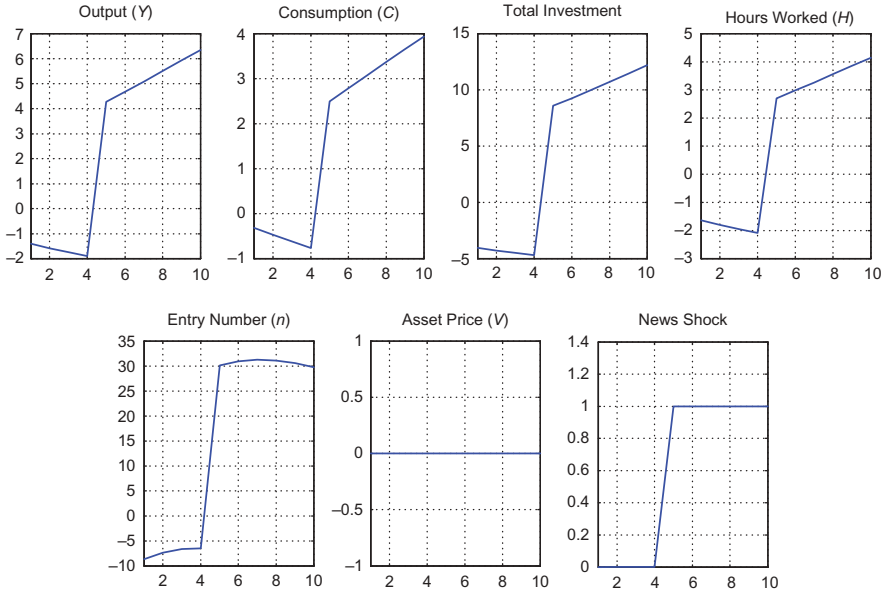

Fig. 2. Impulse responses to TFP news shock with exogenous survival rate
Notes: The figure shows theoretical percentage responses to a favourable news shock about TFP (defined in the last panel). The horizontal axes indicate quarters.

[15] More specifically, in a model with an endogenous survival rate, *Nt* increases in the impact period corresponding to good news about TFP, causing other aggregate variables to increase. Therefore, in this case, the EDBC can be explained.
[16] The total investment consists of the physical capital I_t/Z_t and the entry cost $n_t f_e$.

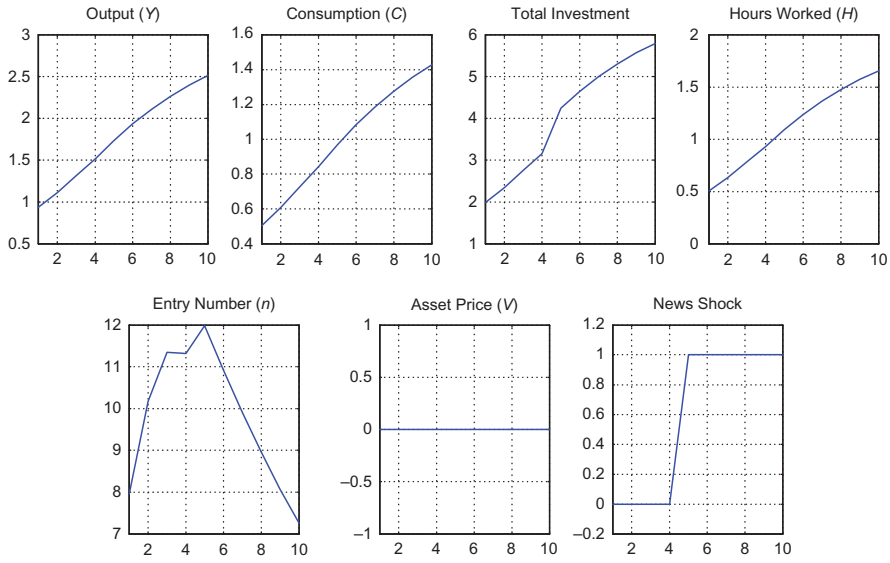

Fig. 3. Impulse responses to IST news shock with exogenous survival rate
Notes: The figure shows theoretical percentage responses to a favourable news shock about IST (defined in the last panel). The horizontal axes indicate quarters.

future IST shock. As evidenced, the positive co-movement among output, consumption, investment, hours worked and firm entry mass can be successfully generated even though survival rate is constant. The main reason for this is that, distinct from the neutral TFP shock, the IST shock would change the relative price of investment. The dynamic adjustment cost implies that the reduction in the future investment goods prices would reduce the current investment goods price as well. As a result, the capacity utilization increases accordingly, which further raises the hours worked and the total output. Furthermore, households will spend more in consumption because of the higher income level, and in turn higher demand attracts more firms to enter the economy. However, according to the free-entry condition, the asset price (V_t) in this case is again constant, which is inconsistent with the empirical finding from the SVECM exercise. To explain our empirical finding from the SVECM, the survival rate is assumed to be endogenous rather than exogenous. With this modification, the Jaimovich–Rebelo model is able to explain the business cycle co-movements under news shocks regarding future TFP and IST.

Figure 4 shows the dynamic responses under a favourable future TFP shock when survival rate q_t is an endogenous function of n_t/N_t. Output, consumption, total investment, hours worked and entry number all increase in response to the news about future TFP.[17] In particular, the path of the entry number in this case becomes much smoother because the endogenous survival rate induces an extra cost for new entrants in the high-entry rate period. As a result, fewer potential firms desire to enter the market at the news-realized period. The reduced competition effect of new entrants enhances the future profit of production, as shown in Equation 16, and thus raises the asset price of functioning firms. Under this premise, more start-ups will be established by entrepreneurs before the news is realized. Meanwhile, the expansion of firm entry induces higher demands for labour and capital and therefore increases the representative household income. Consequently, the aggregate economy experiences a boom in response to the news shock. The robustness check indicates that keeping other parameters unchanged, the aforementioned results hold in a wide range of $\frac{q'\frac{n}{N}}{q}$, namely, $[-1, -0.12]$ With respect to a favourable future IST shock, introducing an endogenous survival rate causes an increase in the asset price increase during the impact period. Therefore, together with the co-movement of other aggregate variables, the EDBC, in this case, can be well explained, as shown in Fig. 5.

V. Conclusions

In the literature, firm dynamics are believed to be an important mechanism for understanding business cycles, though their role in explaining EDBC remains unknown. By incorporating an endogenous firm entry problem into Jaimovich and Rebelo's (2009) well-established model,

[17] As the mass of new functioning firms $q_t n_t$ is monotonic increasing in the entry number n_t, the dynamics of these two variables have similar patterns. To save space, we only discuss the entry number.

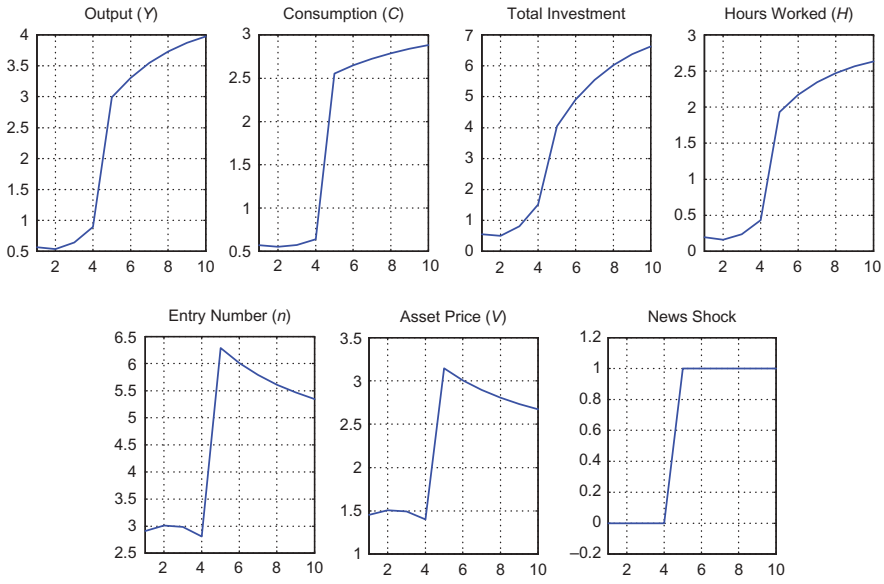

Fig. 4. Impulse responses to TFP news shock with endogenous survival rate
Notes: The figure shows theoretical percentage responses to a favourable news shock about TFP (defined in the last panel). The horizontal axes indicate quarters.

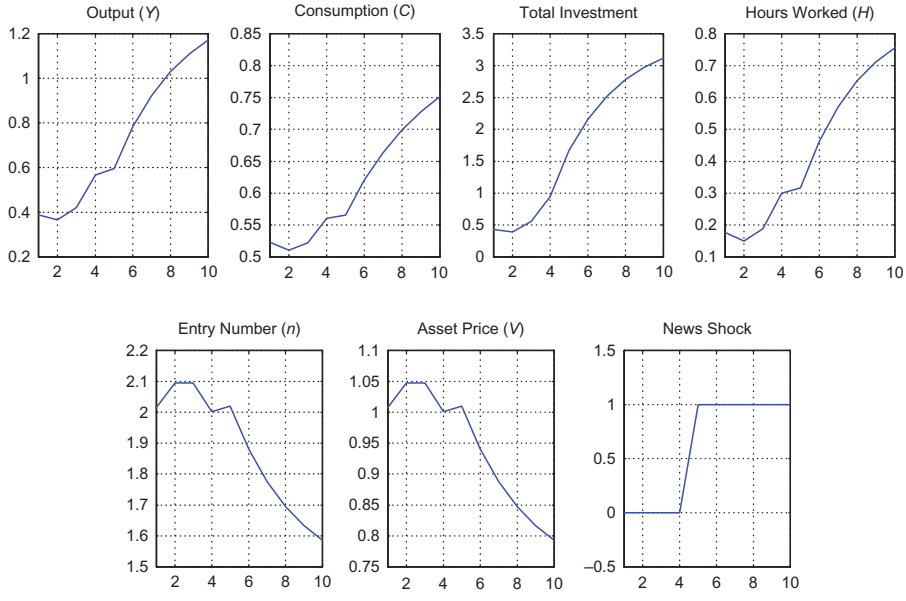

Fig. 5. Impulse responses to IST news shock with endogenous survival rate
Notes: The figure shows theoretical percentage responses to a favourable news shock about IST (defined in the last panel). The horizontal axes indicate quarters.

we find it generates a recession rather than a boom in response to a favourable future TFP shock. This is mainly because there is no cost for large movement of firm entry, and thus, when the good news affects the economy, potential firms optimally choose to enter the industry at the news-realized period. As to a favourable future IST shock, positive co-movement among output, consumption, investment, hours worked and firm entry still could be generated in the extended Jaimovich–Rebelo model with exogenous survival rates. However, the asset price is constant, which is sharply inconsistent with the empirical finding. After endogenizing the survival rate of new entry firms, the impulses of main macroeconomic variables are smoothed, and hence, the extended

Jaimovich–Rebelo model can generate positive co-movement of the main macroeconomic indicators, including output, consumption, investment, labour, entry mass and asset price.

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References

Audretsch, D. B., Houweling, P. and Thurik, A. R. (2000) Firm survival in the Netherlands, *Review of Industrial Organization*, **16**, 1–11.

Beaudry, P., Collard, F. and Portier, F. (2011) Gold rush fever in business cycles, *Journal of Monetary Economics*, **58**, 84–97.

Beaudry, P. and Lucke, B. (2010) Letting different views about business cycles compete, *NBER Macroeconomics Annual 2009*, **24**, 413–55.

Beaudry, P. and Portier, F. (2006) Stock prices, news, and economic fluctuations, *American Economic Review*, **96**, 1293–307.

Bilbiie, F., Ghironi, F. and Melitz, M. (2008) Endogenous entry, product variety, and business cycles, *NBER Macroeconomics Annual 2007*, **22**, 299–353.

Den Hann, W. J. and Kaltenbrunner, G. (2009) Anticipated growth and business cycles in matching models, *Journal of Monetary Economics*, **56**, 309–27.

Gunn, C. and Johri, A. (2011) News and knowledge capital, *Review of Economic Dynamics*, **14**, 92–101.

Hannan, M. T., Carroll, G. R., Dundon, E. A. *et al.* (1995) Organizational evolution in a multinational context: entries of automobile manufacturers in Belgium, Britain, France, Germany, and Italy, *American Sociological Review*, **60**, 509–28.

Jaimovich, N. (2007) Firm dynamics and markup variations: implications for multiple equilibria and endogenous economic fluctuations, *Journal of Economic Theory*, **137**, 300–25.

Jaimovich, N. and Floetotto, M. (2008) Firm dynamics, markup variations and the business cycle, *Journal of Monetary Economics*, **55**, 1238–52.

Jaimovich, N. and Rebelo, S. (2009) Can news about the future drive the business cycle?, *American Economic Review*, **99**, 1097–118.

Karnizova, L. (2010) The spirit of capitalism and expectation-driven business cycles, *Journal of Monetary Economics*, **57**, 739–56.

Lükepohl, H. (2005) *New Introduction to Multiple Time Series Analysis*, Springer, Berlin.

Mata, J. and Portugal, P. (1994) Life duration of new firms, *Journal of Industrial Economics*, **42**, 227–45.

Schmitt-Grohe, S. and Uribe, M. (2012) What's news in business cycles, *Econometrica*, **80**, 2733–64.

Wang, P. (2012) Understanding expectation-driven fluctuations: a labor-market approach, *Journal of Money, Credit and Banking*, **44**, 487–506.

Wang, P. and Wen, Y. (2011) Understanding the effects of technology shocks, *Review of Economic Dynamics*, **14**, 705–24.

Appendix: Data

All of the data used in SVECM analysis are quarterly frequency from 1955Q1–2009Q4.

(1) TFP: total factor productivity, adjusted by capital utilization, downloaded from John Fernald's website: www.frbsf.org/economics/economists/staff.php?jfernald.

(2) SP: real stock price, downloaded from Robert Shiller's website: www.econ.yale.edu/~shiller/data.htm

(3) Y: real GDP series, obtained from St. Louis FED economic database.

(4) NF: the number of new business incorporations is reported by the US Bureau of Economic Analysis (BEA). The data can be downloaded from the website: www.bls.gov/bdm/. Because the series is discontinued (up to 1994Q4) as a result of a reprogramming of resources at BEA, we extend it to 2009Q4 using the US Bureau of Labor Statistics (BLS)'s establishment birth and death data. To check the robustness of the series, we conduct the dynamic responses exercise by running the data up to 1994Q4; the impulse responses present similar patterns as those from the full sample.

The SP, Y, NF series are transformed in per capita terms by dividing them by the population of age 15 to 64.