Optimal Exit Policy with Uncertain Demand

Michele Bisceglia Jorge Padilla Joe Perkins Salvatore Piccolo

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- Does this tell the whole story about exit?

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- **Q:** How does exit policy affect investment incentives and consumer welfare when investments are sunk and demand is uncertain?

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- Under-investment problem can be solved by a lenient exit policy
- With higher demand uncertainty, consumer welfare maximization requires lower exit barriers
- Application: Mergers

Literature

- *Exit in oligopoly.* Telser (1965), Ghemawat-Nalebuff (1985), Fudenberg-Tirole (1986): No investments & exogenous exit value

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- *Dynamic merger policy.* Mermelstein et al. (2020), Gilbert-Katz (2021), Mason-Weeds (2013): Symmetric information in takeover game

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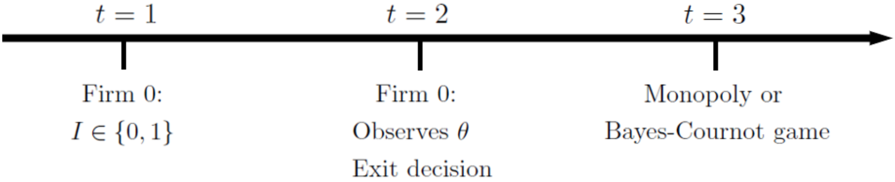

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  - $\theta^\star(I, K)$ increasing in K for all I

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- Firm 0's expected profit

$$\pi_0^\star(I,K) \triangleq \underbrace{\int_{-\sigma}^{\theta^\star(I,K)} K \frac{d\theta}{2\sigma}}_{\text{Exit value}} + \underbrace{\int_{\theta^\star(I,K)}^{\sigma} x_0^\star(\theta, I, K)^2 \frac{d\theta}{2\sigma}}_{\text{Market value}}.$$

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- Value of investment $\Delta\pi_0\left(K\right) = \pi_0^\star(1,K) - \pi_0^\star(0,K)$:

$$\Delta\pi_0\left(K\right) = \underbrace{\int_{\theta^\star(1,K)}^{\theta^\star(0,K)} \left[x_0^\star\left(\theta,1,K\right)^2 - K\right] \frac{d\theta}{2\sigma}}_{\text{Participation effect }(+)} +$$

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- $\Delta\pi_0(\cdot) > 0$ for all $K \in [0, \overline{K}] \implies I^\star = 1$ iff $\psi \leq \Delta\pi_0(K)$

Investment and Exit Value

- Differentiating $\Delta\pi_0(\cdot)$ w.r.t. K gives

$$\underbrace{-\int_{\theta^\star(1,K)}^{\theta^\star(0,K)}\frac{d\theta}{2\sigma}}_{\text{Exit effect}\quad(-)}+\underbrace{\int_{\theta^\star(0,K)}^{\sigma}\underbrace{\frac{\partial x_0^\star(\cdot)}{\partial\theta^\star(\cdot)}\frac{\partial\theta^\star(\cdot)}{\partial K}}_{+}\underbrace{\left[x_0^\star(\theta,1,K)-x_0^\star(\theta,0,K)\right]}_{+}\frac{d\theta}{\sigma}}_{\text{Selection effect}\quad(+)}$$

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- $\Delta\pi_0(K)$ is single peaked in K and features a maximum at

$$K^\star \triangleq \left(\frac{b^2(2\sigma + \mu(1-b))}{8(4-b^2)}\right)^2 \in (0, \overline{K})$$

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Consumer Surplus

- Expected consumer surplus $CS(I,K)$

$$\int_{-\sigma}^{\theta^\star(I,K)} \underbrace{\frac{\mu^2}{8}}_{CS^M} \frac{d\theta}{2\sigma} + \int_{\theta^\star(I,K)}^{\sigma} \underbrace{\left[\frac{1}{2}\sum_{i=0,1} x_i^\star(\cdot)^2 + b x_0^\star(\cdot)\, x_1^\star(\cdot)\right]}_{CS^D(\theta,I,K)} \frac{d\theta}{2\sigma}$$

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- Social value of investment: $\Delta CS(K) \triangleq CS(1, K) - CS(0, K)$:

$$\Delta CS(K) = \underbrace{\int_{\theta^\star(1,K)}^{\theta^\star(0,K)} \left(CS^D(\theta, 1, K) - CS^M\right) \frac{d\theta}{2\sigma}}_{\text{Switch to duopoly } (+)} +$$

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- $\Delta CS(K) > 0 \Longrightarrow$ *Under-investment problem* for $\psi > \Delta\pi_0(K)$

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$$\frac{\partial CS(I,K)}{\partial K} = \frac{1}{2\sigma}\underbrace{\frac{\partial \theta^\star(\cdot)}{\partial K}}_{(+)}\Bigg\{\underbrace{CS^M - CS^D(\theta^\star(\cdot), I, K)}_{\text{Switch to monopoly (?)}} +$$

$$+\int_{\theta^\star(\cdot)}^{\sigma}\underbrace{\frac{\partial x_1^\star(\cdot)}{\partial \theta^\star(\cdot)}\left[x_1^\star(\cdot) + b x_0^\star(\cdot)\right]}_{\text{Strategic effect }(-)} d\theta + \int_{\theta^\star(\cdot)}^{\sigma}\underbrace{\frac{\partial x_0^\star(\cdot)}{\partial \theta^\star(\cdot)}\left[x_0^\star(\cdot) + b x_1^\star(\cdot)\right]}_{\text{Output enhancing effect }(+)} d\theta\Bigg\}$$

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- Results:
  - $K^{\star\star}(1) = 0$
  - $K^{\star\star}(0) \in (0, K^{\star})$ iff $b > b_0^{\star}$ and $\sigma < \sigma_0^{\star}$; otherwise $K^{\star\star}(0) = 0$

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  - Otherwise just sets $K = K^{\star\star}(0)$

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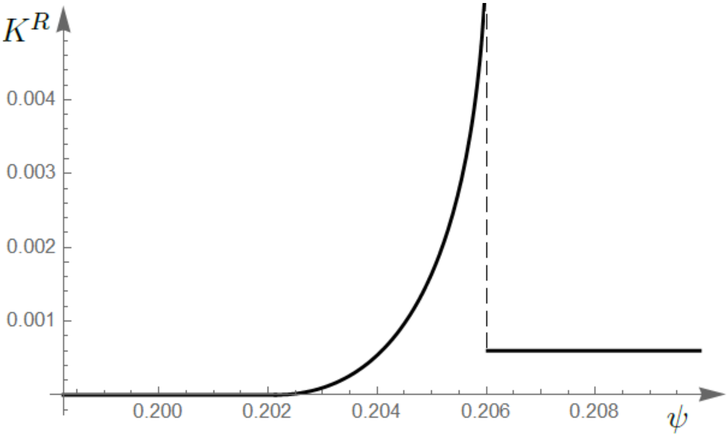
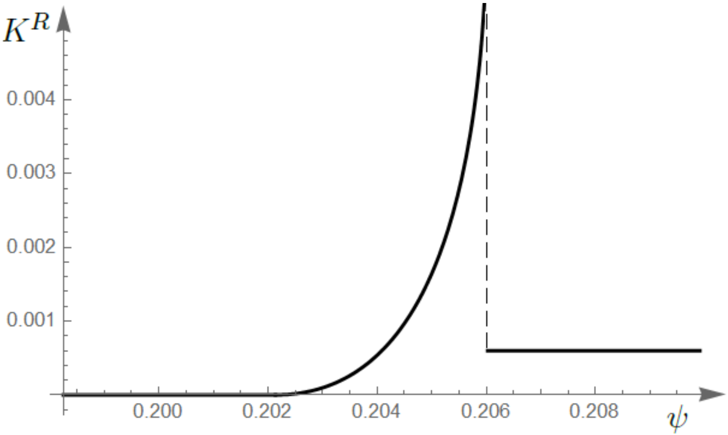


Optimal Ex-Ante Exit Policy

For all $\psi \in \Psi$, the optimal exit policy is $K^R = \widehat{K}$



The region of parameters Ψ expands as σ grow large

Endogenous Exit Value: Start-up acquisition

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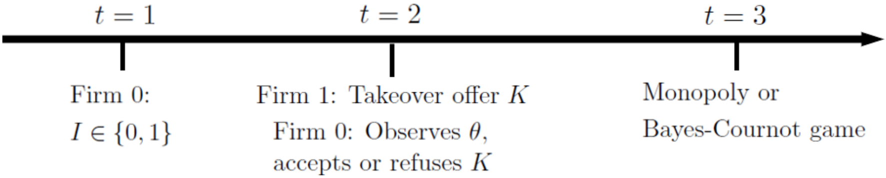

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- Firm 0 invests iff $\psi \leq \Delta\pi_0(L) = \pi_0^\star(1, y = L) - \pi_0^\star(0, y = L)$

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  - $\psi > \overline{\psi}$: Incumbent not willing to offer K^P $\implies l = 0$, $K^e = 0$: merger never takes place

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- Industries in which investments are costly require relatively lenient merger/liquidation policies to secure investments

Thank you!

Comments are Welcome.

Michele Bisceglia (michele.bisceglia@tse-fr.eu)
Jorge Padilla (JPadilla@compasslexecon.com)
Joe Perkins (JPerkins@compasslexecon.com)
Salvatore Piccolo (salvatore.piccolo@unibg.it)