Exit, selection, and the value of firms

Hugo A. Hopenhayn, JEDC 1992

Presented by Jesse Perla

New York University

March 23, 2010

Tobin's q

- Tobin's q and average q:
  - $q = \frac{\text{firm value}}{\text{replacement cost of capital}}$
  - $\bar{q} = \frac{\sum \text{firm value}}{\sum \text{replacement cost of capital}}$, for an industry or the entire market
  - Is $q \neq 1$ an indicator of efficiency of competition?

Variation in q

- Systematic difference between industries and firms. Often correlated to static measures of monopolistic power.
- How could average or marginal $q < 1$?
  - Irreversible investment. Declining industry.
- How could $q > 1$? Lindenberg and Ross [1981] suggest:
  - Monopoly Rents: Pricing power.
  - Ricardian Rents: Assets difficult to imitate
- Hopenhayn [1992]: Explore the bias in $\bar{q}$ and distribution of q in a perfectly competitive industry equilibrium

Demand and Environment

- Discrete time
- Consumers and Demand:
    - Single, homogeneous good
    - Aggregate demand Q has inverse demand: $p = D(Q)$
- Firms:
    - Continuum of firms
    - Firms are price competitive price takers
    - p_t is the equilibrium price.

Firm Cost Heterogeneity

- Firms heterogeneous over $\phi \in \mathbb{R}$
- To produce output x_t, cost is $c(\phi_t, x_t) \searrow$ in ϕ_t
- ϕ_t is Markov: $\phi_t \sim F(\phi'|\phi)$
- F is iid across firms
- New entrants draw from distribution $G(\phi)$

Firm Profits

Production is a static decision:

- Solve static problem to convert from cost to profits
- Indirect Profits: $\pi(\phi, p) \quad \nearrow$ in ϕ, p
- Indirect Profit Maximizing Output: $x(\phi, p)$

Exit Decision

- Timing:
  - i) Realize ϕ
  - ii) Make exit choice
  - iii) Otherwise produce, collect profits
- Firm Value

$$v(\phi; p) = \max\left\{0, \pi(\phi, p) + \beta \int v(\phi'; p) F(d\phi'|\phi)\right\}$$

- Under reasonable requirements on intrinsics, for each $p \, \exists \phi^*$,

$$v(\phi^*; p) = 0, \quad \text{Exit if: } \phi \leq \phi^*$$

Entry Decision

- Timing:
  i) Pay fixed cost c_e. Interpret as irreversible initial investment.
  ii) Draw ϕ from G
  iii) Can exit immediately, otherwise $\phi' \sim F(\phi'|\phi)$
- Value of entry:

$$v^e(p) = \int v(\phi; p) G(d\phi) - c_e$$

- Free Entry condition: $v^e(p) \leq 0$
- Under technical assumptions, $\exists ! p^*$ s.t. $v^e(p*) = 0$

Industry

- Aggregates:
  - Price p
  - μ_t measures number of firms over ϕ
- Total mass of firms: $M_t = \mu_t(\mathbb{R})$
- Aggregate Supply:

$$Q(\mu, p) = \int x(\phi, p)\mu(d\phi)$$

Stationary Industry Evolution

Given λ mass of entrants each period, ϕ^* reservation value:

$$\mu_{t+1}([\phi^*, s]) = \left[\int F(s|\phi)\mu_t(d\phi) - \int F(\phi^*|\phi)\mu_t(d\phi)\right] + \lambda\left[G(s) - G(\phi^*)\right]$$

$$\mu_{t+1}([-\infty, s]) = 0 \qquad \forall s < \phi^*$$

Invariant Measure if $\mu_{t+1} = \mu_t \quad \forall t$

Stopping Times/Decomposition of Distribution

- Let α_τ be the fraction of entrants remaining after τ periods
- Let $\tilde{\mu}_\tau$ be the distribution over ϕ of firms entering τ periods ago.
- Let $\tilde{\mu}_0$ be G conditional on $\phi > \phi^*$. i.e. enter and stay.
- Assume finite expectation of stopping time: $\sum_{\tau=0}^{\infty} \alpha_\tau$

Decomposition of Distribution:

$$\mu = \lambda \sum_{\tau=0}^{\infty} \alpha_\tau \tilde{\mu}_\tau$$

Stationary Equilibrium

$(p^*, \phi^*, \lambda^*, \mu^*(\phi))$, such that:

i) Market Clearing: $p^* = D(Q(\mu^*, p^*))$

ii) Solve Exit Problem: $v(\phi^*; p^*) = 0$

iii) Free Entry, Zero Profit: $v^e(p^*) = 0$

iv) Invariant measure $\mu^*(\phi)$

Proposition

Given a stationary equilibrium with entry and exit (and 11 'reasonable' technical assumptions), $\bar{q} > 1$

No Ex-post Uncertainty

- $\phi_{t+1} = \phi_t$
- Value function:

$$v(\phi; p) = \max\left\{0, \frac{1}{1-\beta}\pi(\phi, p)\right\}$$

- Entry remains the same:

$$v^e(p) = \int v(\phi; p) G(d\phi) - c_e$$

- Decision is still reservation ϕ^*.
- After successful entry, always remain, so distribution: μ is G conditional on $\phi \geq \phi^*$

Stationary Equilibrium

(p^*, ϕ^*, M^*), such that:

i) Market Clearing: $p^* = D(Q(\mu^*, p^*))$

ii) Solve Exit Problem: $v(\phi^*; p^*) = 0$

iii) Free Entry, Zero Profit: $v^e(p^*) = 0$

iv) $M^* = \mu(\mathbb{R}) = 1 - G(\phi^*)$

Bias of $\bar{q}$

- Entry gives expression for 'replacement cost of capital':

$$c_e = \frac{1}{1-\beta}\int_{\phi \geq \phi^*} \pi(\phi, p^*) G(d\phi)$$

- Value function conditional on post-entry continuation gives average value:

$$\bar{v} = \frac{1}{1-\beta} \frac{\int_{\phi \geq \phi^*} \pi(\phi, p^*) G(d\phi)}{1 - G(\phi^*)}$$

$$\implies \qquad \bar{q} = \frac{\bar{v}}{c_e} = \frac{1}{1 - G(\phi^*)} > 1$$

Higher Barriers to Entry

- Interpret c_e as containing barriers to entry
- A higher c_e yields a higher p^*:
  - From free Entry: $v^e(p) \leq \int v(\phi; p) G(d\phi) - c_e$
- Which gives a lower reservation:
  - From $v(\phi; p) = \max\left\{0, \frac{1}{1-\beta}\pi(\phi, p)\right\}$
- Giving a lower average q value:
  - From $\bar{q} = \frac{1}{1-G(\phi^*)}$
- . . . contrary to 'standard intuition'

Increasing Differences

Proposition

If π is strictly increasing in p and ϕ then for $p' > p$, $v(\phi, p') - v(\phi, p)$ is strictly increasing in ϕ. i.e. higher p gives a value function with a higher slope (over ϕ)

Higher Fixed Costs

- Assume $c(\phi, q) = c_f + vc(\phi, q)$ for fixed and variable costs
- A larger c_f yields a higher p^* from free entry
- Which gives a higher reservation ϕ^* (see diagram)
- Giving a higher $\bar{q}$ value

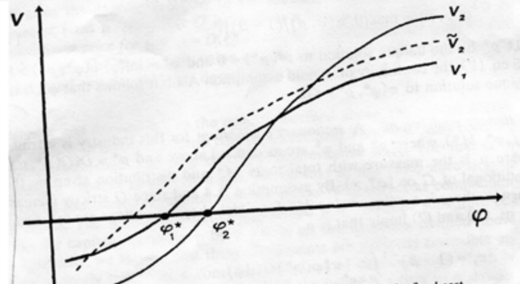

Fig. 1. Fixed costs and selection – Effect of an increase in the fixed cost.

Summary of Results

- Looking at only surviving firms gives biased estimates of 'ex ante' profitability
- Unless industry is declining, q values will tend to be biased above 1.
- Selection, rather than monopoly rents, can generate many of the same results on $\bar{q}$
- Entry and exit alone can generate a distribution of q values.

Bibliography

Hugo A. Hopenhayn. Exit, selection, and the value of firms. Journal of Economic Dynamics and Control, 16(3-4):621–653, 1992. URL http://ideas.repec.org/a/eee/dyncon/v16y1992i3-4p621-653

Eric B Lindenberg and Stephen A Ross. Tobin's q ratio and industrial organization. Journal of Business, 54(1):1–32, January 1981. URL http://ideas.repec.org/a/ucp/jnlbus/v54y1981i1p1-32.html.