Consumer inertia, firm growth and industry dynamics.

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The Aim

This paper develops a model of firm growth and survival emphasizing the interaction between idiosyncratic costs and brand loyalty or consumer inertia (consumer base) and explores its ability to account for various facts on industry dynamics (Dunne, Roberts and Samuelson 1988,89 and Davis Haltiwanger 1992).

- firms are born small
- bigger and older firms have lower hazard rates
- bigger and older firms invest more in cost reductions R&D
- downward sloping density of firm sizes

Related Literature

- Earlier literature: the only characteristic of firms is its productivity/cost of production (Jovanovic 82, Hopenhayn 92), F&R analyze cost and costumer base interactions effects on firm dynamics.
- Ericson and Pakes (95) and Fishman and Rob (95,99) consider R&D, but no costumer base and entry and exit.
- Burdett and Coles (1997) consider the evolution of customer bases and its effect on pricing, but impose exogenous exit and do not consider R&D.

The insight

Consumers must incur search costs to learn about the prices of new sellers.
New consumers and firms continuously appear and are randomly matched.
In eqlm (bc of search costs and optimal p's) consumers are locked in with their original firm⇒incumbents compete with new entrants only for first time buyers
As they acquire new consumers⇒D stock grows (the longer it stays in the market the greater its market share).

Model

- Discrete time, continuum of firms (homogeneous product) and consumers.

Consumers

- Population s.t. turnover: every period.
  - a measure of v enters, a fraction of δ exits (δ / v inv. stock).
  - exit prob.: same across consumers and independent of age.

- Indentical consumers, unitary demand, valuation $\overline{p}$.
  - Upon entry$\Rightarrow$randomly and costlessly matched with a seller.
  - Subsequently$\Rightarrow$costlessly return to the previous seller, but switching to a new seller is costly (σ):
    - p's distrib. in the market is known, but not p of particular sellers
    - to learn the price of a new seller costs σ ($\exists$ unlimited sequential sampling).

Model

Firms

- Bear 4 type of costs:
  - k entry cost
  - F fixed cost of production
  - c_i marginal cost, with $c_m > c_{m-1} > ... > c_1$
  - w invest. R&D cost$\Rightarrow$a c_i-firm becomes a c_j-firm with Pr. $g_{ij}(w)$

  assume:
    - $g_{mm}(w) = 1$,
    - $0 < g_{ij}(w) < 1$ for $i \neq m, \forall j$
    - $c_m > \overline{p} \geq c_{m-1}$ (c_m-firms always exit)
- τ Age (time elapsed since entry)
  - firms accumulate costumers only gradually

Assumption A

1) $G'_{i,j}(w) > 0 > G''_{i,j}(w)$ (positive and decreasing $MP_{R\&D}$)
2) $G'_{i,j}(w) > G'_{i+1,j}(w)$ (complementarity btw $R\&D$ and current cost)

Model

Entrants

- Infinite pool of potential entrants
- Pay K $\Rightarrow$draw c_i with $Pr(c_i) = \alpha_i \sim \alpha \equiv (\alpha_1, ..., \alpha_m)$
- Age $\tau = 1$

Timing

- Observe states (c_i, z)
- Decide whether to exit or not
- If does not exit$\Rightarrow$pay F and choose R&D and price

Model

- Since consumer have identical unit demand, have identical positive search costs, and search sequentially⇒the equilibrium price of each firm is the monopoly price $\overline{p}$ (Diamond 1971)⇒consumers accepts it and will never switch to a new seller.
- He remains with his first seller and exits the market if that seller exits⇒
  - incumbents accumulates new consumers
  - new entrants can only access newborn consumers: x

⇒Consumer stock at age τ

$$z(\tau) = x + ... + x(1-\delta)^{\tau-1} = \frac{x\left[1-(1-\delta)^{\tau}\right]}{\delta}$$

Model

Dynamic programming problem of a firm:

$$\begin{aligned} R_i(z;x) &= \max\left\{0, -F + z(\overline{p} - c_i)\right. \\ &\left. +\beta \max_{w\geq 0}\left\{-w + \sum_{j=1}^{m} g_{ij}(w) R_j[x + z(1-\delta)]\right\}\right\} \\ i &= 1, ..., m \end{aligned} \quad (3.2)$$

Free Entry

The equilibrium x^* satisfies

$$\sum_{i=1}^{m} \alpha_i R_i(x^*; x^*) = K$$

given x^* there exists z^* s.t.

$$R_i(z_i^*; x^*) = 0$$

z_i^* is the critical size so that firms with c_i remain operative iff they have

Equilibrium

Exit strategies, prices, R&D expenditures, consumer search strategies, flows of firm entry and exit, and a distribution over firm types s.t.:

(E.1) Each firm chooses a $p(c, \tau)$ and $w(c, \tau)$ to max. profit.

(E.2) Each consumer has a surplus-maximizing reservation-price strategy, $r(c, \tau)$: the consumer buys from a (c, τ)-firm whenever the price is no higher than $r(c, \tau)$

(E.3) There is a constant flow of entry, y, so that each entering firm makes zero expected profit.

(E.4) There is an exit strategy $\tau^*(c)$ so that all (c, τ)-firms with $\tau < (\geq) \tau^*(c)$ exit (stay, respectively), and this decision is optimal

(E.5) There is an invariant distribution over firm types, $f(c, \tau)$ given the eqlm. entry rate y and exit strategy $\tau^*(c)$.

Properties of Equilibrium

Probability of exit decreasing in size

- Results from the fact that a firm's value increases with age, because:
  - The **current profit** increases in age: the passage of time increases the firm's customer stock⇒the unit profit applies to larger sales.
  - The **continuation value** is increasing in age: two reasons
    - a firm with a larger stock of customers gets a bigger boost from turning low-cost in the future
    - investment in cost-reducing innovations increase in firm size (from A2 complementarity of costs and R&D)

Firm size and R&D expenditures (Prop 4.1)

(i) R&D investments - the RHS maximizer of (3.2) - $\uparrow$ in z.
(ii) R&D investments $\downarrow$ in i.

Properties of Equilibrium

The size distribution of firms

- The density of the size distribution of firms is decreasing
  - the bigger is the size the longer must the firm have escaped adverse cost shocks, which occurs with a smaller probability.

Productivity and Size Relationship

Usually suggested in the popular press: small firms are nimble and dynamic but are bound to become big

- The model is consistent, in a sense, with this view:
  - in eqlm: MC of firms with size$< z_j^*$ is $< c_j$
  - MC of **some** firms with size$> z_j^*$ is $> c_j$

But larger firms are more likely to decrease their MC bc. invest more in R&D

(relationship btw. size and costs is indeterminate here, -not as in Jovanovic, Hopenhayn, etc-).

Properties of Equilibrium

Technological progress, entry and the stock market value of firms

- Assume that the initial distribution α as well as g_{ij} shift to the left
- $\uparrow$ firms' profits and values $\Rightarrow\uparrow$ rate of entry and $\downarrow$ flow of new customers to each firm
- value of new firms remains unchanged (K)
- value of old firms goes up: Suppose, for example average unit cost faced by older firms is the same as the AUC of new entrants (stochastic process for unit costs is a martingale) $\Rightarrow$
  - An old firm derives value from its locked in customers (the cost reduction $\uparrow$ the value of the old customer stock), and
  - from the future arrival of new customers.(same as a new entrant: the value of this flow $= K$, before and after the cost reduction)

  $\Rightarrow$ the valuation of old firms must increase.

the 2 predictions of the model ($\uparrow$ entry and stock market valuation) are consistent with the stock market behavior in the U.S. during the late 1980's and the 1990's.

Final Remarks

This paper develops a model where firm growth and survival depend on both idiosyncratic costs and the accumulation of consumer base, where firms R&D expenditures and exit are endogenous variables.

Results indicate that

- The density distribution of firms is decreasing in size
- Older firms are less likely to exit than younger firms
- Larger firms spend more on R&D