Growth through Heterogeneous Innovations

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Research Question

- Research Question
  - ⋆ How innovation differ between small and large firms?
  - ⋆ How firms adjust their innovation decision across their life cycle?
  - ⋆ What is the relation between heterogeneous behavior and aggregate variables?

- Previous literature neglected
  - ⋆ Heterogeneity of innovation across firm size
  - ⋆ Strategic behavior of innovation.

This paper

- Data work and empirical facts
  - ⋆ Match the LBD (Census data) with USPTO
  - ⋆ Citations: External vs. Internal innovation.
  - ⋆ Citations: Radical vs. Follow-up innovation.

- Endogenous growth model
  - ⋆ Introduce 2 types of innovation: External & Internal
  - ⋆ Heterogeneity in innovation step size
  - ⋆ Stationary distribution of quality.

Stylized Facts

- Small firms grow at a faster rate than larger firms
- R&D intensity is decreasing with firm size.
- Small firms have more radical innovation.

The Model

- Firm dynamics embedded in endogenous growth a la Klette & Kortum (2004)
  - ⋆ Firm level investment decision to grow
  - ⋆ Heterogeneity in firm size
  - ⋆ Competition between incumbents and entrants

- Two different innovation decisions: Internal (II) and External (EI)
  - ⋆ II: Investment in own existing portfolio.
  - ⋆ II: Fixed step size of innovation λ
  - ⋆ EI: Undirected innovation outside existing portfolio.
  - ⋆ EI: Radical innovation w.p θ, step size $\eta\bar{q}$
  - ⋆ EI: Follow up innovation w.p $1-\theta$, step size $\eta\alpha^{k_j}\bar{q}$

How do we get some nice results?

- Examining the value function

$$rV(\mathbf{q}) - \dot{V}(\mathbf{q}) = \max_{\substack{x \in [0,\bar{x}] \\ \{z_j \in [0,\bar{z}]\}_{\mathcal{J}}}} \left\{ \begin{array}{l} \sum_{q_j \in \mathbf{q}} \underbrace{\pi q_j}_{\text{Profits}} - \underbrace{\hat{\chi} z_j^{\hat{\psi}} q_j}_{\text{Internal R\&D}} - \underbrace{\tilde{\chi} x^{\tilde{\psi}} \bar{q}}_{\text{External R\&D}} - \underbrace{\Phi \bar{q}}_{\text{Fix Cost}} \\ \sum_{q_j \in \mathbf{q}} \underbrace{z_j \left(V(\mathbf{q} \oplus \{q_j(1+\lambda)\} \ominus \{q_j\}) - V(\mathbf{q}) \right)}_{\text{Internal Innovation}} \\ \sum_{q_j \in \mathbf{q}} \underbrace{\tau \left(V(\mathbf{q} \ominus \{q_j\}) - V(\mathbf{q}) \right)}_{\text{Creative Destruction}} \\ + \underbrace{x \left[\mathbb{E}_j V(\mathbf{q} \oplus \{q_j + \bar{q} s_j\}) - V(\mathbf{q}) \right]}_{\text{External Innovation}} \end{array} \right.$$

- Blue terms make the value function linear in q_j.
- Red terms keep the distribution of q stationary.

Decomposing growth

TABLE 7
GROWTH DECOMPOSITION

ACTUAL VALUES			IN PERCENTAGE TERMS		
Internal	External	New Entry	Internal	External	New Entry
.0020	.0055	.0026	19.8%	54.5%	25.7%

What's next?

- Heterogeneity in firms
  - ⋆ Observed differences are out of "luck".
- Industrial policy analysis
  - ⋆ Welfare effects: C vs. g.
  - ⋆ Optimal Policy: Subsidize R&D? Which one?
- How do expand this framework to explain recent trends?
  - ⋆ Market concentration
  - ⋆ Ownership of the firm: M&A, VC investment, IPO.