

Learning By Building: Complementary Assets and the Migration of Capabilities In U.S. Innovative Firms

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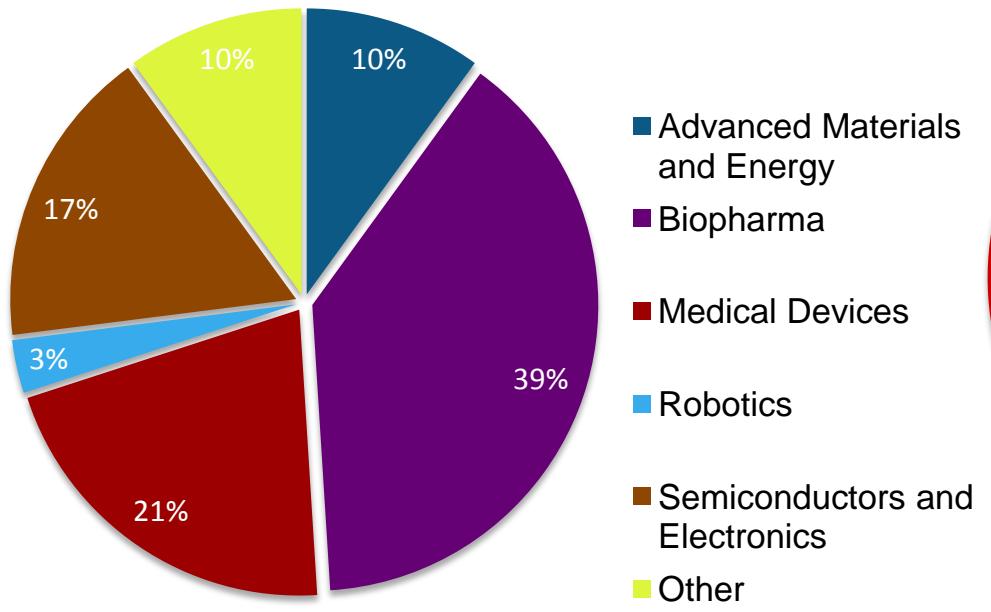
Scale Up of Innovative Firms

- Motivation
 - US economic model relies on new innovative firms
 - Debates about importance of manufacturing
 - Lack of research on how innovative firms develop complex technologies in manufacturing
- Research Questions
 - What are the implications of innovative firms' scale-up strategies for the US innovation ecosystem?
 - What are the processes and pathways by which innovative production-oriented firms scale their technology?
 - What are the critical factors necessary for scaling? What, if any, barriers exist?

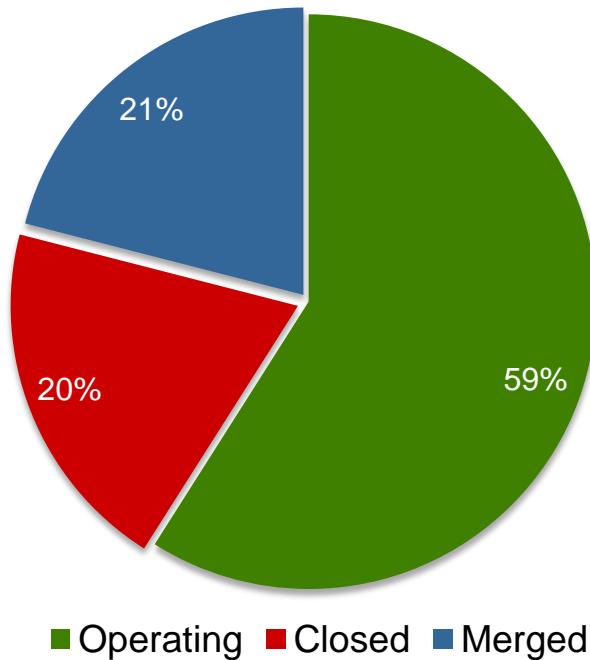
Critical Case of 150 Production Firms

Started with MIT Licensed Technology (1997-2008)

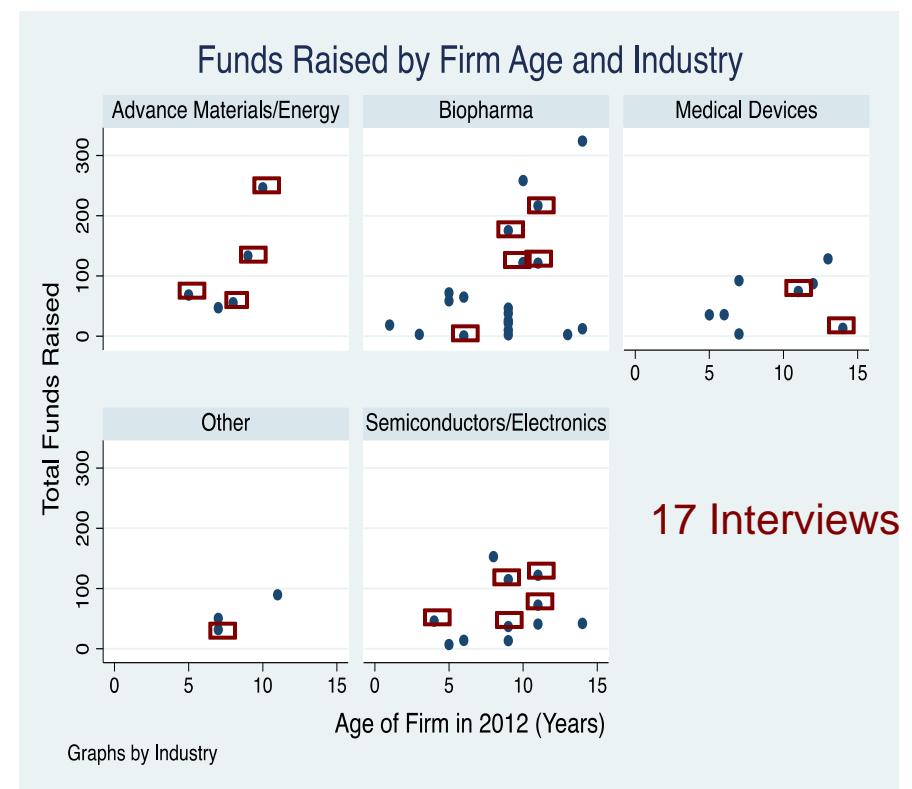
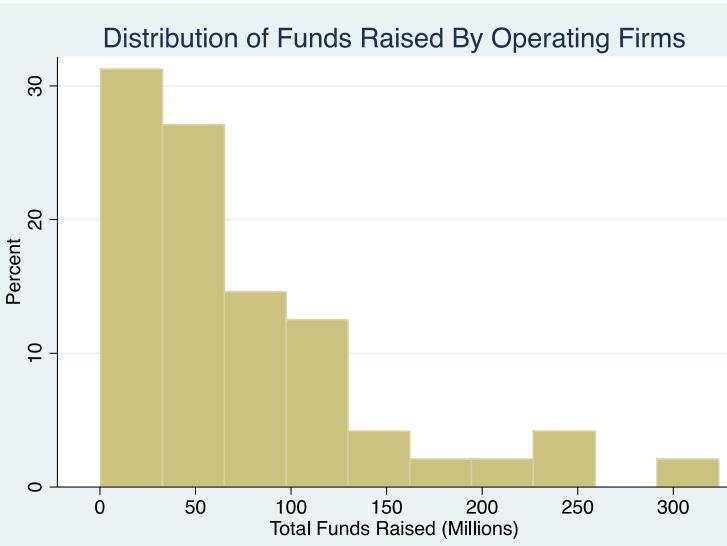
By Industry



By Current Status



A Majority of the Firms Raised Large Amounts of Venture Capital



- 82 production firms received VC financing
- 52 of these still in operation
- Mean of \$74M over 9 years

Findings: Robust Innovation Ecosystem at the Early Stages of Scale Up

- **Capital Available for Up to 10 Years**
- **Thick Labor Markets:**
 - Need access to diverse “high intellect” talent
 - Easy to find for prototyping and pilot phases
- **Networks Matter**
 - Key individuals deliver resources
- **Thick Supplier Markets**
 - Range of suppliers with an emphasis on speed and quality
 - *“We kept eight machine shops busy for two weeks at full capacity getting a system ready.”*

Search for Complementary Assets Leads Firms Overseas

- **Significant influx of new capital** required to reach commercial scale
 - \$30 - 60 million
 - “*VCs cannot make any money on something that costs \$100 million and takes at least 10 years to build.*”
- **Strategic partners and foreign governments** provide complementary assets
 - “*When [the company] transitions from the normal VC model, there is no other model to jump to, so they go abroad.*”

Implications of this Shift Abroad

- Critical moment in firm's growth
 - “**Inflection band**” of 2-3 years
 - Knowledge is loosely codified;
 - Process of “**learning by building**” in manufacturing for scale up
- Financing, capabilities and customers/suppliers **pull technology development abroad**
 - Demand offers opportunity to iterate on technology
 - Reinforced by aggressive public policies

Long-Term Consequences for the U.S.?

- **Learning by doing** occurs overseas
 - Decline in capabilities means loss in “industrial commons”
(Pisano and Shih 2012)
- Reinforces **movement of center of gravity** for industries away from the U.S.
 - Initially resulted from de-verticalization of U.S. industry
 - Accelerated by laissez-faire venture capital markets
(Chesbrough et al. 2006)
- **Reduces benefits to the country of downstream activities** in terms of investments and jobs (*in situ* development)
 - Possibly breaks virtuous cycle of capabilities->innovation->capabilities8

Directions for Future Research

- Financial structures like “megafunds” that can provide alternatives to non-dilutive foreign capital (Fernandez et al. 2012)
- Comparative analysis of industry-specific market conditions as shaped by demand and institutions in biopharma, clean energy, and advanced manufacturing
- Understand role of strategic partners and foreign investors for a larger national sample