A New View of the Skew: Quantitative Estimates of the Quantity and Quality of Entrepreneurship

Catherine Fazio, MIT Innovation Initiative

NCSES/CNSTAT Innovation Indicators Workshop
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“America’s great challenge is to ... bring about a substantial increase in the numbers of highly successful new companies ... Nothing less than the future welfare of America and its citizens is at stake.”

“The problem is that it is very difficult, if not impossible, to know at the time of founding whether or not firms are likely to survive and/or grow. This is true even with venture-capital backed firms”

A Tale of Two Bookstores

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Spotlight! -- August 16th

These are the books we love, offered at Amazon.com low prices. The spotlight moves EVERY day so please come often.
What do Traditional Measures Tell Us?

**Quantity Based Measures:**

- Hathaway and Litan (2014a, 2014b)

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**Outcome-Based Measures**

*VENTURE CAPITAL INVESTMENTS IN U.S. (B*)

```
<table>
<thead>
<tr>
<th>Year</th>
<th>Billion $</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>$30.43</td>
</tr>
<tr>
<td>2009</td>
<td>$20.33</td>
</tr>
<tr>
<td>2010</td>
<td>$23.52</td>
</tr>
<tr>
<td>2011</td>
<td>$29.91</td>
</tr>
<tr>
<td>2012</td>
<td>$27.70</td>
</tr>
<tr>
<td>2013</td>
<td>$30.28</td>
</tr>
<tr>
<td>2014</td>
<td>$50.99</td>
</tr>
<tr>
<td>2015</td>
<td>$59.70</td>
</tr>
</tbody>
</table>
```

"Silicon Valley's denial is over: Everybody thinks we're in a bubble"

http://www.businessinsider.com/silicon-valleys-denial-is-over-everybody-thinks-were-in-a-bubble-2015-10
To maximize relevance and utility of data collection programs and statistical products on entrepreneurship to policymakers, NCSES should:

- Recognize SMEs and IDEs as different in kind
- Broaden entrepreneurial information systems to include measures of entrepreneurial quality
- Develop tools that enable policymakers to evaluate SMEs and IDEs separately and in context at the time of formation
Outline

• Motivation: Mapping entrepreneurial growth potential from the time of founding

• Brief overview:
  – Introduction of quantitative methodology for estimating entrepreneurial quality
  – NCSES/CNSTAT Focus:
    • Business registration records
    • Choice of startup characteristics

• New Measures and Findings

• Potential as a policy tool at subnational and national levels
Accounting For Entrepreneurial Quality: Brief Overview of New Approach

- Calculates consistent estimates of the underlying growth potential of startups
  - Combines population-level business registration records with predictive analytics
  - Draws on startup characteristics at or near time of founding
  - Derives conditions under which predictive analytics yields consistent estimates

- Develops three new population-level statistics
  - EQI – the average growth potential (or “quality”) of any given group of new firms
  - RECPI – the number of startups within a particular region expected to later achieve a growth outcome
  - REAI – the ability of a region to convert entrepreneurial potential into realized growth

- Offers novel characterization of entrepreneurial ecosystems over time and at arbitrary level of geographic granularity, and also aggregates to (60% of) the State of American Entrepreneurship

NCSES/CNSTAT Focus: Developing New Data on IDE

• Approach builds on three interrelated insights to develop a “new” data source on IDE
  – Business registration is a practical requirement for growth.
  – Markers of entrepreneurial quality are observable at or near the time of business registration.
  – Meaningful growth outcomes can be observed with a lag, creating the potential for a mapping between growth and start-up characteristics.

• Entrepreneurial quality is the estimated probability of growth given startup characteristics.
Business Registration

• Defacto requirement for businesses seeking meaningful growth outcome
• Public
• Comprehensive
• Comparable over time and place
# Example: MA Business Registration

## Corporations Division

### Business Entity Summary

**ID Number:** 042226590

**Summary for:** DIGITAL EQUIPMENT CORPORATION

<table>
<thead>
<tr>
<th>The exact name of the Domestic Profit Corporation:</th>
<th>DIGITAL EQUIPMENT CORPORATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merged into <strong>COMPAQ COMPUTER CORPORATION</strong> on 12-31-1999</td>
<td></td>
</tr>
<tr>
<td>Merged with <strong>MAYNARD DEVELOPMENT CO., INC.</strong> on 06-27-1974</td>
<td></td>
</tr>
<tr>
<td>Merged with <strong>MAYNARD INDUSTRIES, INC.</strong> on 06-27-1974</td>
<td></td>
</tr>
<tr>
<td>Merged with <strong>APL SOFTWARE SYSTEMS, INC.(PA)</strong> on 06-27-1975</td>
<td></td>
</tr>
<tr>
<td>Merged with <strong>DEC REALTY TRUST(MA TR)</strong> on 08-13-1981</td>
<td></td>
</tr>
<tr>
<td>Merged with <strong>COMPAQ MERGER, INC.</strong> on 06-11-1998</td>
<td></td>
</tr>
</tbody>
</table>

**Entity type:** Domestic Profit Corporation

**Identification Number:** 042226590

**Date of Organization in Massachusetts:** 08-23-1957

**Current Fiscal Month/Day:** 12/31

**Previous Fiscal Month/Day:** 06/30

**The location of the Principal Office:**

- **Address:** 40 OLD BOLTON RD.
- **City or town, State, Zip code, Country:** STOW, MA 01775 USA
NCSES/CNSTAT Focus: Developing New Data on IDE

• Approach combines three interrelated insights to develop a “new” data source on IDE
  – Business Registration as a Practical Requirement for Growth.
  – **Markers of Entrepreneurial Quality are Observable at or Near the Time of Business Registration.** Firms with the potential and ambition for a meaningful growth outcome likely have different “start-up characteristics” including measures directly observable within business registration records (firm name) as well as publicly available measures that can be matched in a systematic manner (e.g., have they applied for a trademark or patent?).
  – Meaningful growth outcomes can be observed with a lag, creating the potential for a mapping between growth and start-up characteristics.

• Entrepreneurial quality is the estimated probability of growth given startup characteristics.
Consider Two Business Names

**Akamai Technologies Inc**
1. Sharp, distinctive, and short name (2 words). (+)
2. “Technologies” suggest is a high tech business (+)
3. “Inc.” says this is a corporation (+)

**Benchmark & Pratt Realtors, LLC**
4. Descriptive and long name (4 words). (-)
5. Eponymous: Has founder last name (“Pratt”) in firm name (-)
6. “Realtors” suggest this is a local business (-)
7. “LLC” says this is a limited liability company (-)
Patenting and Firm Growth: Helicos Biosciences Corporation

- December 5, 2003: Founded in Cambridge
- December, 2009: IPO as HLCS

United States Patent
Lapidus, et al.

Short cycle methods for sequencing polynucleotides

The invention provides methods for sequencing a polynucleotide comprising:

Inventors: Lapidus; Stanley N (Bedford, NH), Buzby; Philip Rich
Assignee: Helicos Biosciences Corporation (Cambridge, MA)
Family ID: 34595948
Appl. No.: 10/852,482
Filed: May 24, 2004
Data: Measures

• Business Registration Measures
  – Corporation – Firm registers as a corporation, rather than a partnership or LLC
  – Delaware Jurisdiction – Firm is registered in DE w/ principal address in MA
  – Eponymy (Daley, Belenzon and Chatterji, 2015) – Firm includes name element of founders
  – Short Name – Firm name includes three words (including registration status such as Inc.)
  – Firm Name Has Last Name
  – Firm Name Has First Name
  – Firm Name is Unique – Has a word that appears 5 times or less in a list of 10M firms.

• Intellectual Property
  – Patent: Patent Application or Assignment within One Year of Founding
  – Trademark: Trademark Application within One Year of Founding
NCSES/CNSTAT Focus: Developing New Data on IDE

• Methodology for measurement of entrepreneurial quality combines three interrelated insights to develop a “new” data source on IDE
  – Business Registration as a Practical Requirement for Growth.
  – Markers of Entrepreneurial Quality are Observable at or Near the Time of Business Registration.
  – **Meaningful growth outcomes can be observed with a lag, creating the potential for a mapping between growth and start-up characteristics.** Rather than assume the relationship between start-up characteristics and entrepreneurial quality, investigate relative importance of different factors by developing a predictive model of growth based on start-up characteristics.

• Entrepreneurial quality is the estimated probability of growth given startup characteristics.
Outline

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• **New Measures and Findings**

• Potential as a policy tool at subnational and national levels
Table 1: The Empirical Model: The Predicted Relationship Between Startup Characteristics and Growth

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Change in the Probability of Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has Short Name</td>
<td>248%</td>
</tr>
<tr>
<td>Firm Named after Founder</td>
<td>-70%</td>
</tr>
<tr>
<td>Corporation (Not Partnership or LLC)</td>
<td>405%</td>
</tr>
<tr>
<td>Trademark in First Year</td>
<td>501%</td>
</tr>
<tr>
<td>Patent and No Delaware Registration</td>
<td>3,534%</td>
</tr>
<tr>
<td>No Patent and Delaware Registration</td>
<td>4,470%</td>
</tr>
<tr>
<td>Both Patent and Delaware Reg.</td>
<td>19,640%</td>
</tr>
<tr>
<td>Sectoral Controls</td>
<td>Included</td>
</tr>
<tr>
<td>State Controls</td>
<td>Included</td>
</tr>
</tbody>
</table>

Guzman and Stern, 2016.
Out of Sample Tests of Estimated Entrepreneurial Quality

10-Fold Test of Predictive Quality of Model*
Top 1% includes 51% of growth outcomes (range: [49%, 53%])
Top 5% includes 69% of growth outcomes (range: [65%, 72%])
Top 10% includes 75% of growth outcomes (range: [70%, 79%])

*10-Fold analysis of model separates the model into 10 random samples and then uses each of those sample as a test sample. We report the average value as well as minimum and maximum (range) of such.
New Population-Level Entrepreneurship Indices

• Entrepreneurship Quality Index (EQI). *Average* estimated entrepreneurial quality within a group of start-ups:

$$EQI_{r,t} = \frac{1}{N_{r,t} \sum_{i \in \{I_{r,t}\}}^\sim}$$

• Regional Entrepreneurship Cohort Quality Index (RECPI). Expected number of growth events within a regional start-up cohort:

$$RECPI_{r,t} = EQI_{r,t} \cdot N_{r,t}$$

• Regional Ecosystem Acceleration Index (REAI). The ratio of realized vs. expected growth events in a region:

$$REAI_{r,t} = \#\text{GrowthEvents}_{r,t} / RECPI_{r,t}$$

• Attributes:
  – Panel or cross-sectional
  – Arbitrary level of granularity
  – Not necessarily geographic in scope
The Quality of Entrepreneurship in Kendall Square
Boston Case Study: Quantity vs. Quality

Number of Firms vs Entrepreneurial Potential
1998 - 2013

Number of Firms

Year


Entrepreneurial Potential (Nowcasted RECP)

Year


Kendall Square

Seaport Dist.

Route 128
Boston REAL maintained a low level during the 2000s
MOVING TO A NATIONAL ANALYSIS....
The State of American Entrepreneurship

Guzman & Stern (2016)
RECPPI / GDP:
The State of American Entrepreneurship Over Time

- RECPPI / GDP shows
  - a sharp raise in potential during the late 1990s
  - followed by a drop (but NOT a collapse) in 2001
  - and more moderate increase after the Great Recession.

- Nowcasted Index tracks closely and documents “boom” since 2010

Guzman and Stern (2016)
Regional Ecosystem Acceleration Index (REAI)

Environment has a Positive Impact on Entrepreneurship Performance

Environment has a Negative Impact on Entrepreneurship Performance

Measured Performance

Projected Performance

Guzman and Stern (2016)
Key Findings: National Level
The State of American Entrepreneurship

- The expected number of growth outcomes (think successful startups) in the U.S. relative to GDP (“U.S. RECPI”) has followed a cyclical pattern that appears sensitive to the capital market environment and overall market conditions.
  - U.S. RECPI reflects broad and well-known changes in the environment for startups, such as the dotcom boom and bust
  - Starting in 2010 there is a sharp, upward swing in the expected number of successful startups formed and the accumulation of entrepreneurial potential for growth
  - U.S. RECPI has exhibited an overarching upward trend, signaling that the state of American entrepreneurship is not imperiled by a lack of formation of high-growth-potential startups, but, instead, by other dynamics or ecosystem effects that may be inhibiting the ability of startups to.

- Relative to quantity-based measures of entrepreneurship, regional variation in entrepreneurial quality appears to hold a stronger relationship to economic growth.

- REAI (the U.S.’ ability to accelerate the growth of new businesses conditional on initial quality) has been falling since the late 1990s and only recently, and mildly, began to recover.
Potential as a Policy Tool: Subnational Level

• Provides new view of the skew of high-potential growth firms
• Enables shared evaluation of mix of IDE and SME at a more granular level
• Permits
  – Tailored analysis of each region’s IDE and SME formation
  – Development of targeted policy interventions for specific goals
  – Experimentation around selected strategies
Opportunities for Collaboration: Scaling the Implementation of Entrepreneurial Quality

- Developing real-time, quarterly metrics of entrepreneurial quality as a statistic for entrepreneurship in the U.S.
  - Report high-growth entrepreneurial activity in ways that go beyond venture capital
  - Offer complementary measure of business dynamism based on predicted growth potential
  - Inform policy as well as outlook of future of U.S. economy
- Connecting entrepreneurial quality with alternative measures of performance via LBD micro-data
  - Employment
  - Productivity
  - Lifecycle dynamics
- Extending the evidence-base for I&E program evaluation
  - Apply methodology to identify correlation between programs, interventions and design elements on growth outcomes
Opportunities for Collaboration: Applying the Methodology to Study Other Facets of I&E

• Implement predictive analytics in statistical approaches
  – Move beyond counts in multiple areas of data (e.g. research outputs, innovation outputs)

• Complement data on innovation (e.g. patents) with the entrepreneurial potential of the patent-holding entities
  – Identify startup characteristics correlated with higher probabilities of filing for/receiving a patent
  – “Nowcast” firms likely to patent in the future

• Tailor entrepreneurial quality measures to complement Science and Engineering indicators with measures of local science-based entrepreneurship
  – Map predicted entrepreneurial quality for NCSES knowledge and technology intensive industries
  – Chart formation rates and locations over time
THANK YOU!