Innovation and firm growth

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Part I

• What do we know about firm growth?
Growth rate distribution

- Little/no growth
- Fast decline
- Fast growth
“a 6-sigma event has a chance of $10^{-9}$ of occurring in the Gaussian case, whereas with the exponential form the chance is 0.0025.”

Growth rate distribution
Stanley et al, 1996

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FIG. 3 Scaled probability density $p_{\text{scal}} \equiv 2^{1/2} \sigma(s_0) p(r \mid s_0)$ as a function of the scaled growth rate $r_{\text{scal}} \equiv 2^{1/2} [r - \bar{r}(s_0)] / \sigma(s_0)$ of sales (circles). The values were rescaled using the measured values of $\bar{r}(s_0)$ and $\sigma(s_0)$. Also we show (triangles) the analogous scaled quantities for the number of employees. All the data collapse upon the universal curve $p_{\text{scal}} = \exp(- |r_{\text{scal}}|)$ (solid line) as predicted by equations (1) and (2).
Steady growth is the norm?
Growth is largely random

• “The most elementary ‘fact’ about corporate growth thrown up by econometric work on both large and small firms is that firm size follows a random walk.”

Geroski (2000: 169)
Growth paths?

Fig. 2. Growth paths of firms surviving until the end of the fifth year. $N = 2184$. Legend: white squares correspond to growth years (above-median growth) while dark squares correspond to decline years (below-median growth), for the first four growth years of each business. Frequencies are shown in each box. If there is no structure in growth rates (i.e. a purely random process), each of the 16 growth paths should occur with probability $1/16 = 6.25\%$. 
To explain growth, we need variables that change within firms over time

• “60% of the total variation in firm growth rates is within firms over time, while 40% of the total variability in firm [growth] is between firm variation.”
Part II

• What do we know about innovation?
Stylized facts on innovation

- The returns to innovation are very skewed...

Fig. 7. Present values by decile for 1990 to 1994 new drug introductions. NPV = net present value; R&D = research and development.
Stylized facts on innovation

• The returns to innovation are very skewed, with long payback times
Models of R&D investment

- **Neoclassical:**
  - Firms are infinitely rational and find the value of R&D that optimizes revenue

- **Evolutionary:**
  - Rules of thumb: X% of sales (Thompson, 1999, SCED)
  - Inertia, bounded rationality
  - Firms have many projects, they fund their favourites, some R&D projects will not be funded (Hottenrott & Peters, 2012 RES)
Uncertainty at every stage
(Mansfield et al, 1977)

• 3 stages of innovation, 3 conditional probabilities of success:
  • Probability that a project’s technical goals will be met (x)
  • Probability that, given technical success, the resulting product or process will be commercialized (y)
  • Probability that, given commercialization, the project yields a satisfactory return on investment (z)

• Overall success: $x \times y \times z$

• If a firm fails at any of these stages: costs but no benefits
Ways to measure innovation

• R&D expenditure
  – Highly persistent (Hall, Jaffe, Trajtenberg 2005 RJE)
• Patents
  – Erratic time series
• Sales new to the market (CIS)
  – Subjectively perceived
• Sales new to the firm (CIS)
  – Same as diversification?
• Product or process innovations introduced (CIS)
  – Subjectively perceived
• ‘Major innovations’ – the SPRU dataset
  – Experts from science, industry and academia were asked to identify the successful commercial introduction of new or improved products and processes (e.g. Robson & Townsend 1984, Van Reenen 1997 JLE, Geroski et al, 1997 RP)
Part III

• Linking innovation and firm growth
Innovation and firm growth

• Theoretical work and questionnaires emphasize the role of innovation for growth

• “Executives overwhelmingly say that innovation is what their companies need most for growth.”
  • McKinsey Global Survey of Business Executives (Carden, 2005:25).

• Empirical work has had little success detecting the influence of innovation on firm growth
Early evidence


- **Mixed evidence:** Freel (2000): although it is not necessarily true that ‘innovators are more likely to grow’, nevertheless ‘innovators are likely to grow more’

- **No effects:** Bottazzi et al., (2001 IJIO): no significant effect for their sample of the worldwide pharmaceutical sector
Cefis & Orsenigo, 2001 RP: p. 1157

• “Linking more explicitly the evidence on the patterns of innovation with what is known about firms growth and other aspects of corporate performance – both at the empirical and at the theoretical level – is a hard but urgent challenge for future research”
Recent evidence

- Quantile regressions to identify heterogeneous effects of innovation along the growth rate distribution
  
- Coad & Rao 2008 RP; Stam & Wennberg, 2009 SBE; Goedhuys & Sleuwaegen, 2009 SBE; Holzl, 2009 SBE; Falk, 2012 SBE; Bartelsman, Dobbelaere & Peters 2014 ICC.
Innovation and growth

- The returns to innovation are very skewed

- Firm growth rates – most firms hardly grow at all, a handful of (innovative) firms experience fast growth

Growth rate distribution
Quantile regression
Innovation and employment growth

• Are robots replacing humans?
• If anything, innovation is usually associated with employment growth at the firm-level
Innovation and employment: many substitution channels
(Spiezia & Vivarelli 2000, book chapter)

- Compensation via new machines;
- Compensation via decrease in prices;
- Compensation via new investments;
- Compensation via decrease in wages;
- Compensation via increase in incomes;
- Compensation via new products
Process innovation reduces employment requirements for a given output  
  but the growth of demand for the old products tends to overcompensate  
these displacement effects

New products do not reduce employment requirements  
  The growth of the demand for the new products is the strongest force behind  
employment creation

Reallocation due to business stealing is estimated at a maximum of one  
third of the net employment created by product innovators

The growth of employment originated from the market expansion induced  
by the new products can be as important as another third
R&D expenditure as part of the growth process

• R&D as a fixed % of sales?
• R&D workers as a share of employment?
• Profits reinvested into R&D?

• What are the causal relations?
• What is the lag structure?
Figure 6. Plot of results from VAR-LiNGAM-estimates with two time lags. Solid arrows indicate positive effects, dashed arrows negative ones. Thick lines correspond to strong effects, thin ones to weak effects.
Yollies
(Veugelers & Cincera, 2010 BPB)

• ‘Yollies’ are Young Leading Innovators
• Young large firms (e.g. Amgen, Cisco, Google, Microsoft, Qualcomm and Sun)
• Page 5: “Almost all of the explanation for the lower R&D intensity of EU yollies can be found in a different sectoral composition”
‘True’ entrepreneurship

- Dennis (2011, JSBM, p99) defines entrepreneurship in terms of being innovative - "entrepreneurship, by definition, is innovative."
- Henreksson (2005: p439) and Reynolds et al (2005 p223) define entrepreneurship in terms of subjective growth ambitions
- Bottazzi & Da Rin (2002, EP, p235) and Avnimelech & Teubal (2006 RP; p1477) confine 'start-ups' to high-tech industries
- Audretsch (2007, p65) writes that "entrepreneurship is the missing link between investments in new knowledge and economic growth."

- The ideal-type or template for an entrepreneurial firm is to be innovative, more likely to be found in high-tech sectors, and also to grow fast
HGFs not over-represented in high-tech sectors

• Henrekson and Johansson (2010, SBE): HGFs are not over-represented in high-tech sectors.

• “A key assumption amongst policy-makers is that high growth firms (HGFs) are dominated by TBFs. [Technology Based Firms] ... The reality is that the representation of technology based firms in the population of HGFs is on a par with their proportion in the economy – and some studies suggest that they may even be under-represented.”

  • Mason and Brown (2012, p2) Report on high-tech HGFs in Scotland

• Daunfeldt, Elert, Johansson (2014, this conference): Swedish HGFs are less frequent in high-R&D sectors
Innovation and HGFs: resolving the paradox

- Innovation is crucially important for HGFs
- HGFs slightly *under*-represented in high-tech sectors
Innovation and HGFs: resolving the paradox

• Innovation is crucially important for HGFs
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• More innovative within sectors?
  – IKEA, Walmart, Starbucks, etc. in low-tech sectors
Walmart  
(Basker, 2007 JEP)

- p179: “By all accounts, technology and scale are at the core of Wal-Mart's advantage over its rivals. ... Wal-Mart's technological edge is in its logistics, distribution, and inventory control.”
- p191: “other chain retailers have either explicitly emulated Wal-Mart or, more broadly, changed their practices in ways that reflect Wal-Mart's influence: Target's vice chairman is quoted as saying that Target is ‘the world's premier student of Wal-Mart’”
Future research

• Growth trigger points? (E.g. diversification, internationalization)

• What is the most effective policy target: HGFs, declining firms, ‘trundlers’, or “sleeping gazelles” (Bornhall, Daunfeldt & Rudholm 2013)?

• Seek variables that vary within firms over time

• Test whether growing firms follow rules of thumb (e.g. R&D as X% of sales)