

A taxonomy of small firm technology commercialization

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How do small, high-tech firms whose *raison d'être* is an innovative technology choose to commercialize?

- Key theoretical issues:
 - Intellectual property protection – (*Teece school*)
 - Without it, firm has very few options
 - With it, firm can choose to go alone or collaborate with large firms
 - Complementary assets
 - Small firms most often lack everything needed to commercialize a product
 - Markets for Technology (*Arora, Fosfuri, Gambardella*)
 - Increasingly prevalent
- Conclusion:
 - Small firms will be ideas traders, if they have IP

Answer: a 7 category taxonomy

- We examined small firms with super strong IP and find it is not so simple
- We paid attention to product vs ideas trading
- We found:
 - Three types of “pure play” ideas traders (in line with theory)
 - Three types of product suppliers, also using ideas trading
 - One type of pure product supplier (no need for complementary assets)

Identifying high tech small firms with super strong IP

- **small firms**
 - 500 or fewer employees
 - independent - all establishments and subsidiaries were unified to the ultimate parent company; their patents counted towards the parent firm patent count.
 - for-profit
 - not bankrupt
 - not a joint venture
 - not foreign owned during the first half of 2003 when the data were collected.
- **sustained, public record of successful technical advance.**
 - Patents used to establish the public record of a firm's innovation.
 - U.S. firms with 15 or more USPTO patents issued 1998-2002.
- **407 firms in the analysis**
 - By the summer of 2006 when this analysis was conducted, 407 firms remained independent and not bankrupt and had viable websites.

Lead sectors and number of firms

Industrial Sector	# firms
Biotechnology	41
Semiconductor and related components	34
Pharmaceutical and Medicine Manufacturing	34
Medical equipment	23
Software and related business services	17
Unique engineering, consulting, products	17
Imaging and display	13
Medical electronics	12
Semiconductor and electronics machinery	8
Wireless and mobile communication systems	8
Optical components	7
Surgical and medical instruments	7
Tissue engineering, regenerative medicine	7
Plastics	6
Material Handling Equipment Manufacturing	6
Miscellaneous and medical devices	6
Battery and cell related	6

Using factor analysis to develop a taxonomy

- Reading of 80 websites informed by theory and literature to propose a list of keywords related to firm technology commercialization strategy.
- Frequency of all keywords on all firm websites obtained using Google and an algorithm
- Factor analysis conducted to study the patterns of keyword use (observed dependent variables) with the goal of discovering something about the nature of firm business models (unobserved independent variables).
- Set of matched control firms identified using Hoovers. Same keyword search and factor analysis
- Factor analysis of serial innovator firms converged to solution. Factor analysis of control firms did not.

Taxonomy of small firm technology commercialization strategy

Pure play ideas traders:

1. Development stage biosciences
2. R&D organization or contractor
3. Service solutions provider (technical consultants)

Product/ideas trading mix:

4. Product solutions provider
5. Highly specialized component supplier (high volume production)
6. Specialized subcontractor firm (one-offs or very low volume production)

Pure product (no need for complementary assets):

7. Consumer goods supplier – *not identified*

1 - Development stage biosciences

- **Description**
 - A small “development stage” firm in biosciences with a “pipeline” though perhaps no actual products at present. Often no revenue and no commercialization though often firms are public.
- **Product trading**
 - No
- **Ideas/technology trading**
 - a pure play ideas trader that identifies itself as a product firm.
 - consulting, R&D may generate revenue
- **Exemplar**
 - biopharmaceutical company focused on the development of monoclonal, antibody-based products for the targeted treatment of cancer, autoimmune and other serious diseases
- **Factor analysis**
 - 11.02% of variation in sample
 - **Keywords (correlation coefficient):** research (0.79) [R&D OR research and development (0.76), research and development AND company (0.75), research and development AND organization (0.58)], clinical trial (0.70), novel (0.74), discovery (0.69), professor (0.60), collaboration OR collaborating (0.71), pipeline (0.63), university OR universities (0.57), expertise (0.56), commercialize AND research (0.59), FDA (0.48), proprietary (0.47)

2 -R&D organization or contractor

- **Description**
 - A very small firm employing PhD's, MD's and masters degree holders, deep expertise in narrow research areas in which they conduct basic/applied research with a commercial orientation. Sells prototypes, patents, or novel production processes and tacit know-how.
- **Product trading**
 - any products will be produced by licensees
- **Ideas/technology trading**
 - a pure play ideas trader selling R&D services
- **Exemplar**
 - earth science, remote sensing, systems development, information technology, and environmental - science and technology support services to federal, state, and local governments and industry
 - electronic lab notebook and execution and analysis software, lab automation and breakthrough materials technology
- **Factor analysis**
 - 5.52% of variation in sample
 - **Keywords (correlation coefficient):** R&D AND Testing (0.93), contract AND research (0.81), technology development (0.72), contract OR subcontract (0.49), consulting (0.59), research AND testing (0.55), machines OR machining (0.45)

3 -Service solutions provider (technical consultants)

- **Description**
 - A firm that tailors a service to the needs of large customers, including software development that addresses a particular business need
- **Product trading**
 - software
- **Ideas/technology trading**
 - a pure play, though software could be considered a product, expertise is sold as a service
- **Exemplar**
 - chip design services for wafer foundries,
 - multi-antenna signal processing software for wireless base stations to improve coverage, client data rates and capacity
- **Factor analysis**
 - 4.58% of variation in sample
 - **Keywords (correlation coefficient):** integration (0.61), solution (0.49), enabling (0.64), consulting (0.63), module OR modular (0.62), government (0.42), provider (0.56)

4 -Product solutions provider

- **Description**
 - Firm's technology augments the process of customers working from a different technology base. Firm develops a turnkey solution.
- **Product trading**
 - a device
- **Ideas/technology trading**
 - integration consulting, training
- **Exemplar**
 - grinding tools, prime wafer polishing systems, precision surfacing solutions to the semiconductor, telecommunications and precision optics industries;
 - CNC router systems (advanced software, the machine, machine options, tooling, ongoing support and training) sold to woodworking, plastics and aerospace
 - optical process control sensors and inspection systems for the electronics industry
 - equipment to produce premium high quality eyeglass lenses on site, on demand
 - medical devices
- **Factor analysis**
 - 4.89% of variation in sample
 - **Keywords (correlation coefficient):** capability (0.51), product AND performance (0.55), solution (0.57) [(system AND integration) OR (system AND solution) (0.65), total AND solution (0.70)], cost AND effective (0.54)

5 - Highly specialized component supplier (high volume production)

- **Description**
 - Firm's technology augments customer's product and is encapsulated in discrete parts incorporated within systemic products of medium to high complexity (e.g. car, TV set, scientific instruments etc)..
- **Product trading**
 - component embodies technological expertise
- **Ideas/technology trading**
 - co-design
- **Exemplar**
 - fluidic effect windshield washer nozzle
 - injection molded closures
 - crosslinked polyethylene packaging used for packaging, oil absorption and sound absorption
 - laptop touchpads
 - constant force lift-and-pivot motion technology embedded in stands and mounts of flat screens
- **Factor analysis**
 - 4.43% of variation in sample
 - **Keywords (correlation coefficient):** assembly (0.41), accessories(0.41), contract OR subcontract (0.61), improve (0.54), OEM (0.59), unmatched (0.41), maintenance (0.66)

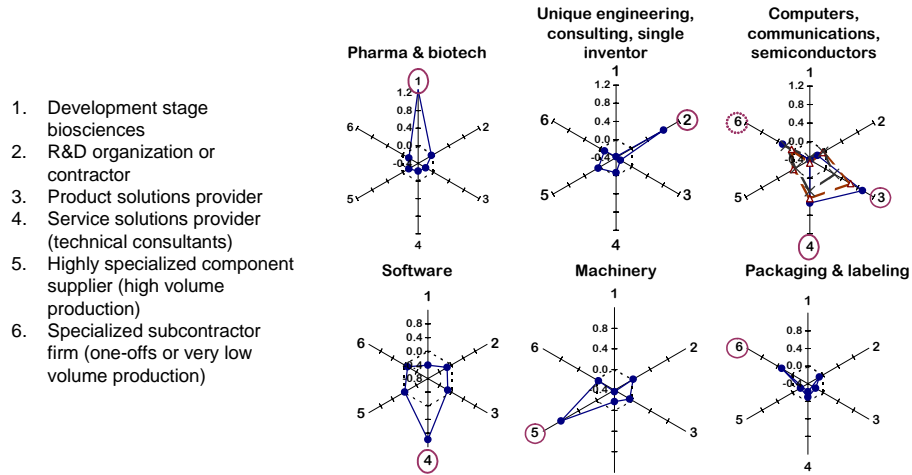
6 - Specialized subcontractor firm (one-offs or very low volume production)

- **Description**
 - Small firms that excel in very specialized technologies for which applications need to be customized and integrated in often highly complex integrated products
- **Exemplar**
 - large-scale outdoor lighting systems
 - cockpit displays, avionics
 - base stations for wireless system networks
 - sophisticated building management systems for integration in intelligent buildings
- **Factor analysis**
 - 3.88% of variation in sample
 - **Keywords (correlation coefficient):** integrated (0.65), custom (0.64), efficiency (0.58), component (0.54)

Consumer goods supplier (not captured in factor analysis)

- **Description**
 - Typically a small firm that develops and often manufactures niche consumer products.
- **Product trading**
 - probably high end products differentiated on quality and performance
- **Ideas/technology trading**
 - no
- **Exemplar**
 - children's product:, cribs, bassinets, bouncers, swings, and juvenile furniture.
 - barbeque sets, coffeemakers
 - sporting goods such as ski equipment, mountaineering gear

Sector loading on factors



Summary: the taxonomy

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