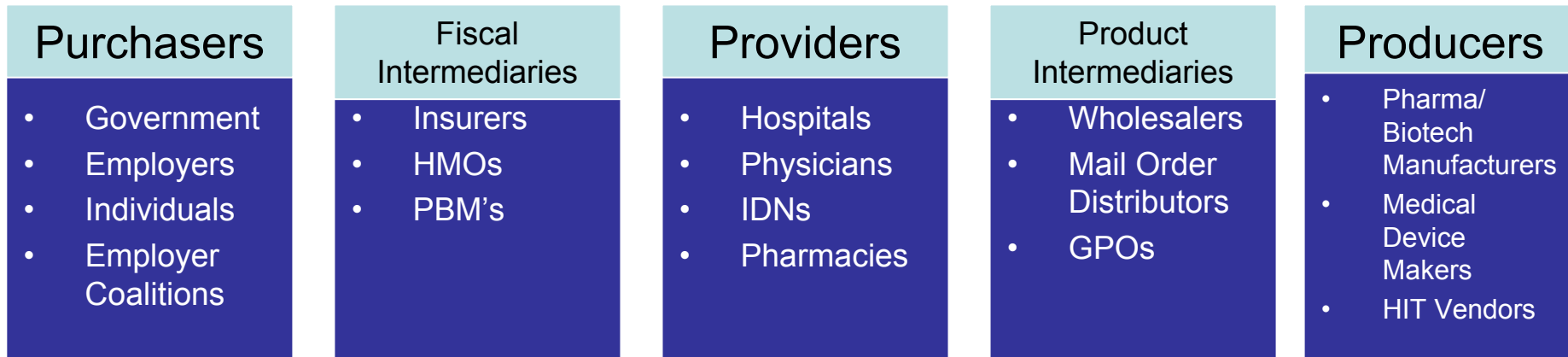


Predictors of Liquidity Events in U.S. Medical Device Companies

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Health Care Value Chain



Source: Burns (2002)

- Within the health care value chain, money flows from left to right and innovation flows from right to left
- Health care management/strategy attempts to explain how firms on the right-hand side create “competitive advantage”

Introduction to Medical Device Companies

- “Medical device firms design, develop, produce, market and sell equipment, supplies and services for the detection, diagnosis, treatment and prevention of disease” (Burns, 2002)
- Medical devices account for approximately 4.67% of national health expenditures and 0.61% of GDP (Burns, 2002)

Table 1: Medical Product Shipments Data (1999)

PRODUCT DESCRIPTION	SHIPMENTS (billions)
Surgical and Medical Instruments and Apparatus	21.355
Orthopedic, Prosthetic, and Surgical Appliances and Supplies	19.242
X-Ray Apparatus and Tubes and Related Irradiation Apparatus	4.069
Electromedical and Electrotherapeutic Apparatus	11.871
Total Shipments	56.537

Research Question & Background

- **Research Question:** What factors affect the entry, growth and success of medical device firms (with special emphasis on small and start-up firms)?
- **Factors affecting market entry:**
 - Access to human resources and the capability to staff for growth (Cardon, 2003).
 - Financial capital a firm currently holds or is able to acquire (Cooper et. Al., 2001).
 - New venture's geographic location (Gilbert, McDougall, Audretsch, 2006).
 - The level of competition within an industry (Baum, Locke, Smith, 2001).
- **Factors affecting market exit:**
 - Firm size: Exiting firms are generally smaller than survivors (Dunne, Roberts, Samuelson, 1988).
 - Longevity: New firms are responsible for the majority of exits (Dunne, Roberts, Samuelson, 1988).
 - Industry concentration: Competition increases the probability of firm mortality (Baum and Singh, 1993).
 - A high entry rate tends to be correlated with a high exit rate (Dunne, Roberts, Samuelson, 1988).

Methodology

- This project will initially study firm exit from venture capital markets
 - Exit is more easily modeled because the unit of observation is an individual firm.
 - Entry requires us to model data at the industry level
- We hope to highlight the relationships between each company's characteristics and its method of exit
- For the purpose of our study, there are two different kinds of exit:
 - “Good exit” occurs when a company has an initial public offering (IPO)
 - “Bad exit” occurs when a company goes bankrupt or becomes defunct
 - Mergers and acquisitions will be considered “good exits” but may also include companies selling off their assets
- Survival analysis models are typically used to represent organizational or individual mortality
 - By modeling “good exits” and “bad exits” separately, we can compare the coefficients produced by each model (should have opposite signs)

Data Sources

- The data for this inquiry was collected from the VentureXpert database
 - VentureXpert database includes data on all start-ups that solicit venture capital financing
- The data was collected from the following industry codes:
 - 5200: Medical Therapeutics (35 companies)
 - 5210: Therapeutic Services (116 companies)
 - 5220: Surgical Instrumentation and Equipment (333 companies)
 - 5221: Surgical Lasers (16 companies)
 - 5230: Pacemakers and Artificial Organs (88 companies)
 - 5240: Drug Delivery and Other Equipment (153 companies)

Total: 742 Companies

Data Elements

- Company Summary:
 - Company status, entry/exit dates, location, industry, business description
- Firms and Funds:
 - Names of investing funds and listing of investment history
- Executives:
 - Listing of executives, board members, and former employees
- Investment Rounds:
 - More detailed description of company's investment history
- Exit:
 - Date and nature of firm exit
- Mergers and Acquisitions:
 - Company's history of mergers and acquisitions (as target and acquirer)

Constructs

- Company Characteristics:
 - Geographic location (proximity to a “hot spot”)
 - Level of competition (industry concentration)
 - Company size (number of employees)
- Merger & Acquisition Activity (as acquirer)
 - Total number of acquisitions
 - Average value of acquisition for each company
- Internal Human Capital:
 - Type and amount of experience (executive, board member, former employee)
 - Related versus unrelated experience (industry type)
- External Human Capital (VC):
 - Amount of experience (by financing round)
 - Related versus unrelated experience (industry type)
- Financial Capital:
 - Number of financing rounds
 - Number of investors and repeat investors
 - Money raised

Explanatory Variables

Variable	Description
Company Characteristics	
HotSpotDummy	Dummy variable identifying whether the medical device company is located in one of seven observed "hot spots" (San Diego, San Francisco/Bay Area, Orange County, Los Angeles Area, Philadelphia, Minneapolis/St. Paul, Boston)
IndustryCodeDummy	Dummy variable representing one of the six industry codes listed for each company (5200, 5210, 5220, 5221, 5230, 5240)
CompanySize	A measure of the total number of employees each company lists
Merger & Acquisition Activity	
NumMAs	The total number of times a medical device company acquires another company
AvgMAValue	Average value of acquisition for each medical device company
Internal Human Capital	
ExecutiveExperience	Total number of times a medical device company's affiliates have been executives within our data set
BoardMemberExperience	Total number of times a medical device company's affiliates have been board members within our data set
FormerEmployeeExperience	Total number of times a medical device company's affiliates have been former employees within our data set

Explanatory Variables (cont.)

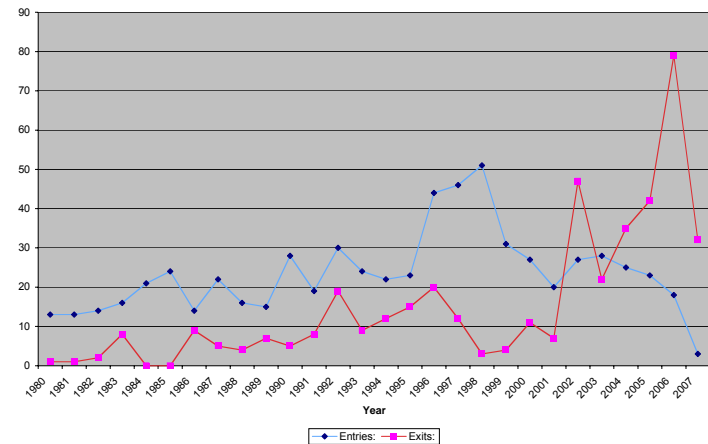
Variable	Description
External Human Capital	
VCRelatedExperience	Total number of times a medical device company's venture capital investors have invested in a company in a related industry
VCUnrelatedExperience	Total number of times a company's venture capital investors have invested in a company in an unrelated industry
Financial Capital	
NumberFinancingRounds	Total number of investment rounds a medical device company experiences
NumberInvestors	Total number of distinct venture capital firms investing in each medical device company
AvgVCParticipation	The average number of times a venture capital firm invests in a specific medical technology company
AvgRoundAmount	The average value of financing rounds for each company

Entry/Exit Statistics

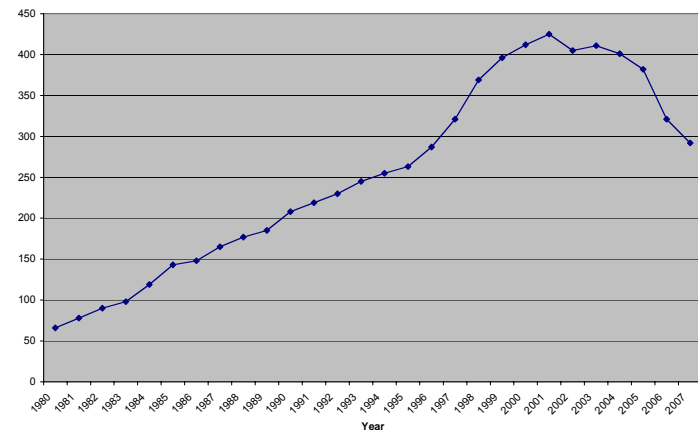
Table 2: Exit Type and Frequency

Category	Exit Type	Companies
Non-Exit	Active Investment	319
Good Exit	Acquisition	185
	Merger	6
	Went Public	170
	In Registration	4
	Leveraged Buyout (LBO)	3
Bad Exit	Defunct	48
	Bankruptcy - Chapter 7	3
	Bankruptcy - Chapter 11	3
Other Exit	Other	1
	Blank	2
Total		744

Firm Entries and Exits



Total Firms



Empirical Model

- To estimate adoption rates with censored data, we can use a Cox proportional hazard model
 - Avoids the need to choose a functional form
 - Accommodates time-varying covariates
 - Baseline hazard function, $\lambda_0(t)$, is left unspecified
- Takes the form: $h_i(t) = \lambda_0(t)e^{\beta x_i}$
- Proportional hazard takes the ratio of hazards:

$$L_1 = \frac{e^{\beta x_1}}{e^{\beta x_1} + e^{\beta x_2} + \dots + e^{\beta x_{10}}}$$

- Only the order of events affects partial likelihood

Results

Variable	Good Exit		Bad Exit	
	Coefficient	Standard Error	Coefficient	Standard Error
CompanySize	-0.005	-0.25	-0.068	-0.64
NumMAs	0.057	(4.33)**	0.219	-1.73
AvgMAValue	-0.002	-0.88	-0.906	-1.26
ExecutiveExperience	0.031	-1.39	-0.133	-1.09
BoardMemberExperience	-0.020	1.74	-1.310	(2.21)*
FormerEmployeeExperience	0.006	-0.26	0.138	-1.51
VCRelatedExperience	0.001	-1.44	0.004	-1.37
VCUnrelatedExperience	0.000	-0.22	-0.003	-1.36
NumberOfFinancingRounds	0.099	(2.62)**	0.073	-0.69
NumberInvestors	-0.008	-0.47	0.054	-0.77
AvgVCParticipation	-0.273	(2.38)*	0.025	-0.11
AvgRoundAmount	-0.005	-0.68	-0.040	-0.77

*Indicates significance at the 0.05 level

** Indicates significance at the 0.01 level

Discussion

- **Merger and Acquisition Activity**
 - More merger and acquisition activity is associated with higher probability of good exit
- **Financial Capital**
 - Higher number of financing rounds is associated with higher probability of good exit
 - More repeat investors are associated with a lower probability of good exit
 - Suggests that companies want to draw funding from a large number of disparate sources
- **Internal Human Capital**
 - More board member experience is associated with lower probability of bad exit

Limitations

- Our data set is limited because of time-constraints we faced this summer
 - We have limited data on venture capital firms, their non-device experience, and their involvement on the board of medical device companies they've invested in
- There are some endogeneity issues surrounding the relationship between venture capital financing and a company's probability of success
 - Are medical device companies able to raise money because they have a good idea or are companies successful because they're able to raise enough money?
- All of our explanatory variables are time-invariant
 - Variables representing experience, M&A activity, and financial capital should increase with time as employees/firms gain more experience.
- Our measures of experience are somewhat incomplete
 - Our measures would ideally measure experience with successful/unsuccessful companies as well as VC firm experience with different stages of financing

Next Steps

- There are several additional pieces of data that we would like to collect:
 - Our sample could include an additional 1,631 companies from the medical devices and biotechnology industry subgroups
 - More detailed data on company executives would allow us to conduct a more in-depth exploration of the value of experience
 - Collecting detailed data on venture capital firms would allow for a more thorough understanding of their investment practices
- While this study is focused on exit, we are primarily interested in market entry and hope to model entry in a future study
 - We are ultimately interested in assessing whether there are inter-related patterns of entry/exit and funding across industries (medical device vs. biotech)

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