The Impact of Angel Investors on Founders of New Ventures in the Medical Technology Industry

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Dedications

To my family, unyielding in their support of my extensive (and long-running) graduate educational endeavors... and equally unyielding in their quickness to knock me down a notch if the MIT-Harvard dual-degree nerd in me threatened to escape.

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The author has no conflicts to disclose with any of the data sources or companies included in this paper.

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ABSTRACT

Founders of new ventures in the medical technology (Medtech) industry require capital to establish, sustain, and grow their companies. Most founders must seek some form of external capital to meet these demands; in Medtech, the most well-known and prestigious of these is venture capital (VC). However, another type, angel investors, may be as important as VCs. Angels are accredited investors that invest their own money directly in new ventures. Founders of new Medtech ventures may choose to seek capital from angel investors in addition to, or instead of, venture capitalists. Unfortunately, there is little research available on outcomes for founders and their firms when angel investors are involved. Like VCs, angels seek financial returns from their investments; however, there may be additional and different motivations at play that make angels willing to grant more friendly terms to founders. As a result, it may actually be advantageous for founders to seek capital from angel investors.

This paper addresses the question of whether founders of new ventures in the Medtech industry have better outcomes in terms of ownership and control of the company when one or more investment rounds involve angel investors in addition to, or in place of, VCs. Ownership is measured by the amount of equity owned just prior to an IPO, and control by the presence of founders as employees or directors at the time of the IPO. Analyzing S-1s from the last 10 years of initial public offerings (IPOs), a dataset was constructed that comprised the shareholders of the 63 Medtech companies that experienced an IPO between 2001 and 2010. Of these, 18 companies had some presence of angel ownership that could be gleaned from the S-1; of those, 12 had at least a 5% stake belonging to angels.

Results presented in the paper show, for the first time, those founders of Medtech firms with angel investors as shareholders at the time of IPO have significantly greater ownership of shares and significantly greater control of the firm as an employee or director than founders of firms without angels present. Angel-backed firms required less investment capital and no more time to reach the IPO, and, importantly, did not suffer with respect to the overall valuation of the firm. On the contrary, there was a trend of firms – and founders themselves – seeming to benefit from a valuation perspective, and significantly better from a multiple perspective, when angel investors were present. Even when firms received backing from venture capitalists, angel investor involvement also seemed to generally improve the performance of the firm and of the founders along the measured dimensions.

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Introduction

For founders of new ventures in the medical technology (Medtech) industry, the ability to find and secure outside capital is often one of the most crucial activities, especially early on. Many new ventures in Medtech are based on ideas from physicians or patents from academic inventors that are unproven and require significant investment to be fully realized into new products and therapies. Even before that, founders that attempt to license patents from universities or hospitals may find that their efforts are rebuffed if they are unable to demonstrate that they have access to the necessary financing from the outset. Rarely, these founders are able to self-finance their companies with their own money, or are able to develop a product or service that generates sufficient revenue to bootstrap the growth of the company internally. Most often, entrepreneurs must turn to external sources of capital investment. There are several types of external capital "available" to founders of new ventures, including government or foundation grants, friends or family members, angel investors, venture capitalists, strategic or financial investors, public equity markets, and bank loans. The focus of this paper will be on a relatively under-explored group, angel investors, and their interactions with founders of new ventures in the medical technology industry.

Angel investors are individuals who invest their personal funds directly in new ventures. In aggregate, as a class of capital, they provide new ventures in the United States (US) with a significant source of external funding. In 2010, angel investors furnished US new ventures with over $20B (1). In contrast, perhaps the most prominent and sought after source of external funding, institutional venture capital (VC), provided US new ventures with $23B in 2010 (2). In the Medtech industry, the comparison is even more interesting – angel investors provided more capital to new ventures in medical devices and healthcare services in all but one of the last nine years. In 2010, the gap between total angel and VC investments was over $3.3B[1]. Despite the amount of overall capital provided, the money from angel investors is spread over a significantly greater number of new ventures and, thus, the average size of the deals is much smaller. This may be one reason why Medtech founders – anticipating significant capital needs – tend to seek money from VCs. But is this the optimal strategy? Given a choice, should founders consider investments from angel investors, or do these early, smaller, dilutive deals fail to create the same value as other sources of capital?

[1] Comparison is calculated using data from the UNH Center for Venture Research 2010 Research Report on Angel Investing (http://wsbe.unh.edu/cvr) and the PwC MoneyTree™ Report (https://www.pwcmoneytree.com/).

Some literature exists discussing the differences between angel investors and venture capitalists, including investor motivations and deal terms, and how entrepreneurs think about sources of external capital. However, there are two significant gaps in this literature. First, there is very little, if any, research that has been conducted with a specific emphasis on founders in the medical technology industry. Second, most of the research that looks at outcomes for new ventures with angel investors is based on either hypothetical models or survey data. This is not surprising, since angel investors are independent individuals generally answering only to themselves and any data (if it exists) is spread over thousands of people. As angel investing activity evolves, some are starting to organize into groups, but this is a recent phenomenon and recordkeeping may be of variable quality.

This paper is an attempt to address both of the literature gaps through an analysis of publicly disclosed records of Medtech firms that have experienced an initial public offering (IPO). These records will be mined to create a dataset that can be used to evaluate the main hypothesis: Founders of new ventures in the medical technology industry experience better outcomes in terms of ownership and control of the company when one or more investment rounds include angel investors in addition to, or in place of, venture capitalists. Ownership will be measured as the amount of equity owned just prior to an IPO, and control as the presence of founders as employees or directors at the time of the IPO. These two key research aims will be assessed by segmenting and comparing those companies with angels present at the time of IPO and those without angels present. Additional analysis will compare the value of the equity in the company, the amount of invested capital, and the time to reach an IPO when angels are involved, in order to understand whether any differences in ownership or control come with compromises in terms of the valuation or the performance of the company. The firms in the dataset will be further divided into subgroups to understand whether the mix of investors – namely, angel investors and venture capitalists (VCs) – has an impact on the analysis. These results are intended to shed light on the financing decisions all founders face, and to provide a clue as to the impact the various funding sources, especially angel investors, may have on new ventures.

Background

The medical technology (Medtech) industry in the United States has, by most any measure, been very successful in creating and commercializing new products for the treatment of disease. Aside from the significant economic impact, according to the Medtech industry's trade group, AdvaMed, between 1980 and 2000 the Medtech industry was, in part, credited with tangible results in the improvement of healthcare patient outcomes in the US, including:

- a 15% decrease in annual mortality;
- a 25% decline in disability rates;
- a 56% decrease in the number of hospital days;
- and a 3.2 year increase in life expectancy (3).

New ventures are an essential part of the lifecycle of innovation in the $140B Medtech industry. Half of the companies employ fewer than 20 employees and nearly three quarters are considered small or medium-sized enterprises (4). While there is are a small number of very large companies responsible for much of the revenues and research and development (R&D) investment, smaller firms still generate almost 30% of the industry's R&D spend. Many of the biggest Medtech companies, among them Johnson & Johnson, Medtronic, Boston Scientific and Covidien, rely on acquisitions of these small companies as an external source to supplement their own internal product development efforts.

One reason new ventures are so prevalent in Medtech stems from the source of new product ideas. Innovations in Medtech are frequently the result of individual practitioners, often in collaboration with engineers, trying to address an unmet clinical need that they personally experience. In one analysis, 99 of the top 100 Medtronic products (in 2008) were originated by physicians (5). Importantly, new ventures are often the vehicle that takes a concept from a physician or a patent from an academic inventor and transforms it into a technology, a product, or, in some cases, an entirely new market. At first glance, this may seem counter-intuitive. Large companies are able to develop large, capital intensive projects and are generally very adept at broad market launches. They are usually better equipped to provide the necessary support to develop a novel product beyond the clinical proof of concept stage, and thus often target acquisitions of small companies just reaching this point. Large companies have the resources, personnel, and contacts to engage many physicians at once, and should be well-positioned to take advantage of any innovative ideas. And, sometimes, this does occur. On the other hand large companies get hundreds or thousands of invention disclosures from both internal and

external sources each year, and it can be difficult at the idea stage to distinguish significant breakthroughs from trivial suggestions. In addition, some large companies are organized to rapidly develop incremental improvements on existing products rather than exploit new technologies that may disrupt a lucrative, established market. Moreover, struggles in large companies to identify the next big market can be due to the same customer focus that appears to support the ability to innovate – disruptive innovations may be ideas that the current customer group is unable to conceptualize or support at the time (6).

In many cases, it falls to individuals to collaborate to solve an unmet clinical need, and then to organize new ventures around these collaborations. These new ventures are critical because they are willing to undertake the process of building a company when the underpinning ideas or inventions are at their riskiest and most unproven. In most cases, patents have not even been granted at the time of the founding. For a large company, weighing the value of a new idea against many other competing opportunities in order to make an investment decision is extremely difficult. In a new venture, the value of an idea is more about the potential value creation than the dollars diverted from other sources, and thus exploiting it in this environment is much more feasible. In addition, the dedicated focus afforded to the idea in a new venture is often much more conducive to advancing its development. In particular, it seems innovations that target brand new markets, technologies, or customers are best developed outside of a large company (7). The tight-knit, interdisciplinary teams present in many new Medtech ventures, and the direct connection between an employee's effort, results, and rewards that can only exist in a small company, combine to provide the ideal setting for a new technology to blossom.

Founders of these ventures take many forms, including physicians, academic scientists, first-time or serial entrepreneurs, and current or former investors[2]. Despite their differences, many founders face a common set of challenges in bringing a new medical technology to market. At the outset, key factors in evaluating the potential of a new Medtech venture include the clinical need for the technology, the path to regulatory approval, whether it is covered under healthcare benefits and payment systems, how much marketing will be required, the strength of the intellectual property (IP), and the trade-offs between therapeutic benefit, safety risks, and cost-saving opportunities (8). When the inventor is a physician or an academic scientist, one the first issues is working out what role – if any – that individual plays in the new venture (9). The next important step is securing access to the crucial intellectual

[2] Review of founders of companies included in the dataset generated for this paper.

property or, if the founder is the inventor, protecting and developing the IP portfolio. New ventures must then work to formulate and execute, often in parallel, strategies for refining the technology into a viable product, for demonstrating the clinical and business value of the technology, for securing regulatory and reimbursement decisions, and for developing appropriate manufacturing processes and quality systems and controls. While technology and manufacturing process development are not unique to Medtech new ventures, the regulatory and reimbursement processes are, and the level of scrutiny of the quality systems is also beyond that of most other industries (10; 11; 12). Underpinning all of these activities and decisions is the uncertainty of whether the technology, or the venture itself, is going to be viable – many key decisions may be based on not much more than educated guesses. The better new ventures are at evaluating and executing these plans, the more uncertainty they can remove and the more value they are able to create around their technologies (13).

The specific activities required to bring a new medical technology to market are complex, time-consuming, and expensive. In a new venture, most activities require direct investment, and all activities require indirect investment in terms of the consumption of capital as overhead over time (measured as burn rate) (14). For example, in medical devices, the two most common routes of regulatory approval are the 510(k) pathway (substantial equivalence to a predicate device) or the PMA pathway (pre-market authorization; a longer, more intensive approval process) (10). According to a recent survey of over 200 medical technology companies, the average cost to bring a 510(k) product from concept to market was $31 million, including $24 million spent on FDA-dependent or related activities (15). The average cost for a more complicated and risky PMA product was $94 million, including $75 million linked to regulatory activities. These costs may not accurately reflect those of a new venture since they may include estimates from large companies with significant overhead, but they do provide one estimate of the amount of investment needed to bring new medical technologies to market. Even when the goal may not be to get the product all the way to market, but rather to prove the clinical utility to a potential strategic partner, the investment can be significant. One estimate by a VC placed the cost of generating the needed clinical data at $20 million (16). Perhaps the best estimate for a new founder is to look at the historical amounts of capital needed to reach any exit (either an acquisition or an IPO) for a new venture in Medtech. In the ten years between 2001 and 2010 (the period of time covered by the dataset in this paper), the median amount of capital invested to the point of exit ranged between a low of $27 million and a high of $64 million (17).

Given the expenditures associated with bringing new medical technologies to market, perhaps the single most important challenge faced by all founders in the Medtech industry is how to fund their ventures. Without a revenue source, all critical activities must be financed with external capital. Access to capital, in fact, may be a crucial determinant of whether a potential founder is even able to get a new venture started and is a key determinant of failure (18; 19). For example, if a founder requires a license from an academic institution or a hospital, one of the factors that those offices consider when deciding whether to license to a potential founder is whether that individual can demonstrate access to appropriate sources and amounts of capital to ensure that a license is fully exploited and does not suffer from under-exploitation (20). Access to capital is not a foregone conclusion, either; one estimate placed the proportion of companies seeking venture capital that actually receive it to be around 2% (21). While the estimate may be low, it is safe to say that a large number of would-be founders never find the money they need to get their new ventures off the ground. An early and crucial decision for most founders, then, is to consider the various sources of capital available to them.

The sources that a founder may consider vary widely in terms of the amount of capital available, the terms (financial and otherwise) accompanying the capital, the non-financial value that a founder may realize, and the "price" that must be paid for the investment in terms of dilution to the founders' ownership. Although this paper focuses mainly on angel capital (and its contrast to venture capital), a brief survey of the various sources is presented here for comparison.

Retained Earnings

If a new venture is lucky enough to be profitable at the outset, the cash flows coming into the firm may be saved and reinvested into the business with no dilution to the owners. This capital can be used for funding operations and, to a lesser extent, growth of the enterprise. Financing through retained earnings allows a founder to avoid or delay the need to secure external funds. However, many new companies (not to mention companies in very capital-intensive industries) often find that, even if they are profitable, their expenditures quickly outpace their earnings, and they need to turn to outside capital to finance their growth. This is usually the case in the Medtech industry, with capital required upfront to secure product approval before any sales can be consummated. However, rarely, a company will generate early revenues or profits from licensing a technology into other (non-medical) fields or from providing services as they develop their own products.

Founder

Nearly all new ventures require some investment of capital from the founder(s) of the venture. In rare cases, capital from the founder may provide the bulk of the required financing. More typically, founders invest their own money (and frequently borrow from banks and credit card companies) in order to develop an idea or technology to the point at which they can begin to attract other people and investors to the venture. A 2000 survey with responses from 131 small businesses suggests that, while many ventures begin with less than $20,000 from the founder, nearly 40% required more than $50,000 and 15% had over $200,000 invested by the founder (18). As significant a sum as this seems, it might only be 1% or less of the total capital required to bring a new medical technology to market (or even to catch the eye of a strategic partner). Therefore, all but the wealthiest founders quickly look beyond their own savings for funds. Seeking external capital can be a positive step, however, as it can help a founder validate and refine the business concept through discussions with potential investors, as well as begin to professionalize the venture (22). Nevertheless, outside investors do like to see founders commit by putting their own resources at risk in the new venture.

Friends and Family

For many founders, the first stop is with friends and family (as a group, sometimes termed Friends, Family, and Fools, FFF) (23). This group may be easier to convince of the merits of the founders' ideas since they are probably, relatively speaking, less savvy than most of the other sources of capital discussed. In addition, it is generally likely that the founder will suffer less dilution and will be able to maintain full control of the venture, in contrast with other potential investors that may demand more equity or representation (24). However, this is balanced by the fact that most founders will not be able to raise significant amounts of money from friends and family (23).

Community, State, and Federal Grants

The biggest source of funding for biomedical research from any level of government is the National Institutes of Health (NIH), which provides over a quarter (greater than $30B annually) of US biomedical research funding (25; 26). While the bulk goes to academic and medical researchers, new ventures can access federal money through research grants to principal investigators working for (or with) the company. More typically, new ventures can get government grants through the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, which together award $2B annually to small high-tech businesses (27). The SBIR/STTR programs are

structured into Phase I (~$250,000 per grant) and Phase II (up to $1M) stages, with application processes for each. Funds from these federal sources are grants, which mean they are a source of non-dilutive capital to founders. In additional to federal funds (which can also include Department of Defense grants and other sources), states may also provide grants to start-ups or biomedical researchers. States and cities have, in some cases, also set up incubators designed to support entrepreneurial activities for regional economic development.

Academic Institutions, Foundations, and Venture Philanthropists

Beyond federal grants, entrepreneurs can also turn to non-profit organizations for funds. Some universities or healthcare provider organizations have programs that support spin-outs from the institutions with small grants or loans that provide the initial capital required (28; 29). Disease foundations are another small but important source for funding biomedical research; often these organizations will make grants for research-stage projects and equity investments in new companies. The latter type of investment is termed venture philanthropy, and several large disease foundations offer programs of this type, including the Multiple Myeloma Research Foundation, the Juvenile Diabetes Research Foundation, and the Cystic Fibrosis Foundation (30). While these grants and investments may be significant – in 2007, venture philanthropy investments were estimated at $75 million – these organizations tend to be narrowly focused on a particular disease or disability and restrict their funds to companies working in those areas. However, as grants or even as equity investments, terms from these sources tend to be favorable and result in less dilution to founders.

Angel Investors (also Angels or Business Angels)

Angel investors are individuals who invest their personal funds directly into new ventures. They represent a form of risk capital, a term for equity investments in unproven new ventures. Angels are often motivated by factors beyond pure financial return, and may be more tolerant of high-risk ventures or those with unconventional business models. Because there are many more angel investors, it can be easier to get access to angel capital than VC. Drawbacks of angel investors include high return expectations, inability to fund follow-on investments, lack of industry experience, and the challenge of managing significant numbers of individual investors (31). The last of these drawbacks is being mitigated over time as, in order to improve the due diligence on a potential investment, many angels are coming together to form groups to share the workload, with each individual making a personal investment decision once the deal has been vetted (24).

Venture Capital

Venture capitalists (VCs), another type of risk capital, are managers of funds supplied to them by their limited partners, so they are generally not investing their own money in the venture (24). Like angel investors, VCs invest in new ventures in return for a large share of the equity, resulting in significant founder dilution. VCs are able to access much larger pools of capital, and can thus complete larger rounds of initial and follow-on investments. VCs often have access to networks of experts in both management and in the specific market pursued by their portfolio companies, so there can be real value provided by a VC besides money. Plus, the validation that comes from a reputable VC investing in the venture can attract other players – potential employees, partners, and investors – that can help the venture succeed. On the other hand, there are far fewer VC deals completed each year than deals with angel investors, and those deals involve a much greater relinquishment of control on the part of the founders (31). Also, because of the nature of their funds, VCs have specific investment horizons that a potential deal has to fit into, which can result in behavior at the time of exit that may be suboptimal for the founder or the firm (32).

Private Equity

Another source of capital is private equity (PE), which is also a term for the broader class of equity investments from non-public sources, into which angel and VC investors fall. In this context, PE is meant to include funds that raise and manage capital from limited partners, and that invest in later-stage companies that are in a growth stage and trying to expand revenue or profitability (33). PE firms usually try to purchase a majority stake of the company (as opposed to VC firms, which often seek a large minority) and attempt to make measurable improvements in the company's operations before seeking an exit. PE firms often prefer to hold companies for a shorter period of time before exiting via IPO or M&A transaction (33). However, PE firms are usually able to invest significant larger sums of money in the company, and are sometimes willing to allow the founders to achieve liquidity in the transaction.

Strategic Investors (e.g., Customers, Channel Partners, Potential Acquirers)

Partnerships with "strategics" – companies in the same or complementary markets that see potential value for themselves in the activities of the new venture – can provide a good way to secure external capital without going to a VC (or, in addition to a VC). Since they are often

interested in the complementary potential of a new technology, often their terms and dilution are more favorable to a founder than a traditional VC's terms. Strategic investors may also represent a potential exit opportunity, and many new ventures target being acquired by a large company rather than build their own marketing and sales organizations (24). Even before the possibility of an exit, strategic partners can provide a revenue or capital source in return for access to future products and technologies (31). However, the presence of a strategic investor can have the effect of dissuading some potential partners or acquirers that compete with the investor from becoming involved.

Public Equity Markets

Other than an acquisition, the public equity markets provide the only way for a founder to liquidate the value created in the venture. This occurs as founders (and others) sell shares to the public, either during or after an initial public offering (IPO). Going public is often a desirable move since this provides ongoing access to investors (as more of the company's equity is sold), creating a source of capital than can fund growth (24). On the other hand, it can be very difficult for a small company to go public. If the revenues are uncertain (or nonexistent) or the risk of failure is perceived to be too great, public investors will reject the company's offering and the IPO will fail. Aside from the performance of the firm, the ability of any company to successfully complete a public offering is contingent on whether there is a market for any IPO at that time (IPO window). In addition, there are significant costs associated with being a public company, including disclosure requirements, compliance with regulations like Sarbanes-Oxley, audit fees, and reporting and control system set-up costs (34). Plus, being public carries with it the responsibility of fiduciary duty to shareholders, which means the founder – even if still the CEO – is really no longer in control of the company.

Banks and Other Lending Institutions

Bank loans or loans from government institutions are considered to be the cheapest source of outside financing (in terms of dilution), except for outright grants. Banks receive interest on their loans but do not expect to share in the value creation in the new enterprise (35). However, banks do require physical assets as collateral to secure the loan or evidence of stable cash flows from earnings, or both, before they consider a new venture to be creditworthy enough to receive a loan (24). The federal government is may be another debt source under certain circumstances; many companies in the clean technology industry have secured guaranteed loans from the Department of Energy. Finally, venture debt is a hybrid form of borrowing whereby a lender receives a small

(relative to a VC) share of the equity in return for making a riskier or unsecured loan, although they too often demand first or second liens on assets or receivables (36).

The variety of sources for capital may seem to indicate that founders of promising new Medtech ventures are able to easily secure funds, but, in reality, this is not the case. Money from friends, family, and the founders themselves is usually insufficient to allow the company to reach its goals. Funding through retained earnings or bank debt assumes the company has a positive cash flow, which is rarely the case for early-stage Medtech. Grants from foundations or the government are limited because they are usually not a significant source of funds, they are typically intended to support specific research or clinical development activities, and they often are targeted at specific diseases or causes that might not fit with the company's mission. Finally, PE firms and public equity markets usually want to see an earnings stream and growth, and therefore are unwilling to accept the often binary uncertainty of a new venture. Thus, many Medtech founders must turn to risk capital investors to fund their ventures (37). Venture capital is the most prominent – and well-researched – source of risk capital, and has long been "glamorized" in the press and academic research as the primary source of outside equity financing for new ventures (38). This paper focuses on a less prominent, but perhaps equally important, source – angel investors. The remainder of the discussion will contemplate angel investors and their interactions with the founders of new ventures, particularly Medtech new ventures. Since angels are often an alternative to venture capitalists and vice versa, where appropriate, venture capitalists will frequently be offered as a point of comparison.

Angel investors, also known as business angels, are typically high net-worth individuals that are unaffiliated with institutional investors and invest their own capital into entrepreneurial ventures in return for a share of the ownership (equity) of the venture (33). The term "angel" comes from the private individuals that funded Broadway plays since (at least) the first half of the 20th century (39). It was first applied to investors in entrepreneurial technology ventures by Professor William Wetzel in his study of sources of informal risk capital from the late 1970's and early 1980's (37). In fact, high net worth individuals have been a primary source of funding for founders of new ventures for much of American economic history; many of the earliest angels were from wealthy families like the Rockefellers and Vanderbilts, which invested in and advised a variety of business entities beginning in the last decades of the nineteenth century (40). A recent survey demonstrates that today's angel investors are most often male, middle-aged, and well-educated. Nearly all have previous management experience,

especially entrepreneurial experience including starting, operating, or selling a successful business – about half had previously launched a new venture (41).

As individual investors, angels are expected to have sufficient personal assets to be able to afford the risk inherent in investing in new ventures. In fact, in the United States, the Securities and Exchange Commission (SEC) regulates the interplay between entrepreneurs and potential backers by requiring companies to restrict to sale of their securities to accredited investors. An individual that can be considered an "accredited investor" is defined by law in Rule 501 of the SEC's Regulation D as "a natural person who has individual net worth, or joint net worth with the person's spouse, that exceeds $1 million at the time of the purchase" or "a natural person with income exceeding $200,000 in each of the two most recent years or joint income with a spouse exceeding $300,000 for those years and a reasonable expectation of the same income level in the current year" (42). In addition, directors, executive officers, or general partners of the company selling the securities are considered accredited investors. Therefore, it is reasonable to expect that most, if not all, angel investors can be considered accredited investors. Some studies have indicated this may not be the case (43), but the fact that the majority of invested capital comes from accredited angel investors suggests it is probably true for the types of ventures considered in this paper.

Angel investors may have less prominence than VCs because they are less organized and do not present as much of a public presence, and because they are usually investing less money in a deal with a company. However, as a class of investors, angels provide a significant source of funds to new ventures. Figure 1 presents a comparison of the total amount of capital invested by angel investors and venture capitalists for each year from 2002 through 2010. Clearly, in aggregate, angels are contributing roughly as much capital to companies as VCs. The exception seems to be in those years during or just after a recession (2002, 2008). This is consistent with the fact that angels are investing out of their own assets, so they are more likely to decrease their investment activity when the value of their portfolios declines. VCs, on the other hand, already have capital committed to them by their LPs, and thus do not need to decrease investment activity at the moment of the recession. Interestingly, the data appears to show that, once a year or two after the recession has passed, the VC investment activity mimics the same decline as the angel investment activity showed previously. This may be consistent with the fact that VCs that are trying to raise subsequent funds during or after the recession find it more difficult to do.

LPs, themselves suffering the effects of a downtown, may be more reluctant to allocate capital to VCs, and may be less likely to do so unless the past performance is exceptional.

Figure 1: Total Invested Capital by Angels and VCs[3]

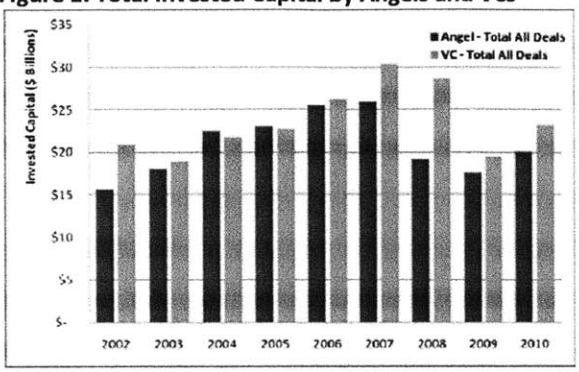


Figure 2: Number of Deals and Per Deal Value[3]

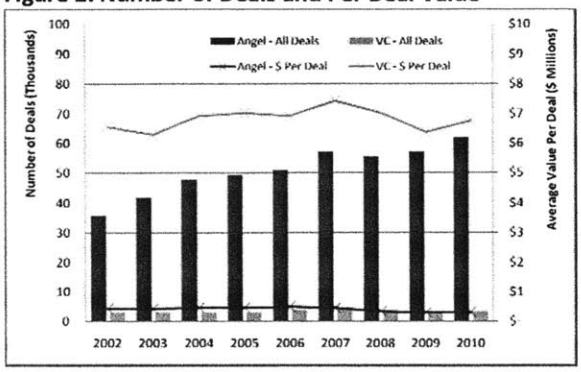


Figure 2 demonstrates that, while the overall amount of capital is similar, there are important and significant differences in how that capital is deployed. The bars represent the number of companies that receive capital each year, whereas the lines show the average amount invested per deal. Angels invest in tens of thousands of ventures each year, a number that has climbed from 36,000 in 2002 to over 60,000 in 2010. VCs fund many fewer companies, ranging between 3,000 and 4,000 most years. However, VCs invest, on average, between $6 and $7.5 million per deal, while angel investors usually put in, on average, less than $500,000 total. Thus, VCs spread their money over far fewer deals but are able to contribute significantly greater capital to those companies in which they invest.

While Figures 1 and 2 provide an interesting perspective on the overall comparison between angel and VC investors, it is important in the context of this paper to consider the data from the perspective of a founder of a new venture in the medical technology industry. Figure 3 is similar to Figure 1, but it focuses on the total invested capital into medical technology companies (it also includes healthcare services, which is a relatively small contribution but could not be accurately separated out from both sets of data). In the case of Medtech, angel investors have typically provided more capital than VCs – and substantially more in years like 2005 and 2010, when the amount is almost double. Also, in Figure 4, it is clear that angels – both in amount of capital and in the percentage of total capital deployed –

[3] Figures 1-4 are compiled using data from two sources. Angel investor data comes from UNH Center for Venture Research Reports on Angel Investing (http://wsbe.unh.edu/cvr). VC data comes from the PWC/NVCA MoneyTree™ Report and is provided by Thomson Reuters (https://www.pwcmoneytree.com/).

invest significantly more money in seed stage deals, which are transactions typically associated with the establishment of a new venture. Although Figure 4 is not restricted to Medtech, it is reasonable to assume the trend holds there too. Of concern to new founders in the present, the share of VC invested capital going towards seed-stage deals has steadily declined since 2004, implying that it may be getting more difficult to secure VC investments in the early stages of a company's growth.

Figure 3: Total Invested Capital in Medtech Deals[3]

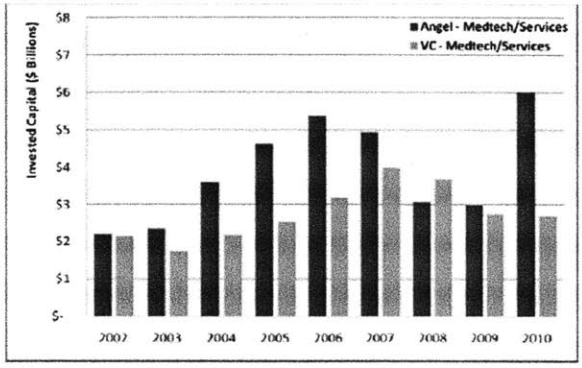
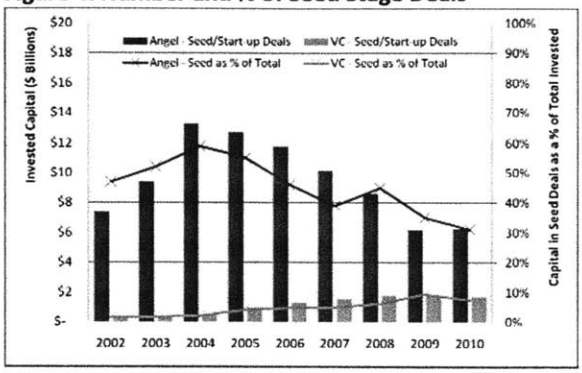


Figure 4: Number and % of Seed Stage Deals[3]



Taken together, Figures 1-4 portray a funding landscape in which most founders of new Medtech ventures would be very to seek and consider capital from angel investors as well as VCs, if only because it is such a significant source of funds. This is especially true if a venture is at the earliest stages of seeking external capital, an area from which VCs seem to be moving. Nevertheless, the figures also point to the fact that the deals most likely to secure angel investing are smaller and earlier-stage; if a firm seeks a much larger or later-stage investment, angels may be unable – or unwilling – to provide the needed capital.

Aside from capital, entrepreneurs often hope that investors will be able to provide additional value to the new venture. Angels or VCs might be asked – or expected – to provide industry experience and contacts, expertise and contacts related to building new businesses, experience raising (or access to) additional funding, and contacts with potential strategic partners. But how well can either angels or VCs meet the needs of new ventures? When faced with a choice, how do angel investors and VCs compare along some of the dimensions most important to an entrepreneur – investment motivations, financial contracting terms and control mechanisms, value-adding ability, and performance at exit (for the purpose of this paper, exits are restricted to initial public offerings).

Investment Motivations

VC motivations are relatively straightforward. Because they receive and manage money from limited partners (LPs), from which they make investments, they are bound by a fiduciary duty to those LPs. While personal motivations might influence the choice of industry or type of firm in which they invest, ultimately they must make decisions that are in the best interest of the fund and their LPs. Frequently, the LP agreements will explicitly stipulate what investments and activities are to be accomplished. VCs also have a vested interest in maximizing value to their fund, since higher returns enable them to raise larger successor funds and earn more from management fees (44; 45).

Angels, on the other hand, are subject to a much broader array of motivations for investing in a new venture. Certainly, one of them is a financial return on investment, which can be significant – an average of 2.6 times invested capital after 3.5 years (46). However, according to angels themselves, other motivations include the excitement and satisfaction of new venture development, a desire to give back to the next generation of entrepreneurs, and an interest in getting involved with new ventures in a new way (47). Angel investors may also be looking to support socially useful technology (this is particularly true in healthcare), to cure a disease with which they have direct experience, to improve local communities by spurring job creation or urban revitalization, or even to enhance their own self-image, self-esteem, or recognition from others (41; 37; 48). The variety of motivations means it may be easier for a founder to find an angel investor willing to support the new venture, but it also suggests that it is important for founders to seek out investors with interests matching their own.

Financial Contracts and Control Mechanisms

A review of very specific financial contracting terms is beyond the scope of this paper, yet it is clear from the literature that VCs drive a harder bargain than angels. VCs may seek a higher valuation, or a larger stake, at an earlier stage (49). They often include more aggressive deal terms like liquidation preferences and anti-dilution protections. Initially, when the information asymmetry between VC and entrepreneur is high, VCs will tend to seek a larger fixed proportion of any eventual exit as a downside protection for the investment. Unfortunately for the entrepreneur, as repeated interactions reduce the asymmetry, the VC then seeks a higher upside component (for example, with warrants) in subsequent financing rounds, although this may be less the case if the VC firm believes it is less likely to be able to directly add value to the firm (50). In addition to financial

terms, VCs rely more on pre-deal screening and formal contractual terms for control than angels (51). VCs are also more willing to act to alter the management structure of the firm; VC-backed companies are more likely and faster to replace the founder with an outside CEO (22).

Compared to the terms from VCs, in many cases angel investors are more flexible. Angels may be less sensitive to valuation or, at least, willing to postpone a valuation decision until a later round (52). In one analysis of Series A rounds, angel investors almost always took preferred shares for their capital (instead of common stock, although many use convertible notes too), but these shares were associated with weaker cash-flow and control rights than VC shares (53). Although it may seem like angels are striking worse deals or taking greater risks, this contracting behavior can be interpreted as rational. Angel investors only receive a payoff from firms that eventually achieve an exit, and angels recognize that many ventures will require additional money, probably from VCs, before they are able to do so. If contracts with angels were restrictive, this could be a barrier to getting capital from VCs, who will be reluctant to strike a deal without unwinding those existing terms (47). Thus, angel contracts may have less restrictive financial terms, including a smaller fixed return proportion relative to VCs or clauses that allow the firm to repurchase the angel's shares at a modest gain (50; 38). In addition, it may simply not be cost-effective for angel investors to write, monitor, and enforce detailed contracts in light of the smaller dollar amounts involved (47).

As with financial terms, formal control mechanisms, even for sophisticated angels, are less stringent than with VCs. Angels will often seek to take an active role in assisting the company after the deal, using their own involvement instead of the contract to monitor their investment (51). Sources report that board seats are granted to angels in less than 50% of all funding rounds, but the angels anticipate involvement in some capacity in almost 90% of their investments (38; 41). Also, angels often invest in deals that are local and relationship-driven, thereby relying on reputational effects to serve as a control on founder behavior (47). The main incentive on which angel investors appear to rely is managerial ownership of large blocks of equity; ideally, founders depend on the success of the firm for their own financial survival (54). This seems a common mechanism since, in one group of new ventures, insiders held the majority of the equity over 80% of the time in deals with angel investors (38). Overall, financial terms and control mechanisms appear to be more favorable to founders when angels are the investors than when VCs are investors.

Value-Adding Ability

For most founders, there are other important inputs that potential investors can provide that help a new venture succeed. Research has demonstrated that VCs have tangible impacts on the companies they fund. The presence of venture capital in a firm results in a greater likelihood of, and a faster time to, launch of a product, especially if the firm is producing something innovative (55). Backing from VCs improves a firm's ability to recognize the business environment and choose the appropriate commercialization strategy (56). It also improves overall efficiency compared to firms without VC backing, which is likely due to the VC's ability to screen for good companies and then improve their productivity through monitoring (57). Companies that obtain VC funding through rigorous due diligence, when compared to companies that do not obtain it, are more likely to professionalize by building up their internal organization, including recruitment policies, HR policies, adoption of stock option plans and other incentives, and hiring of management talent (22). Companies with experienced VC investors are also more likely to go public (58). Receiving VC funding is a vote of confidence causing external investors in both private and public equities to raise their implied valuation estimates, increasing the likelihood that a firm achieves a successful exit (50).

On the other hand, the value-adding abilities of VCs have limits, and there are some disadvantages to VC funding. Anecdotally, while it may be easier to secure large financing rounds, this is not always a strong indicator of success; at some point, it becomes harder to attract subsequent investment because of the sheer amount of existing invested capital and because the terms that would be required are unpalatable to existing VCs. Also, the efficiency advantages from VCs exist in the first two rounds of funding, but do not exist in subsequent rounds (57). As mentioned above, VC-backed companies are more likely to see the founder replaced as the CEO by an outsider (22). However, there is evidence that the presence of a Founder-CEO with a significant concentration of ownership at the time of IPO decreases likelihood of failure of the firm over the following five years (59). Disconcertingly, a concentration of VC ownership significantly increases the likelihood of firm failure unless it is balanced by the presence of a Founder-CEO, which may be due to the post-IPO desire of the VC firm for rapid exit, making it less supportive of long-term firm initiatives. One theoretical exercise predicted that if a VC's value-adding ability was judged to be high, then the value-maximizing choice is to select the VC, whereas if it is judged to be low, then an entrepreneur maximizes value by choosing an angel investor (regardless of value-adding ability) (60).

Angels can themselves provide significant value-adding ability to firms. Angel investors are able to offer attractive deal terms and valuations, move quickly on deals, and provide the appropriate amount of capital to founders (61). The sheer diversity of angels means that founders can probably connect to individuals compatible with their needs, whether they are guidance and connections or a willingness to be hands-off and trust the founder to make the right decisions (48). Considering angel investments only, firms that receive angel funding are more likely to survive for four years, receive additional (non-angel) funding, and have stronger growth, suggesting that the inputs provided by angels – especially those in addition to capital – have a significant impact on firm success (40). Many angels, especially organized angel groups, maintain strong ties to VCs that allow a smooth transition to successive funding rounds. From an exit perspective, in smaller deals, the literature indicates that angel-backed companies are as likely to experience an IPO or an acquisition as VC-backed companies (53). Importantly, angel-backed companies, which have much less invested capital than VC-backed firms, may be able to seek faster exits at lower values that still provide a very good return to founders and angels; this is not true for VCs that need to put more money to work and have bigger exits (62; 63). However, even if the fast exit is not possible, angels are often more willing to be patient due to lack of a fiduciary duty or fund horizon; many are as protective as founders in terms of the appropriate exit path and ensuring that the company's assets are protected as they transition to another firm (48).

However, the value from angels seems to be limited to smaller, early-stage investments. Follow-on investment capital from angel investors may be harder to obtain than from VCs (48). Survey data suggests that even if a venture is able to find it, or if it is forced to fill a large investment round with angels due to lack of interest from VCs, the venture will have worse outcomes (58; 53). Also, there is at least a perception that, assuming the firm will require additional capital from VCs, working with angels initially can make the handoff difficult as they are crowded-out by new financing terms or pro rata requirements, or find the priorities of the firm shifting (48). Finally, angel investors also may not be as aggressive as VCs in abandoning yet-to-be-successful ideas, which can mean that an entrepreneur is left floundering with a failing company instead of moving on (62).

Underpricing at IPO

Although an exit may seem far off as a founder seeks early-stage funding, it is still important to consider how potential investors behave at the time of exit. To be relevant to this paper, the exit to

consider is the IPO. Both angel investors and VCs have an incentive to accept lower than fair market value (underpricing) for their investment at IPO in order to enhance the liquidity of their position, but this incentive is shared among all pre-IPO investors, including founders and insiders (44). However, VC-backed firms tend to have greater one-day returns, and thus greater underpricing, than firms without VC backing. This is consistent with the grandstanding theory, whereby VC firms are willing to the bear the cost of underpricing in order to take companies public and send a signal of strength, establishing a positive reputation and increasing their ability to raise subsequent funds (32). Underpricing by a VC-backed firm occurs whether angel investors are involved or not, though it is worse when they are not. More specifically, when both VCs and angel investors are present as shareholders at the time of the IPO, angels have less incentive to underprice, which yields a direct monetary benefit to the venture. This is probably due to either the angel's desire to sell shares directly as part of the IPO (more common when angels are present) or to the VCs not having to "pay the price" since they can distribute shares to LPs at whatever the market price happens to be (44).

It is clear that the literature – and the risk capital industry – acknowledges that both angel investors and venture capitalists are reasonable sources of funds for founders of new ventures in the medical technology industry. There are recognized advantages and disadvantages to each, and situations in which they might be complementary to one another are balanced by instances in which they would be more adversarial. This paper looks at IPOs and considers outcomes of Medtech founders who have selected funding from these two sources, so it is instructive to first consider outcomes of all firms (not just Medtech) undergoing IPOs in a certain period. Using methods similar to this paper, Johnson and Sohl review all IPOs from 2001-2007 and classified investors as VC, angel, or other, and compared the characteristics of the firms depending on the investor mix (44). Table 1 summarizes some of the results.

Table 1: Summary of Results from "IPO and Pre-IPO Shareholders: Angels versus Venture Capitalists"[4]

	All IPOs (N=665)	Angel Shares (%)	VC Shares (%)	Age at IPO (years)	Market Cap (millions)
No Angel, No VC	38%	0.00%	0.00%	27.5	$833
Angel, No VC	13%	21.2%	0.00%	21.4	$775
No Angel, VC	33%	0.00%	34.7%	14.4	$423
Both Angel, VC	16%	14.6%	36.4%	10.9	$639

[4] Data in Table 1 is compiled from various tables found in a UNH CVR working paper (44).

These data are presented to show that there are differences in firm characteristics and outcomes depending on the mix of investors. The data are not directly applicable to, and do not predict, the results of this paper, nor are they meant to, but they do provide a good segue.

This paper will also use an analysis of firm and investor characteristics at the time of IPO, in this case to study the outcomes of Medtech founders under the primary hypothesis: Founders of new ventures in the medical technology industry experience better outcomes in terms of ownership and control of the company when one or more investment rounds include angel investors in addition to, or in place of, venture capitalists. For ease of analysis, the overall hypothesis will be separated into two primary research aims, H_1 and H_2. One primary aim, H_1, will be to assess the amount of founder ownership in a firm at the time of IPO, and discern whether it varies depending on the investor mix represented by shareholders. The other primary aim, H_2, will be to understand whether the level of control of the firm by the founders at the time of the IPO varies depending on investor mix. More explicitly:

H_1: Founders of new ventures in medical technology own a greater share of the firm at the time of an initial public offering when angel investors are present among the shareholders.

H_2: Founders of new ventures in medical technology have a greater degree of control of the firm at the time of an initial public offering when angel investors are present among the shareholders.

In both cases, characteristics and outcomes of the firm will also be compared to determine whether they differ significantly depending on the investor mix. Together, these two primary aims will help address the main question in the research: Are founders of new ventures in medical technology better off when they seek external capital from angel investors, or not?

Methods and Data Sources

In reviewing the literature, one important finding is that most of the research addressing the outcomes of new ventures that receive funds from angel investors is based on either informal anecdotal accounts or surveys. Surveys of angel investors, while informative, can suffer from two types of inherent bias that make it difficult to draw conclusions from the data. One type is survivor bias, which occurs when researchers receive data only from people who continue to be active angel investors, thus potentially missing data from angels who failed and ceased investing. The other type is self-selection bias, which is a reflection of the fact that people who have had positive experiences with angel investing are more likely to share their numbers than those who have had negative experiences. To avoid the potential issues with survey data, this paper makes use of the fact that all companies issuing an initial public offering (IPO) of equity are required to submit a detailed, regulated S-1 document to the SEC. While this method does reduce survey bias, it is important to acknowledge that the paper will be unable to assess pre-IPO company failures, since they are not accounted for in the dataset.

The sample dataset used for this paper's analysis of IPOs in the medical technology industry was obtained from the Securities Data Corporation (SDC) Global New Issues listings, accessed through the ThomsonReuters SDC Platinum database (v4.0.3.1, courtesy of the MIT Library System). The database was queried as follows:

Select the Database:	Global New Issues
Set Issue Date Range:	01/01/2001 to 12/31/2010
Set Issuer/Borrower Nation:	United States
Set IPO Type:	Select All IPOs
Select Issuer/Borrower SIC Codes:	See Appendix Table A-1 for list of SIC codes included

The date range was selected to include the last ten full years of IPOs, and was designed to be long enough to generate a reasonably significant number of IPOs for the purpose of analysis. This range also had the dual advantages of avoiding the extreme IPO volatility associated with the internet bubble in the late-1990's (for example, 1996 had at least 61 Medtech IPOs), and of not extending so far into the past that the angel investor hypothesis becomes less relevant. The Standard Industrial Classification (SIC) codes were used to restrict the query to healthcare related new issues. A list of the primary SIC codes included in the query, as well as their descriptions, is included in the Appendix (Table A-1).

The SDC report was exported into Microsoft Excel to enhance ease of data manipulation. The dataset was filtered at this time to include only those companies listing on one of the US exchanges, including NASDAQ, NYSE, OTC, Pink Sheet, and Small Cap Market. Individual rows were screened to detect the presence of repeat entries for the same company; an entry was considered a repeat if the company name and issue data were identical. A total of 11 repeated entries were found and removed, leaving a total of 232 IPOs in the healthcare field between 2001 and 2010, inclusive.

At this stage, further screening was undertaken to restrict the dataset to companies involved in the medical technology industry. The first step was to review the company description from the SDC report (for example, "Mnfr surgical, medical instr"). If the description obviously identified the company as a part of the medical technology industry (as with the example), the entry was included. Similarly, if the description obviously identified the company as being primarily part of another healthcare industry (for example, "Mnfr pharmaceuticals"), the entry was excluded. In the interest of having a more uniform dataset, the decision was made to exclude companies dealing with therapeutics (pharmaceuticals, biologics), software and IT services, research services, provider and provider services, and diagnostics (tests, equipment, products, services). Diagnostics companies were excluded because, although in some ways similar to Medtech, many of those companies and products are a better fit with the biotechnology industry (and attracted similar investor interest). If a category designation could not be made from the SDC description, then an internet search was conducted and judgment was rendered based on the company's description, mission, and product lines. At this point, the final dataset of medical technology IPOs from 2001 to 2010 contained 63 companies.

It is important to acknowledge that one limitation of this dataset is the bias introduced by researcher categorizations of what constituted a Medtech company. Although efforts were made to be consistent, it is conceivable that a Medtech company was excluded or that a company involved in another industry was included. Although the results are not likely to change significantly due to the inclusion or exclusion of any one single company, some subgroups were quite small and could be sensitive. However, statistical significance, where it occurred, was usually great enough to be robust at the 95% confidence level to the presence or absence of an additional company. A more serious issue would be if the SDC descriptions were systematically misleading, but a survey of company websites suggested that the descriptions were good indicators of the company's focus.

The next step in developing the full dataset was to review the S-1 forms for each of the companies registering for an IPO. All S-1 forms were available from the SEC website through the EDGAR Database of Online Corporate Financial Information[5]. Many companies file a number of amended S-1 forms (S-1/A) between their original filing date and the eventual issue date. To remove the potential for inaccuracies in the number of shares or the principle shareholders, the closest complete S-1/A to the actual date of issue was used. Data collected from each S-1/A included the number of common shares outstanding just prior to the IPO (including the conversion of preferred shares and any options or warrants exercisable within 60 days of the IPO), the number of shares issued in the IPO (excluding any overallotment), and the total post-IPO shares. The offer price was identified through an internet search, most frequently from Elsevier Business Intelligence's Strategic Transactions website[6], which also served to verify the number of shares that were sold in the IPO. The aggregate amount of invested equity capital in the firm was also recorded from a table that appeared in the Dilution section of each S-1.

In addition to the overall number of shares, the S-1/A documents were used to analyze the mix of shareholders present in the company at the time of the IPO. All S-1s have a section titled Principal and Selling Stockholders, which includes all shareholders with a stake equal to or greater than 5% of the outstanding pre-IPO equity, all named executives and directors, and any shareholders selling shares as part of the IPO. Every shareholder listed in this section, along with the amount of stock owned (or controlled) by them, was recorded for each of the 63 companies in the dataset. Special attention was paid to identifying founders and their role in the company as an employee or director, if they were named as such in the S-1, as well as the founding date (to calculate the time from founding to IPO). If the latter two items were not part of the S-1, an internet search was conducted to ascertain the information; in every case, at least one founder and a year of founding were identified.

After recording individual shareholders and the size of their stake in the company from the S-1, the next step was to classify each shareholder into categories that enabled meaningful analysis. Since the primary hypothesis relies on identifying the impact of angel investment on founders, and since the primary comparator for angel investors is VCs, three categories were easily designated (founders, angels, and VCs). Two additional categories were established to encompass the remaining equity – non-founder insiders, which include executives and directors, and other shareholders, a broad category

[5] Available at http://www.sec.gov/edgar.shtml.
[6] Available at http://sis.windhover.com.

representing financial and strategic investors. Classification was reviewed carefully to ensure no overlap; once a shareholder was assigned to a category, it could not be placed into any other.

An important challenge was identifying and classifying investors from among the shareholders. If a firm (or fund) owned more than 5% and was listed, it was classified as either VC or other shareholder; the VC designation was based on whether the firm appeared on the NVCA membership list[7], or on whether an internet investigation of the firm made it apparent it was a VC. Parent companies, strategic investors, and financial investors (including hedge funds, mutual funds, and private equity firms) were all identified and categorized as other shareholders. No firms were classified as angel investors, which is a reasonable outcome because the majority of angels invest individually in a deal, even when they are part of an organized group. Individuals listed in the S-1 went through a process of elimination before being classified as angel investors. Founders were identified and categorized as such. Executives and other employees of the firm, as well as directors, were classified into the non-founder insider category. The only exceptions were those directors that were not otherwise insiders, did not represent an entity invested in the firm, and held stakes greatly in excess of the other directors of comparable tenure to them. This triggered an additional search for evidence that they were an angel investor, including previous purchases of preferred shares or internet descriptions of them undertaking angel investing activities.

The remaining individual shareholders were reviewed for factors that could exclude them from being considered angels. If an individual represented an investment firm that held shares in the company, or if they controlled shares but disclaimed beneficial ownership and the source of those shares could be identified as not an angel investor, then the individual was classified as other shareholder. Individuals sharing the last name of another shareholder from a different category were either placed in that category, or into the other shareholder group. At the end of the process, if individual investors could not be excluded into another category, they were considered to be angel investors.

Here again it is necessary to point out the limitations of the dataset. It is quite conceivable that some of the individual investors have been misclassified; given the efforts to exclude them, the hope is that the angel investor list is sufficiently accurate, or at least conservative enough, to be able to reach valid conclusions. It is conceivable that some of these parties are unidentified insiders, former employees, or

[7] Available on the NVCA website: http://www.nvca.org/index.php?option=com_mtree&Itemid=173.

friends or family of the founder. Nevertheless, it is reasonable to confidently make comparisons between shareholder groups if the definition of an angel investor, for the purposes of this paper, is an individual that meets all of the inclusion and exclusion criteria used during the classification process.

Another noteworthy limitation, perhaps, is the fact that, for most firms, the total ownership represented in the S-1 and assigned to various entities is less than 100%. It is difficult to discern the specific makeup of the shareholders that are not included in the S-1. From the perspective of this paper, however, it is reasonable to assume that this limitation would most likely manifest in an underestimation of angel investors' shares of a company. Individual angel investors, more than any other investor type, are likely to have relatively small stakes in a firm at the time of IPO, particularly if the firm has received additional capital from VCs or other financial investors, and thus not appear in the S-1. Finally, in some instances, no information about the founders or their equity in the firm could be found. These cases usually occurred in the groups without angels, and is consistent with the fact that some firms begin without a founder (as a spinout from a VC firm, for example) or that some founders are washed (or bought) out by significant investment from VCs or other financial investors. Thus, these entries were left with a founder stake of 0%. However, the analysis is robust to excluding these 0% entries; no results are altered meaningfully.

Once all investors were classified, they were grouped together into the appropriate categories for each company, creating a distribution of ownership that could be compared between firms. For the purpose of assessing the impact of angel investing on the amount of ownership, two different comparisons were made. In one, firms were divided into those that had any angel investor presence and those that had no angel investors as shareholders. Arithmetic means were calculated, variances were tested using an F-test (at a 95% confidence level), and then the means were assessed for statistically significant differences at a 95% confidence level using a two-sided T-test with the appropriate variances (equal or unequal, depending on the outcome of the F-test). In the second comparison, firms were divided into four subgroups based on investor distribution between angel investors and VCs – No Angel, No VC; Angel, No VC; No Angel, VC; and Both Angel, VC. These groups were compared visually in box-and-whisker plots in which the ends of the whiskers represent the maximum and minimum values in the range, the box represents the 25^{th} to 75^{th} percentile, and the line in the box represents the median. The groups were then analyzed for statistically significant differences at a 95% confidence level with an ANOVA test and then the corrected repeated-comparison post-tests among all groups. The same

process was also used to assess the value of the different stakes at the time of IPO (calculated by multiplying the stake with the overall firm valuation), in order to understand if there is a tradeoff between ownership and value for any of the subgroups.

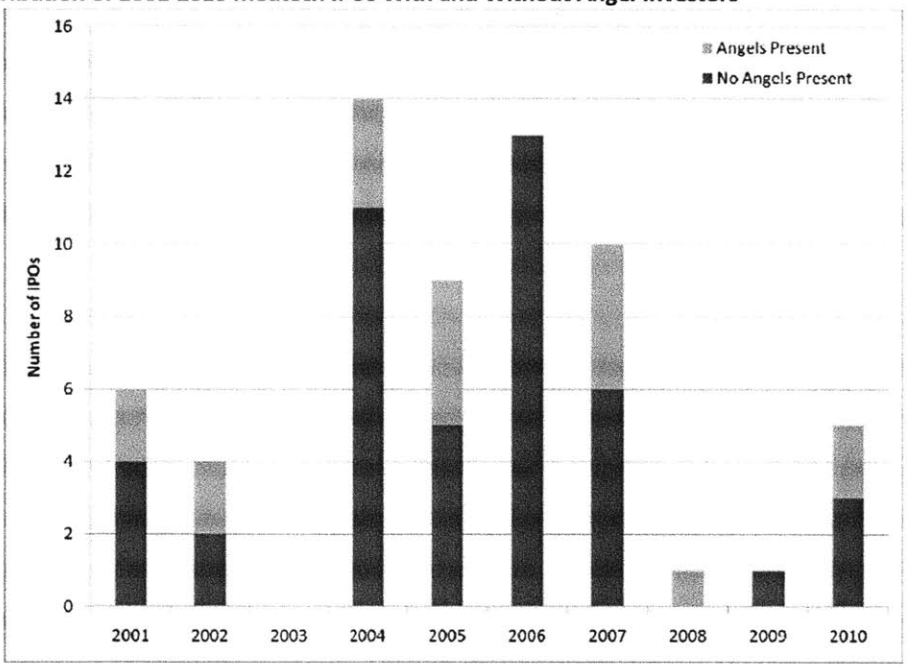
The final step was to assess the impact of different distributions of investors on the level of control that a founder has been able to maintain at the time of the IPO. To do this, all of the founders of each of the companies were assessed and categorized as an employee, a director, or an employee or director. The same subgroups as the previous analysis were used; the data compared were proportions of founders in each of the categories among the different subgroups. In this case, the number of firms was less important than the overall number of founders in each subgroup, which served as the denominator for the calculations of proportions of directors and employees. The comparison between angels and no angels was assessed for statistical significance at a 95% confidence level using a Fisher's Exact test of a 2x2 contingency table. The comparison between the four subgroups comparing angel and VC investor presence was assessed at a 95% confidence level using the Marascuillo procedure, a statistical analysis used to simultaneously examine multiple comparisons between all groups of proportions after the data have been collected.

Results

Summary Characterization of IPO Dataset

A unique and rich dataset comprised of medical technology companies that underwent an IPO between 2001 and 2010 was created from S-1 and S-1/A disclosures to the SEC at the time of registration. After screening for the appropriate set of new issues and excluding non-Medtech firms, the result was 63 companies. Tables containing the full set of companies, including descriptions, firm characteristics, IPO information, and the raw ownership and valuation data can be found in the appendix (in Tables A-2 and A-3). The distribution of the IPOs over the ten year period included in the dataset, shown in Figure 5, was reviewed to verify that no major differences were present between firms with angel backing and firms without it. As can be seen, angel-backed companies are evenly spread among companies without angels, and no clustering of angel-backed companies distinct from normal IPO variability is apparent.

Figure 5: Distribution of 2001-2010 Medtech IPOs With and Without Angel Investors



Turning to the dataset, Table 2 presents the high-level results of the shareholder identification and classification process. A total of 18 of the 63 firms (29%) were deemed to have at least one angel investor. There was no minimum requirement for how much equity an angel had to hold in order to be included, and the range was fairly broad (from <1% to >31%). Of the 18 firms, two-thirds had angel investors holding an aggregate of at least 5% of the outstanding equity at the time of the IPO. Half had individual angel investors that held at least 5%. Table 2 demonstrates that a significant proportion of

firms had angel investors at the time of IPO, although the amount of that ownership was variable and frequently low. Relatively few firms had individual angel investors that managed to maintain at least a 5% stake through the time of the IPO.

Table 2: US Medtech New Issues with Angels

US Medtech New Issues (2001 - 2010)	63
Companies with Angel Investors (Any Angel Investors in S-1)	18
Companies with Angel Investors (All Angel Investors Own >5%)	12
Companies with Angel Investors (Single Angel Investor Owns >5%)	9

Table 3: US Medtech New Issues Subgroups

Companies with No Angel or Venture Capital Investors	13
Companies with Angel, with No Venture Capital Investors	6
Companies with No Angel, with Venture Capital Investors	32
Companies with Both Angel and Venture Capital Investors	12

Table 3 includes the subgroups used for additional analysis of the companies in the dataset. Four subgroups were created to compare the impact of different investor profiles – firms with neither angel nor VC investors (In the labels of figures: No Angel, No VC); firms with angel investors but without VCs (Angel, No VC); firms without angel investors but with VCs (No Angel, VC); and firms with both angel and VC investors among their shareholders (Both Angel, VC). As Table 3 shows, more than half (32 of 63) of the firms in the dataset were backed by VCs without the presence of angel investors. Only about 10% (6/63) of the companies were backed by angels without any investment by VCs, perhaps reflecting the challenge of bringing a medical technology firm to the point of an IPO on the small amounts of capital available from angel investors. One important result of the relatively small numbers of companies in each of the subgroups is that statistically significant differences will be hard to demonstrate when comparing across investor profiles.

Analysis of Ownership Stake Size and Valuation at IPO

The primary objective of the review of S-1 documents was the collection and classification of shareholders. For each company, the goal was a distribution of equity into the five shareholder categories so that a comprehensive picture of the owners of a firm could be generated. Once the classification was complete, the companies were separated into different groups for analysis. Table 4 contains the results from the shareholder classification and analysis efforts. Each of the primary categories – Founders, VCs, Angels, Other Shareholders, and Non-Founder Insiders – is included, as is the total proportion of shares that were captured by the disclosures in the S-1 (the remainder of the shares was held by stockholders with less than 5% of the firm and could not be classified).

Table 4: Average Ownership Stake at IPO by Shareholder Category

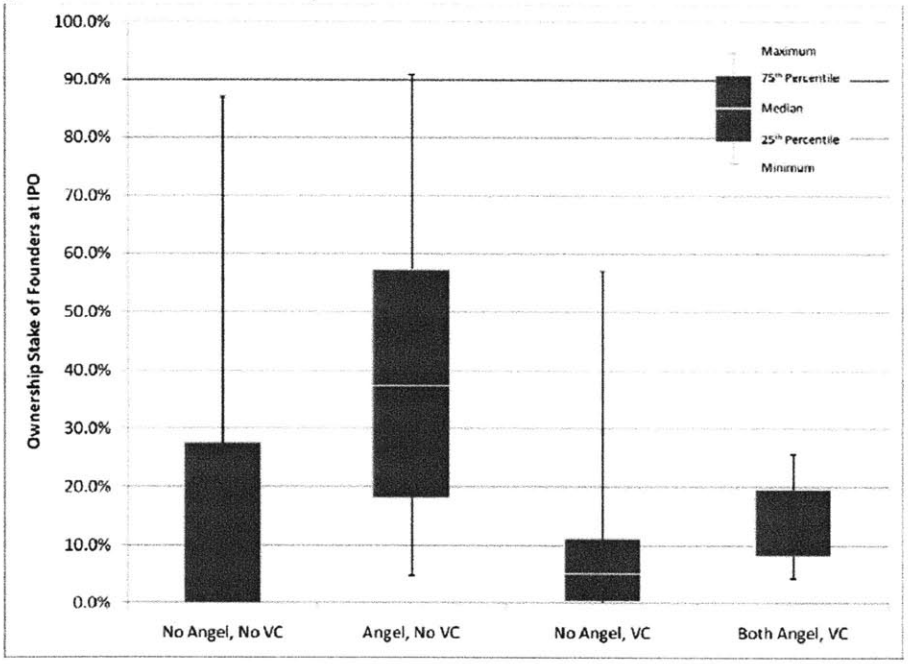
	Founders	VC	Angel	Other Shareholders	Non-Founder Insiders	Total
All	18.1%	31.7%	3.0%	28.4%	6.3%	84.4%
Angels Present	22.8%	22.6%	10.6%	15.8%	5.0%	76.8%
No Angels	15.6%	35.3%	0.0%	33.5%	6.8%	87.4%
p-value	*0.0412*	*0.1240*	*0.0001*	*0.0055*	*0.1135*	*0.0138*
No Angel, No VC	19.1%	0.0%	0.0%	68.3%	6.1%	93.5%
Angel, No VC	41.1%	0.0%	13.8%	17.3%	4.7%	76.8%
No Angel, VC	8.8%	49.7%	0.0%	19.5%	7.1%	84.9%
Both Angel, VC	13.6%	33.9%	9.1%	15.0%	5.2%	76.8%

Table 4 represents an analysis of one of the primary objectives of this research – the level of founder ownership at the time of IPO and how it is impacted by investors, specifically angel investors. Two sets of comparisons are included in Table 4; one divides the firms into two categories, those with angel shareholders and those without, and the other further subdivides by accounting for the presence of VCs in addition to angels. In the first comparison, average ownership stakes are compared and tested for statistically significant differences. Importantly, Table 4 reveals that founders have a statistically significant (at a 95% confidence level) greater amount of ownership of their firms when angel investors also own shares at the time of the IPO. Looking across, VC ownership trends down when angels are present (not significant), other shareholders own significantly less, and insiders are similar. Of note is the fact that, on average, less of the firm's total equity is accounted for when angel investors are present; this is compatible with the idea that angels, which may invest as a group but are individual shareholders, are less likely to own 5% of the company (and be in the S-1) by the time of an IPO.

Drilling deeper, Table 4 also contains a comparison of ownership stakes that reflects separately controlling for the presence of angel investors and VCs. Focusing on the founder ownership stakes, the average stake without angels or VCs is approximately 19%. However, founder ownership more than doubles to 41% when angels are present without VCs. Conversely, when VCs are present in the absence of angels, the level of founder ownership is decreased to below 9%. Adding angels back into the mix with VCs does improve the average founder's stake to around 14%. These results imply that the presence of VCs tends to drive down the amount of ownership of the firm by founders, but the presence of angels tends to drive it up. Although the trends are very strong, the subgroups were found to not be statistically significantly different when analyzed using post-ANOVA comparison tests, as the small

sample sizes overwhelmed the differences. Acknowledging that means are not always the most representative measure of a group of data, Figure 6 presents the investor profile subgroup analysis in another, more visual way that includes the minimum, 25th percentile, median, 75th percentile, and maximum level of founder ownership in the subgroup. Figure 6 supports the conclusions drawn from the data in the table, although it does show much more overlap than the means would suggest. Still, it is clear those firms with angel investors but without VCs have the greatest extent of founder ownership at IPO, and that the presence of angels with VCs in a firm increases the founder ownership relative to VCs alone. This analysis focus on founder ownership, but the appendix contains similar plots for the remaining shareholder categories from Table 4.

Figure 6: Comparison of Founder Ownership Across Investor Profiles



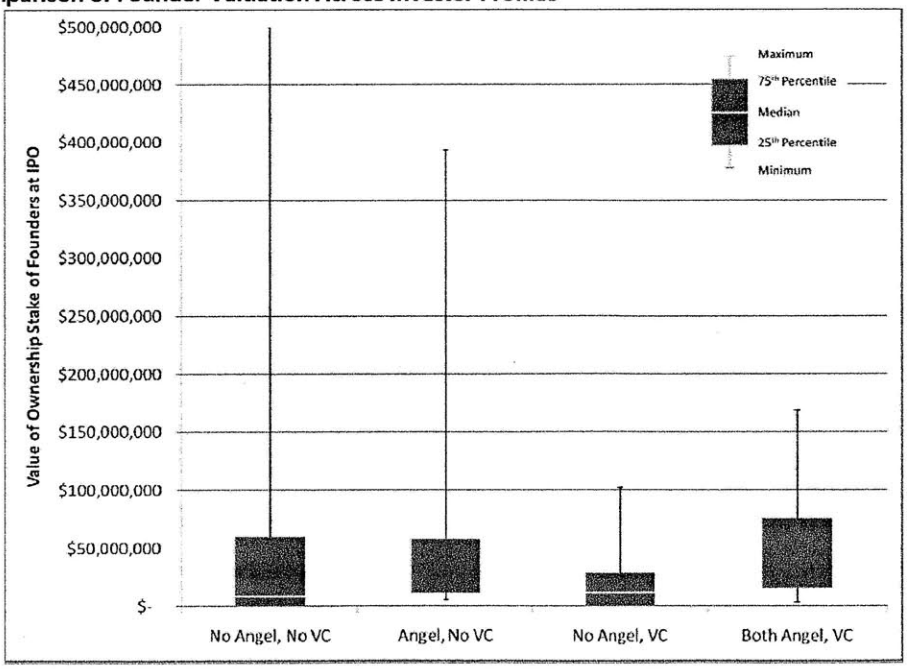
Having demonstrated that, at least in this dataset, angel investors play an important role in preserving the ownership of founders at the time of IPO, it is important to consider the valuation of the founders' stakes – and of the firms as a whole – to make sure that the increased ownership does not come at the expense of financial value created in the firm. Table 5 is similar to Table 4, but takes the additional step of converting each shareholder category's stake into a valuation by multiplying the ownership by the overall firm valuation. The average valuation of all firms at the time of IPO (calculated as the confirmed offer price multiplied by the shares outstanding after the IPO, excluding overallotment) was $314M. As expected, the angel investor category had the lowest valuation because it had the smallest stake. VCs had a much greater valuation because of the greater ownership stake they obtain.

Table 5: Average Value of Ownership Stake at IPO by Shareholder Category

	Founders	VC	Angel	Other Shareholders	Non-Founder Insiders	Total
All	$ 60,129,612	$ 87,850,995	$ 7,640,714	$ 104,910,816	$ 20,506,233	$ 314,339,041
Angels Present	$ 67,458,672	$ 91,470,001	$ 26,742,500	$ 74,591,166	$ 21,017,968	$ 362,295,585
No Angels	$ 56,249,522	$ 86,403,392	$ -	$ 117,038,676	$ 20,301,539	$ 295,156,424
p-value	*0.3679*	*0.8881*	*0.0001*	*0.2971*	*0.9329*	*0.4561*
No Angel, No VC	$ 99,175,154	$ -	$ -	$ 254,544,334	$ 22,845,364	$ 388,430,811
Angel, No VC	$ 90,173,305	$ -	$ 24,674,612	$ 48,268,259	$ 9,542,207	$ 219,622,465
No Angel, VC	$ 18,923,084	$ 121,504,770	$ -	$ 61,729,131	$ 19,268,110	$ 257,263,704
Both Angel, VC	$ 56,101,355	$ 137,205,002	$ 27,776,444	$ 87,752,619	$ 26,755,849	$ 433,632,144

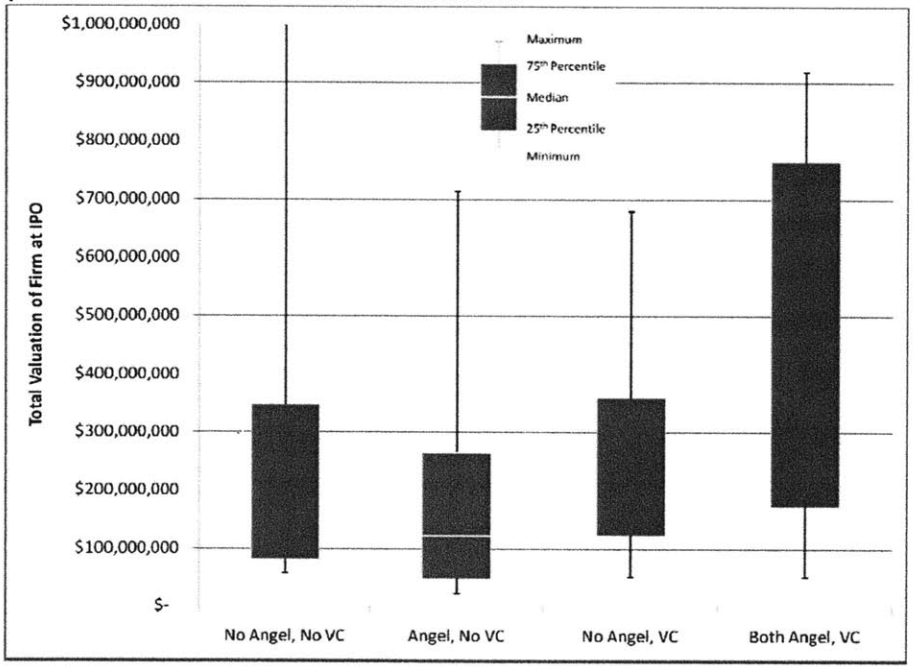
Looking at the angel versus no angel comparison in Table 5 from the perspective of the founder, there is a trend towards the presence of angels increasing the value of the stake (from $56M to $67.6M), but the difference is not statistically significant. Similarly, from the overall firm valuation perspective, the presence of angels meant an increasing value trend (from $295M to $362M) that was not statistically significant. Valuations in the entire dataset ranged from a low of $23M to a high of over $2B, so statistical comparisons are likely to be impaired by the large variability in the groups. The bottom of Table 5, along with Figures 7 and 8, presents the valuation data across investor profiles. The values from the founder perspective mimic the relationships in Table 4, but are not statistically significant. Figure 7

Figure 7: Comparison of Founder Valuation Across Investor Profiles



presents the expanded valuation data across the investor profiles from the founder perspective. Note that, for ease of visualization, Figure 7 cuts off the maximum valuation shown at $500M, although the maximum for the No Angel, No VC investor profile was actually about $580M. All of the groups overlap and are roughly similar, although firms with VCs but no angels again seem to penalize founders the most. From the data in Figure 7, it is clear that, at a minimum, greater founder ownership does not come with a monetary penalty. Likewise, as Figure 9 shows, there is not an obvious penalty in terms of overall firm valuation. In this case, the overall distributions are similar, although firms with angel investors but no VCs do trend lower in terms of the median (and the mean, in Table 5). The best scenario of the investor profiles seems to be the combination of both angels and VCs, which had the highest mean as well. Figure 8 also cuts off the maximum valuation shown at $1B for visual purposes, although the maximum for the No Angel, No VC investor profile was actually about $2.1B.

Figure 8: Comparison of Firm Valuation Across Investor Profiles



As with the ownership stake, the appendix contains plots similar to Figures 7 and 8 presenting the valuations for each of the remaining shareholder categories from Table 5.

Analysis of Founder Control at IPO

Table 6 represents the other primary objective of this research – how much control founders are able to maintain over their firms at the time of the IPO. For the purposes of a more rigorous analysis, control was defined as founders having a role in the company as either a director or an employee (although in

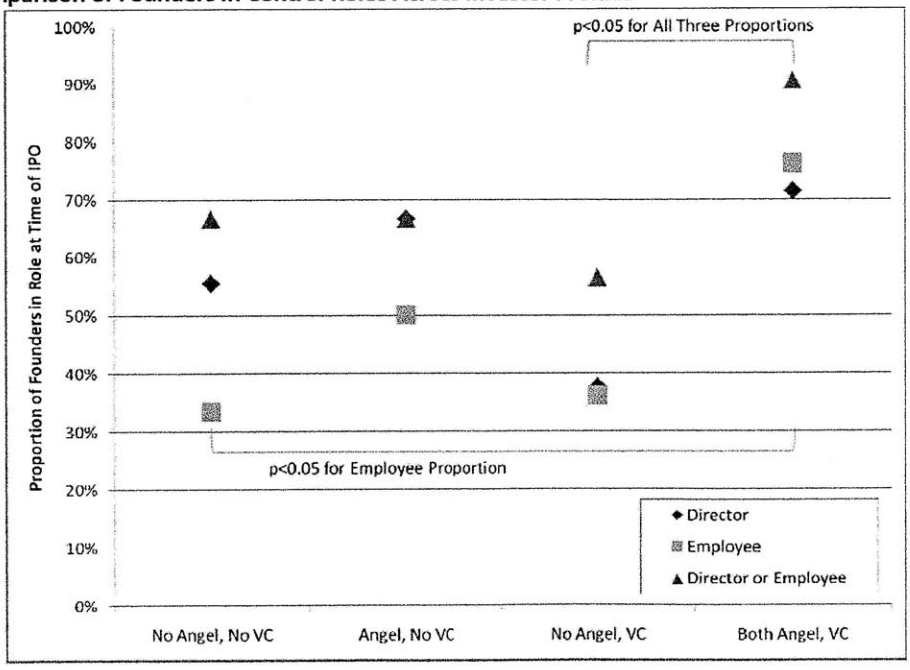
many cases it was both). Overall, founders were present as directors about half of the time, and as employees slightly less than that. Combining those two, founders were either a director or an employee nearly two-thirds of the time. Considering the primary comparison, firms with angel investors present

Table 6: Proportions of Founders in Director and Employee Roles at IPO

	Director	Employee	Director or Employee
All	49%	44%	65%
Angels Present	70%	67%	82%
No Angels	41%	36%	59%
p-value	*0.0076*	*0.0036*	*0.0191*
No Angel, No VC	56%	33%	67%
Angel, No VC	67%	50%	67%
No Angel, VC	38%	36%	57%
Both Angel, VC	71%	76%	90%

as shareholders versus firms without angel investors, Table 6 demonstrates that founders have a statistically significant (at a 95% confidence level) greater level of control over their firms at the time of the IPO when angel investors also own shares. When angel investors are present, founders are directors or employees over 80% of the time. Looking at the proportions across the investor profiles, founders are approximately as likely to be directors or employees in every profile, except when both VCs and angels are present, in which case founders are one or the other 90% of the time. Figure 9 represents

Figure 9: Comparison of Founders in Control Roles Across Investor Profiles



the same data as in the bottom of Table 6, but presented in a more visual way. Interestingly, companies with both angel investors and VCs are statistically significantly (at a 95% confidence interval) more likely than companies with only VCs to have founders present at the time IPO for each of the three proportions, and more than firms without either angels or VCs for the employee proportion.

Analysis of Firm Characteristics at IPO

The final part of the results consider whether the presence of angels, or the more specific investor profile, has any influence on some firm-level and IPO characteristics. Table 7 presents data that most founders would find interesting, including the total invested capital in the firm at the time of the IPO, the multiple calculated by dividing the overall firm valuation at IPO with the total invested capital, and the time to IPO (calculated as the difference between year of founding and year of the IPO).

Table 7: Average Investment and IPO Characteristics

	Firm Valuation at IPO	Total Invested Capital	Valuation to Invested Capital Multiple	Time to IPO
All	$ 314,339,041	$ 85,209,915	6.6	8.9
Angels Present	$ 362,295,585	$ 63,142,056	11.0	9.3
No Angels	$ 295,156,424	$ 94,037,058	4.9	8.8
p-value	*0.4561*	*0.1542*	*0.0894*	*0.6764*
No Angel, No VC	$ 388,430,811	$ 79,825,312	7.8	10.7
Angel, No VC	$ 219,622,465	$ 43,223,012	16.5	9.7
No Angel, VC	$ 257,263,704	$ 99,810,580	3.7	8.0
Both Angel, VC	$ 433,632,144	$ 73,101,578	8.2	9.2

While no statistically significant differences arise from the angel versus no angel comparison in Table 7, there are some interesting trends. Average total invested capital is almost 50% higher in firms without angels present as shareholders (from $63M to $94M). Although the overall valuations are closer, the differences between the two help to drive the multiple when angels are present to more than double the other group (11x vs. 5x invested capital). The signal from the multiple data is that firms with angels present are able to generate their value in a more capital efficient manner than firms without angels. As far as time to IPO, both groups are close to 9 years, with the companies with angels as shareholders trending slightly longer.

The data are even more interesting when considering the analysis across investor profiles. The bottom of Table 7 presents the data when controlling for angel and VC shareholders at the time of IPO. The

presence of angel investors without VCs correlates with much lower total invested capital and a much higher valuation multiple, especially when compared to firms with VCs but no angels – firms with angels only consumed less than half of the invested capital and yielded a multiple over four times as high as firms with VCs only. However, it is interesting to note that adding angel investors to the mix with VCs helps reduce the invested capital (from $100M to $73M) and improve the multiple (from 3.7x to 8.2x). On the other hand, the time to IPO diverges a little bit, with angel-only firms taking nearly two years longer than VC-only firms; adding angels and VCs together also adds over a year to the VC-only time.

Figure 10: Comparison of Total Invested Capital Across Investor Profiles

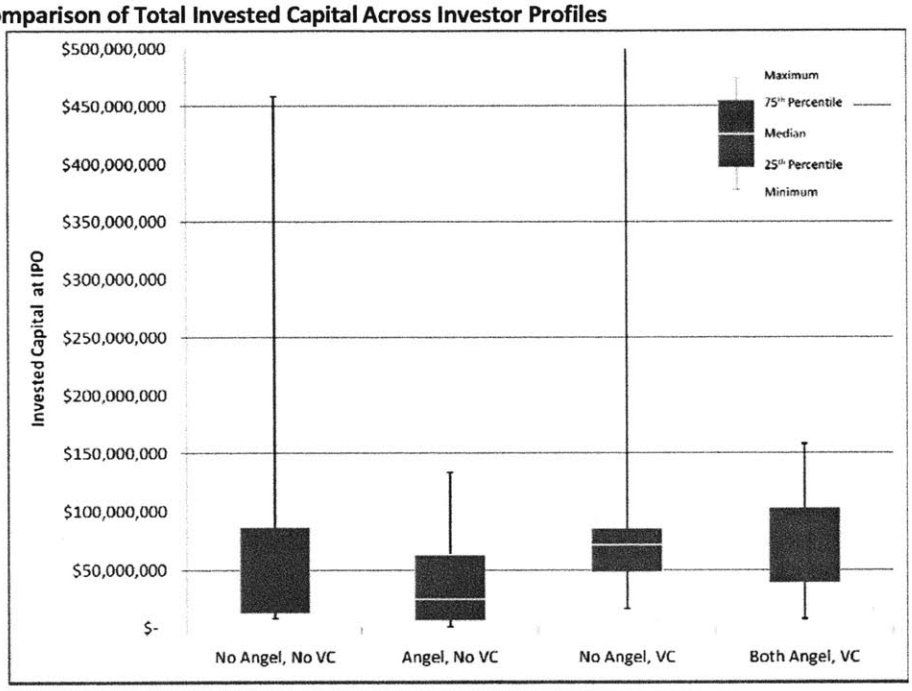
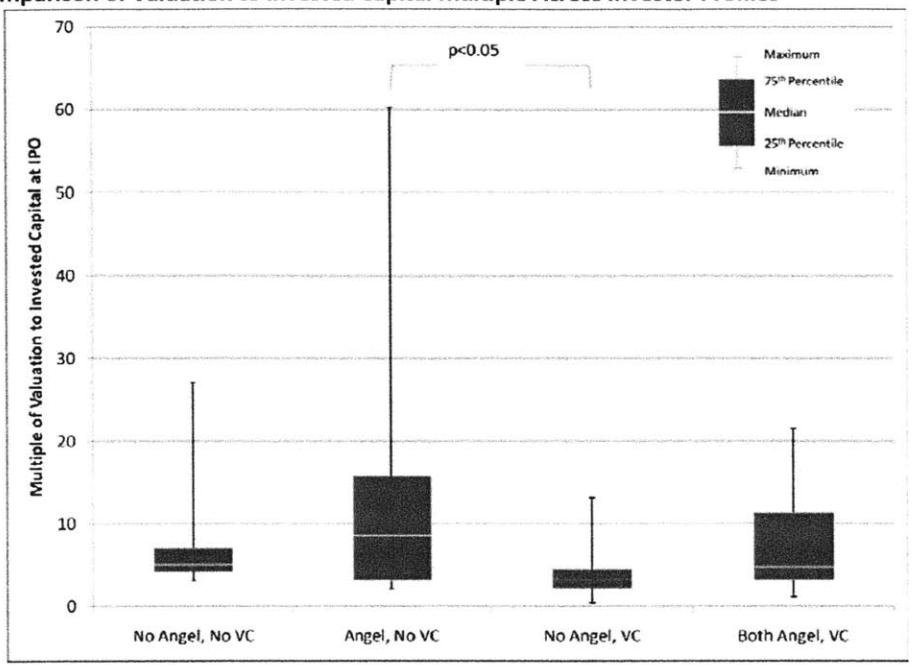


Figure 10 presents the investor profile data more completely. As before, to improve visualization, the figure cuts off the maximum invested capital at $500M, though the actual maximum for one group was about $640M. This figure sheds some light on why the average differences were not statistically significant. The overall distributions for most of the investor profiles were fairly similar, although the Angel, No VC group was lower than the others. Having angels involved also seems to limit the outliers – maximum values of invested capital in the two categories without angels exceeded $450M.

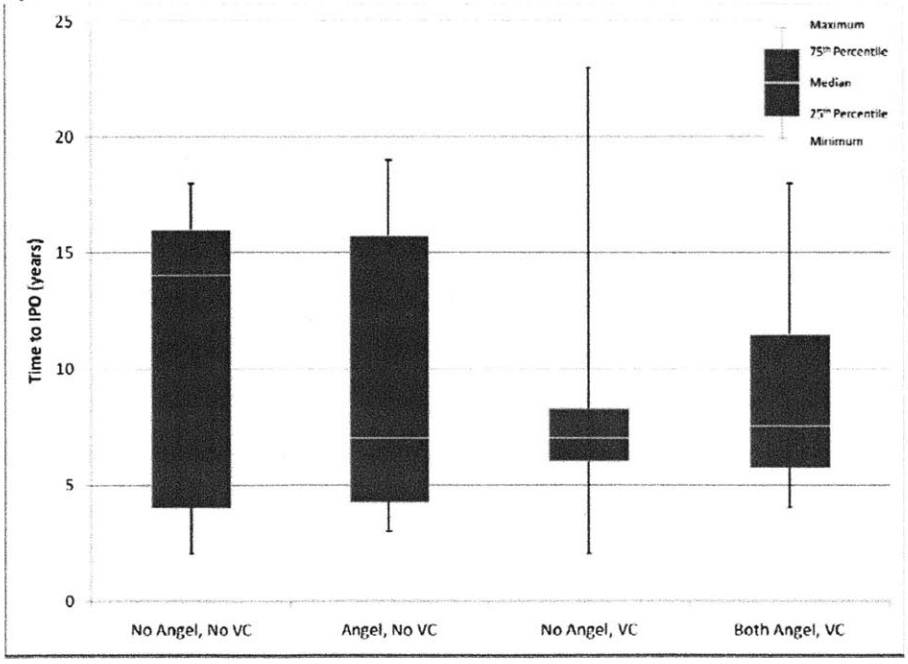
Figure 11 similarly presents the investor profile data for the multiple of valuation to total invested capital at the time of the IPO. The figure highlights a statistically significant difference (at a 95% confidence level) between firms with only angels and firms with only VCs, but actually shows that the distributions between the categories, aside from the angel-only group, are fairly similar.

Figure 11: Comparison of Valuation to Invested Capital Multiple Across Investor Profiles



Finally, Figure 12 compares the time to IPO across investor profiles. Interestingly, the VC-only group shows a similar median but a much tighter distribution; perhaps this is driven by VC fund lifecycles and the need to achieve an exit within a fixed period of time. Otherwise, the other groups are fairly similarly distributed, although the group with no angels or VCs had a much higher median than the other three.

Figure 12: Comparison of Time to IPO Across Investor Profiles



Discussion and Conclusions

This paper set out to assess whether founders of new ventures in the medical technology industry have better outcomes in terms of ownership and control of the company when one or more investment rounds involve angel investors (in addition to, or in place of, venture capitalists). It did so by separately considering, at the time of the IPO, whether founders own more of their companies and whether they have a greater degree of control, due to their presence as a director or an employee, when angel investors are also shareholders. These research aims were represented by the hypotheses H_1 and H_2:

> H_1: Founders of new ventures in medical technology own a greater share of the firm at the time of an initial public offering when angel investors are present among the shareholders.
>
> H_2: Founders of new ventures in medical technology have a greater degree of control of the firm at the time of an initial public offering when angel investors are present among the shareholders.

The results presented herein, notably those in Table 4 and Table 6, allow us to accept both H_1 and H_2 (more precisely, to fail to reject them), and thus the overall hypothesis. The presence of angel investors statistically significantly increases founder level of ownership and control over the firm at the time of the IPO. Moreover, these benefits appear to come without any penalty in terms of the overall valuation of the firm or the time to IPO.

To move beyond the results at face value, however, there must discussion of several important topics to help place these data into context and explore any meaningful conclusions. First among these is how relevant these results are for all founders in the medical technology industry, especially when prevailing wisdom suggests that an exit via IPO is rare. If, for example, the belief is that a new Medtech venture has no chance of reaching an IPO, then it is easy to dismiss this research as irrelevant. To address this concern, first consider Figure 5. Despite the lay press' infatuation with the IPO window being open or closed, at least one Medtech company was able to successfully complete an IPO in every year except 2003. Clearly, some years were much more plentiful in terms of IPOs than others, but it remains a viable exit option. Another data source to consider is the survey results from the Kauffman Foundation's Angel Investor Performance Project (AIPP)[viii]. Analysis of this publicly available dataset (briefly discussed at the

[viii] The AIPP survey results are summarized in a public-use data file available from the Kauffman Foundation that can be accessed at http://sites.kauffman.org/aipp/. Analysis of the dataset is discussed briefly in the appendix.

end of the appendix) reveals that 11% of angel-backed healthcare companies, and 9% of angel-backed Medtech companies, were able to complete an IPO. In terms of exit via a merger or an acquisition (M&A), 32% and 36%, respectively, were bought by another operating firm. This implies an IPO-to-M&A ratio of 4 to 1 for angel-backed Medtech companies. This may be an overestimate – certainly there is concern over the potential for bias in this dataset, and another paper estimates the ratio at closer to 6.7 to 1, or 13%, for VC-backed firms (43) – but it does reflect the fact that Medtech exits via IPO have been, and will in all likelihood continue to be, viable. Further support for this comes from a 2011 Silicon Valley Bank SVB Analytics Insight Update on the recent exit trends for venture-backed medical device and equipment companies, which shows IPOs occurring in 12 of the past 15 years (17). Even if exits via IPO are in the minority, they do occur.

More importantly, this paper's demonstrations of the benefits of angel investors to founders may be considered relevant regardless of the fact they were derived from a study of IPOs, if the relationship between these outcomes, and those of a firm that might exit via an M&A transaction, can be understood. If angel investors do have a role in promoting capital efficiency (discussed below), as the data presented indicates, this would be a benefit to any firm planning an M&A exit. Similarly, the differences in ownership and control seem to result primarily from the trade-off between angel and VC investors, and these investor types are probably also present in Medtech ventures that do not reach an IPO. If anything, the bias would be in favor of making these results more relevant since there is a greater chance that an angel-backed firm can reach an M&A exit without VC participation than an IPO exit. The exception to this would be if there are factors not accounted for in this paper – "soft" factors like network contacts and introductions to potential acquirers – that would favor a firm with VC investors. However, once recognized, a founder can mitigate this issue by seeking well-connected angels or introductions from other sources.

Returning to the results, assuming the positive relationship demonstrated in this paper between angel investor participation and founder outcomes holds true, it is important to consider explanations for why there is a relationship, and what might cause it. There seem to be at least three different possibilities: one, that angels are willing to agree to more advantageous terms than VCs; two, the role of sorting, which is the idea that angels and VCs are able to choose better firms; and three, most interestingly, that angel investors can actually enforce more capital efficient behavior in new ventures. The first possibility was discussed in the background, and there is clear evidence from both founders and investors that

angel financing and control terms are friendlier to founders than VC terms. This has a direct impact on founders since they are retaining more ownership and control at the earliest rounds, giving them more of a chance to demonstrate value. Moreover, it is possible that this effect extends through into additional rounds of funding where VCs are present – contract terms, though probably worse than angel terms, may be better because the firm already has external capital involved.

The second explanation, sorting, was introduced in the background section. Sorting refers to the fact that investors are able to look at different proposals and choose the best among them (58). Obviously, this paper assumes that a venture has sufficient merit to attract at least angels at the beginning. Angels are one layer of sorting; they can screen for stronger entrepreneurs or venture ideas at the outset, choosing those that demand less invested capital yet still be very successful (and thus are more likely to have better outcomes, like IPOs, and higher multiples). VCs also represent a sorting layer, one that is far more discriminating given there are so many fewer companies in which they invest. However, there may be value to founders seeking VC money in having been "pre-screened" by angel investors, if it makes it more likely that the ventures will be able to attract the additional capital needed. There is probably some truth to this; anecdotally, VCs suggest that many of the companies that receive funding have also previously received investment from angels. Taking it a step further, perhaps the initial funding from an angel investor provides a way for founders to defer the more aggressive sorting process of VCs until a stronger signal of the potential of the firm – and of the founder – can be demonstrated. The extra benefit is that the VC firms that sort the best – and are probably the hardest from which to secure funds – also are associated with better outcomes for their ventures (58).

The third explanation is the most interesting, but also the most difficult to assess and prove. It is possible that the lower invested capital associated with angel-backed companies is not a function of investors' choices of ventures, but rather a result of angel investors promoting, either directly or indirectly, behaviors and actions that are more capital efficient than other investors, especially VCs. Perhaps the presence of angel investors is a proxy for a venture's pursuit of a fundamentally different strategy in the way that capital is allocated and consumed. A founder that seeks angel capital will be expected to demonstrate progress to agreed-upon milestones using only the funds provided by the angel investors and any other non-dilutive sources. In the case of a very large seed-stage investment round underwritten by VCs, the amount of capital injected into the company allows founders and employees to relax, knowing that the company will survive if a mistake is made, or a milestone is

missed, or a test fails. However, when the founding team prioritizes the preservation of their own equity – and seeking angel investment may be a sign that this is the case in a new venture – the result may be a culture of capital efficiency that permeates throughout decisions and activities. In reality, it may not be that angel investors are pushing a capital efficient strategy; rather, it may be the result of macroeconomic factors that force the choice. In this view, founders would be incentivized to seek out angel investors that are willing to invest lower amounts of capital, and do not have the same (somewhat perverse) incentives as VCs that need to put substantially more money to work. Founders can "right-size" an angel round simply by adding or subtracting individual investors, and this control empowers them to make the best decisions for the firm in an environment that encourages conservative financial behavior. Organizations would tend to be leaner and product development less expensive, both of which make the venture much more appealing to potential acquirers (45) – and make the probability of a higher multiple at exit that much higher.

Whether terms, sorting, or capital efficiency, if the results of the analysis are held to be both true and as an explicit result of angel investment, on who should the results have an impact and why? The primary impact would be felt by potential (or existing) founders of new ventures in the medical technology industry. It is legitimate to wonder how applicable the paper is to the average Medtech founder; after all, every new venture must be adequately capitalized or it will perish, and the founder's primary responsibility is to keep the lights on. Still, even in that context, there are lessons that can be instructive. If possible, founders should seek angels for early stage investments, or create a plan that allows for an early angel round. Angel groups are a good way to scale the investment process in both directions, making a slightly larger round more efficient. Plus, angel groups are probably able to access a larger network of potentially helpful contacts.

More specifically, it may be best for a founder to focus on choosing those tasks that are value-creating and de-risking, and that are able to be accomplished with less capital, allowing a smaller initial early round with angels, an action that is associated with better firm outcomes. The result of this strategy is a focus on consistently trying to build and demonstrate value with the lowest required investment, which is an advantageous when approaching potential investors in subsequent funding rounds. Practically, there is likely to be increasing competition for capital from VC funds as they move later stage and fewer LP funds flow into the asset class, so any differentiating factor is important. Scarcer funds, while good for VCs, will serve to put unwanted pressure on valuations and deal terms. Aside from internal strategy,

since most new ventures do not operate in a vacuum, competitors may also be utilizing a capital efficient strategy. Unfortunately, If there is competition for exits between the founder's firm and the more capital efficient alternative, the founder may lose out if the acquirer prefers the leaner organization (with less overhead to absorb), even if the product is as good or slightly better.

From a founder's perspective, there are, of course, instances in which angel investors do not represent the best choice. The results from this paper might not hold true for a new venture in which the primary strategy is to conduct acquisitions or a roll-up of other firms, or for a venture that is a spin-out of an established company and comes equipped with projects and an established organization. In these cases, more capital can often be an advantage and even a requirement for success. Also, as the literature reviewed in the background suggested, highly regulated Medtech products are often very expensive to bring to market. There may simply be a point in the lifecycle of a venture at which angel capital is not sufficient. In fact, there is evidence touched on in the literature review that implies that if a firm has to fill a large round with angel investors instead of VCs, the outcomes for that firm will be worse.

Investors of different types can also draw lessons from the results in this paper. For angel investors, some organization into groups and professionalization is probably good, and would serve to enhance some of the benefits that are often associated with VCs but not individuals. Angels should continue to either choose firms that can be capital efficient, or influence firms in their portfolios to be that way. Also, the results suggest that angels should not be too afraid of working with VCs; although valuation and multiple outcomes are not quite as good for firms with only angels, they are improved over firms with only VCs. For VCs, it is interesting to consider the role that angel investors can play in the screening and sorting process, particularly if seed-stage investing is no longer attractive to the VC firm. Choosing ventures that have already proven their concepts out and know they need a larger amount of capital and eliminating those that are probably going to be able to exit without much additional investment are both ways that VCs can improve their own returns by working with angel-backed new ventures.

Finally, one other class of members of the Medtech ecosystem can draw value from this paper – sources of intellectual property for innovations in medical technology, including hospitals, research laboratories, and universities. To these institutions, the results suggest that they would be wise to consider the expected requirements for invested capital when they look to license IP. Certain types of technologies

that are much more capital intensive may be better off (from the perspective of the licensor) going to a larger company able to self-finance development instead of to a new venture, which, based on these results, has worse outcomes for the founder due to much more dilution. On the other hand, the focus and efficiency of a start-up could generate good results and returns if the expected capital needs are lower. The results of this paper can be considered applicable to these decisions based on the assumption that an initial IP licensor is most similar to a founder in terms of standing in the firm at exit.

One issue not previously discussed is how relevant these results are to the overall success of the firm, after the IPO. It would be interesting to consider whether companies with greater founder ownership and control experience similar outcomes to those with less, but with more backing from VCs. This paper intentionally avoided looking post-IPO because the offering often represents an intentional relinquishing of ownership and control on the part of the founder, so it is harder to assess the impact. Literature reviewed in the background, however, can provide some insight. VC ownership concentration, unless balanced by founder-CEO ownership concentration, was associated with a significant increase in the likelihood of firm failure in the five years after an IPO (59). If that is the case, than the fact that firms with angel-backing in this paper had founders with, on average, a higher degree of ownership and control means that these firms are more likely to be successful over the following five years than firms without angels present as shareholders.

As a counter to much of the discussion, there are several things that the results do not say about new Medtech ventures and their founders. There are many inputs into a successful venture, only one of which is capital, and any of these – including the macroeconomic environment or just plain luck – may be what makes a firm succeed or fail. There are those factors that affect the potential valuation of a firm that are not directly controlled by the founder, like competition and the regulatory regime. This paper also focuses exclusively on US-based companies listing in the US, so it does not extend to firms and founders based in other countries or thinking about listing overseas. In addition, going forward, it is possible that the results in this paper could be rendered irrelevant by external factors. For example, a significant shift in the macroeconomic environment or in the healthcare funding policies of the US could mean that Medtech ventures will be unable to go public. On the other hand, these sorts of changes do present another reason for founders to be efficient with the capital that is invested into the firm.

Finally, the results discussed in this paper reveal several promising directions for future research. One theme would be research that verifies the data and methods used by this paper. Surveying angel investors identified in this paper to determine what proportion can be technically defined as angels, and what proportion consider themselves angels, would be a good exercise to test the shareholder classifications. On the other side, surveying firms that received funds from the shareholders in this dataset would also reveal clues about the investment process and whether those firms consider their investors to be angels, or even whether the firms actually made an active decision to seek angel capital. Also, continuing to follow the firms post-IPO would provide evidence of whether the outcomes were, in fact, better for angel-backed companies. Another theme would be to validate the results described by this paper. Some literature exists looking at the companies that receive angel investing, but it might be instructive to do a more comprehensive assessment at what the firms themselves believe are the impacts of angel investments on them. The most interesting, and probably most difficult, extension would be to do a prospective comparison of founders and new ventures in the medical technology industry as they approach their initial financing decisions. One way that this could be accomplished would be to "enroll" licensees (in particular, licensees that are entrepreneurs or new business entities) of medical technology intellectual property from one or more institutional (university, hospital) technology transfer offices, and in a prospective study follow them longitudinally over enough time to cover failure or a successful exit. In this way, with a large enough dataset, the differences in the performance of firms could potentially be attributed to the financing decisions and the role of investors in these firms. A close watch of the strategic decisions of the firms could also shed light on whether capital efficient strategies are more effective, and on how these strategies are developed and enforced (i.e., from the founders or from the investors).

In summary, previous research suggests that many founders have realized the benefits of angel financing already. In one survey of founders of technology-based companies, about 60% had raised money from angels. The top factors that led them to a deal were less dilution, receiving the appropriate amount of money (and not being forced to take more), speed in closing the deal, and pre-money valuation (61). Founders requiring more investor patience, having greater managerial ability, or having a preference for retaining control match best with angel investors, while founders requiring managerial coaching, faster growth match, or larger amounts of capital match best with VCs. Firms having some of both characteristics match best with mixed investors (53). From this paper, by proving the primary hypothesis, we can add that founders of firms with angel investors as shareholders at the time of IPO

have significantly greater ownership of shares and significantly greater control of the firm as an employee or director than founders of firms that do not have angel investors present at the time of IPO. Angel-backed firms required less invested capital and no longer to reach the IPO, and, most significantly, did not pay a price in terms of a negative impact on the overall valuation of the firm. On the contrary, there was a trend of firms – and founders themselves – seeming to do better from a valuation perspective, and significantly better from a multiple perspective, when angel investors were present. Even when firms received backing from venture capitalists, angel investors also seemed to generally improve the performance of the firm and of the founders. Thus, this paper has helped to demonstrate that angel investors seem to be an important source of capital, as well as non-monetary value, to founders of new ventures in the medical technology industry.

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Appendix

Table A-1: List of Primary SIC Codes and Descriptions Used in the SDC Query

Primary SIC Code	SIC Code Description
2836	Biological products, expect diagnostic substances
8731	Commercial physical and biological research
3843	Dental equipment and supplies
8072	Dental laboratories
8049	Doctors' offices
3845	Electromedical and electrotherapeutical apparatus
8062	General medical and surgical hospitals
8099	Health and allied services
8082	Home health care services
2835	In vitro and In vivo diagnostic substances
8052	Intermediate care facilities
8092	Kidney dialysis centers
3826	Laboratory analytical instruments
3821	Laboratory apparatus and furniture
7352	Medical equipment rental and leasing
8071	Medical laboratories
5047	Medical, dental, and hospital equipment and supplies
2833	Medicinal chemicals and botanical products
8059	Nursing and personal care facilities
8041	Offices and clinics of chiropractors
8021	Offices and clinics of dentists
8011	Offices and clinics of doctors of medicine
8031	Offices and clinics of doctors of osteopathy
8042	Offices and clinics of optometrists
8043	Offices and clinics of podiatrists
3851	Ophthalmic goods
5048	Ophthalmic goods
3842	Orthopedic, prosthetic, and surgical supplies
2834	Pharmaceutical prepartions
8063	Psychiatric hospitals
8051	Skilled nursing care facilities
8069	Specialty hospitals, except psychiatric
8093	Specialty outpatient facilities
3841	Surgical and medical instruments and apparatus
3844	X-Ray apparatus and tubes and other irradiation equipment

Table A-2: Firm Description and IPO Characteristics for All Companies Included in the IPO Analysis

Issuer	SIC Code	Business Description	State	Issue Date	Total Common Equity Shares			Offer Price	Valuation at IPO	Invested Capital	Time to IPO
					Pre-Offer	Issued	Post-Offer				
Accuray Inc	3841	Mnfr,whl radiosurgical devices	California	2/7/2007	42,043,386	7,333,333	49,376,719	$ 18.00	$ 888,780,942	$ 41,716,000	17
AGA Medical Holdings Inc	3845	Mnfr cardio medical devices	Minnesota	10/20/2009	43,260,834	13,750,000	50,236,834	$ 14.50	$ 728,434,093	$ 178,337,335	14
Align Technology Inc	3843	Mnfr,whl med devices	California	1/25/2001	35,616,402	10,000,000	45,616,402	$ 13.00	$ 593,013,226	$ 129,100,000	6
Alphatec Holdings Inc	3841	Mnfr spine treatment prod	California	6/2/2006	23,653,476	9,300,000	32,953,476	$ 9.00	$ 296,581,284	$ 47,088,085	16
Amyris Inc	2869	Biotech co (Synthetic Fuels)	California	9/27/2010	37,142,963	5,300,000	42,442,963	$ 16.00	$ 679,087,408	$ 383,947,000	7
AngioDynamics Inc	3841	Mnfr vascular devices	New York	5/26/2004	9,192,857	1,950,000	11,142,857	$ 11.00	$ 122,571,429	$ 26,417,000	16
Animas Corp	3841	Mnfr insulin pumps	Pennsylvania	5/19/2004	14,209,900	4,250,000	18,459,900	$ 15.00	$ 276,898,500	$ 82,138,000	8
Artes Medical Inc	8731	Dvlp,mnfr med prod	California	12/19/2006	11,085,731	4,600,000	15,685,731	$ 6.00	$ 94,114,386	$ 81,556,051	7
AtriCure Inc	3841	Mnfr surgical devices	Ohio	8/5/2005	7,901,530	4,000,000	11,901,530	$ 12.00	$ 142,818,360	$ 29,286,000	5
Baeta Corp	3841	Dvlp stage med tech co	New Jersey	6/4/2010	22,816,708	915,400	22,816,708	$ 1.00	$ 22,816,708	$ 378,328	3
BioForm Medical Inc	3842	Mnfr med aesthetics prod	California	11/6/2007	34,596,230	10,000,000	44,596,230	$ 8.00	$ 356,769,840	$ 71,910,000	8
BioMimetic Therapeutics Inc	3841	Biotech co	Tennessee	5/12/2006	10,967,370	4,500,000	15,467,370	$ 8.00	$ 123,738,960	$ 52,330,431	7
Bruker AXS Inc	3844	Mnfr,whl x-ray equip	Wisconsin	12/14/2001	44,532,261	9,000,000	53,532,261	$ 6.50	$ 347,959,697	$ 25,073,790	4
CABG Medical Inc	3841	Mnfr bypass graft	Minnesota	12/7/2004	11,391,725	5,500,000	16,891,725	$ 5.50	$ 92,904,488	$ 7,827,161	5
Cardica Inc	3841	Manufacture stapling devices	California	2/2/2006	5,949,337	3,500,000	9,449,337	$ 10.00	$ 94,498,370	$ 39,550,257	9
Codexis Inc	2869	Biotech co (Biocatalyst)	California	4/21/2010	27,909,280	6,000,000	33,977,068	$ 13.00	$ 441,701,884	$ 215,184,907	8
Conor Medsystems Inc	3841	Mnfr vascular medical devices	California	12/14/2004	26,104,734	6,150,000	32,254,734	$ 13.00	$ 419,311,542	$ 86,308,420	5
CryoCor Inc	3841	Mnfr surgical equip	California	7/13/2005	6,889,229	3,700,000	10,589,229	$ 11.00	$ 116,481,519	$ 46,828,233	5
CTI Molecular Imaging Inc	3826	Mnfr positron emission equip	Tennessee	6/20/2002	32,016,926	10,000,000	42,016,926	$ 17.00	$ 714,287,742	$ 41,462,000	19
Cutera Inc	3845	Design laser products	California	3/30/2004	6,988,114	3,100,000	10,088,114	$ 14.00	$ 141,233,596	$ 7,739,000	6
Cynosure Inc	3845	Mnfr,whl aesthetic med devices	Massachusetts	12/8/2005	6,242,877	4,000,000	10,242,877	$ 15.00	$ 153,643,155	$ 12,310,367	14
Dexcom Inc	3841	Mnfr med device	California	4/13/2005	20,486,761	4,700,000	25,186,761	$ 12.00	$ 302,241,132	$ 71,351,738	6
Digirad Corp	3845	Mnfr,whl med imaging prod	California	6/9/2004	12,502,409	5,500,000	18,002,409	$ 12.00	$ 216,028,908	$ 85,300,000	11
DJ Orthopedics Inc	3842	Mnfr,whl orthopedic prod	California	11/14/2001	10,055,566	7,800,000	17,855,566	$ 17.00	$ 308,544,622	$ 86,392,000	2
Electromed Inc	3845	Mnfr therapeutic prod	Minnesota	8/13/2010	6,187,885	2,000,000	8,187,885	$ 4.00	$ 32,751,540	$ 6,108,696	18
Electro-Optical Sciences Inc	3841	Design,dvlp medical equip	New York	10/28/2005	6,513,164	4,000,000	10,513,164	$ 5.00	$ 52,565,820	$ 20,083,573	16
EnteroMedics Inc	3845	Mnfr medical devices	Minnesota	11/14/2007	11,309,113	5,000,000	16,309,113	$ 5.00	$ 81,545,565	$ 65,217,068	5
ev3 Inc	3841	Manufacture medical instrument	Minnesota	6/16/2005	19,214,000	11,765,000	30,979,000	$ 14.00	$ 433,706,000	$ 642,099,000	5
FoxHollow Technologies Inc	3841	Mnfr,whl med devices	California	10/27/2004	17,588,321	4,500,000	22,088,321	$ 14.00	$ 309,236,494	$ 80,881,428	8
Hansen Medical Inc	3842	Mnfr med robotics	California	11/15/2006	14,303,982	6,250,000	20,553,982	$ 12.00	$ 246,647,184	$ 62,319,812	4
HemoSense Inc	3841	Mnfr,dvlp,whl monitoring sys	California	6/28/2005	6,033,764	3,500,000	9,533,764	$ 5.50	$ 52,435,702	$ 40,024,091	8
Insulet Corp	3841	Mnfr,whl medical devices	Massachusetts	5/14/2007	17,983,237	6,700,000	24,683,237	$ 15.00	$ 369,498,555	$ 119,765,016	7
IntraLase Corp	3845	Mnfr medical lasers	California	10/6/2004	19,169,479	6,300,000	25,469,479	$ 13.00	$ 331,103,227	$ 74,691,215	7
Ivivi Technologies Inc	3845	Medical tech co	New Jersey	10/18/2006	7,092,435	2,500,000	9,592,435	$ 6.00	$ 57,554,610	$ 8,162,100	17
Kinetic Concepts Inc	3841	Mnfr therapeutic beds	Texas	2/23/2004	66,291,366	3,500,000	69,791,366	$ 30.00	$ 2,093,740,980	$ 458,611,346	7
Kyphon Inc	3841	Mnfr med devices	California	5/17/2002	29,644,570	6,000,000	35,644,570	$ 15.00	$ 534,668,550	$ 40,451,012	8
LeMaitre Vascular Inc	3841	Mnfr,wholesale medical devices	Massachusetts	10/19/2006	9,772,064	5,500,000	15,272,064	$ 7.00	$ 106,904,448	$ 20,694,000	23
Luna Innovations Inc	8731	Dvlp,mnfr fiber optic prod	Virginia	6/2/2006	6,234,325	3,500,000	9,734,325	$ 6.00	$ 58,405,950	$ 11,463,456	16
MAKO Surgical Corp	3841	Mnfr medical implants	Florida	2/14/2008	13,338,284	5,100,000	18,438,284	$ 10.00	$ 184,382,840	$ 55,792,628	4
Masimo Corp	3845	Mnfr,dvlp medical devices	California	8/7/2007	51,316,788	1,500,000	52,816,788	$ 17.00	$ 897,885,396	$ 97,971,000	18
MedSource Technologies Inc	3841	Mnfr surgical instruments	Massachusetts	3/26/2002	17,024,424	8,340,000	25,364,424	$ 12.00	$ 304,373,088	$ 133,433,000	4
Micrus Endovascular Corp	3841	Mnfr,wholesale medical devices	California	6/16/2005	10,441,021	3,250,000	13,691,021	$ 11.00	$ 150,601,231	$ 70,128,888	9
Natus Medical Inc	3845	Mnfr,whl med screening prod	California	7/19/2001	9,835,621	5,075,000	14,910,621	$ 11.00	$ 164,016,831	$ 16,354,000	14
Nephros Inc	3841	Medical device and tech comp	New Jersey	9/20/2004	10,022,072	2,100,000	12,122,072	$ 6.00	$ 72,732,432	$ 23,493,538	7
Northstar Neuroscience Inc	3845	Dvlp,mnfr med device	Washington	5/4/2006	17,079,971	7,265,000	24,344,971	$ 15.00	$ 365,174,565	$ 80,963,838	7
NuVasive Inc	3841	Mnfr med devices	California	5/12/2004	16,842,983	6,500,000	23,342,983	$ 11.00	$ 256,772,813	$ 85,395,000	7
NxStage Medical Inc	3845	Mnfr portable dialysis machine	Massachusetts	10/27/2005	14,691,521	5,500,000	20,191,521	$ 10.00	$ 201,915,210	$ 92,398,852	7
Obagi Medical Products Inc	2834	Mnfr,whl skin care sys,prod	California	12/13/2006	17,799,183	4,000,000	21,799,183	$ 11.00	$ 239,791,013	$ 8,854,943	18
Power Med Interventions Inc	3841	Mnfr surgical cutting prod	Pennsylvania	10/25/2007	12,679,395	3,850,000	16,529,395	$ 11.00	$ 181,823,345	$ 157,912,805	8
Quinton Cardiology Systems Inc	3841	Mnfr,market cardiology equip	Washington	5/6/2002	7,548,675	4,000,000	11,548,675	$ 7.00	$ 80,840,725	$ 13,245,100	4
Restore Medical Inc	3841	Mnfr medical device	Minnesota	5/16/2006	11,251,225	4,000,000	15,251,225	$ 8.00	$ 122,009,800	$ 39,918,048	7
SenoRx Inc	3841	Mnfr,whl med devices	California	3/28/2007	9,480,572	5,500,000	14,980,572	$ 8.00	$ 119,844,576	$ 54,243,728	9
Stereotaxis Inc	3845	Mnfr,whl cardiology instrument	Missouri	8/11/2004	20,664,857	5,500,000	26,164,857	$ 8.00	$ 209,318,856	$ 130,093,425	16
Symmetry Medical Inc	3842	Mnfr,whl implants	Indiana	12/8/2004	24,920,087	8,000,000	32,920,087	$ 15.00	$ 493,800,555	$ 138,285,000	4
Tenglon Inc	2836	Mnfr replacement organs	Pennsylvania	4/9/2010	6,353,536	6,000,000	12,353,536	$ 5.00	$ 61,767,680	$ 147,900,000	7
TheraSense Inc	3841	Mnfr,whl glucose testing sys	California	10/11/2001	32,089,847	6,000,000	38,089,847	$ 19.00	$ 723,707,093	$ 120,396,078	5
Thermage Inc	3845	Dvlp cosmetic surgery prods	California	11/9/2006	16,475,924	6,000,000	22,475,924	$ 7.00	$ 157,331,468	$ 48,450,000	10
Tomotherapy Inc	3845	Mnfr,whl radiation therapy sys	Wisconsin	5/8/2007	38,145,337	10,200,000	48,345,337	$ 19.00	$ 918,561,403	$ 42,735,000	10
Trans1 Inc	3841	Mnfr medical devices	North Carolina	10/16/2007	13,276,502	5,500,000	18,776,502	$ 15.00	$ 281,647,530	$ 40,565,000	7
VNUS Medical Technologies Inc	3845	Mnfr med devices	California	10/20/2004	10,333,792	4,000,000	14,333,792	$ 15.00	$ 215,006,880	$ 53,455,000	9
Volcano Corp	3845	Mnfr catheters,guidewires	California	6/14/2006	25,118,208	6,800,000	31,918,208	$ 8.00	$ 255,345,624	$ 68,312,000	6
Wright Medical Group Inc	3842	Mnfr surgical joint devices	Tennessee	7/12/2001	20,972,408	7,500,000	27,979,704	$ 12.50	$ 349,746,300	$ 76,471,000	2
XTENT Inc	3841	Mnfr medical devices	California	1/31/2007	18,096,308	4,700,000	22,796,308	$ 16.00	$ 364,740,928	$ 76,412,842	6

Table A-3: Ownership Stake and Value of Stake for All Companies Included in the IPO Analysis

Issuer	Ownership of Firm at the Time of IPO (%)						Value of Stake at the Time of IPO ($)					
	Founder	VC	Angel	Other Investors	Insiders	Total in S-1	Founder	VC	Angel	Other Investors	Insiders	Firm Total
Accuray Inc	4.3%	9.10%	5.7%	47.3%	9.0%	75.4%	$ 38,217,581	$ 80,879,066	$ 50,660,514	$ 420,393,386	$ 79,545,894	$ 888,780,942
AGA Medical Holdings Inc	40.0%	0.00%	0.0%	60.0%	0.0%	100.0%	$ 291,373,637	$ -	$ -	$ 436,841,926	$ -	$ 728,434,093
Align Technology Inc	15.5%	33.30%	6.3%	15.6%	8.7%	79.4%	$ 91,917,050	$ 197,473,404	$ 37,359,833	$ 92,510,063	$ 51,710,753	$ 593,013,226
Alphatec Holdings Inc	2.4%	0.00%	0.0%	64.4%	4.0%	70.8%	$ 7,058,635	$ -	$ -	$ 190,998,347	$ 11,981,884	$ 296,581,284
Amyris Inc	11.0%	33.30%	0.0%	33.9%	7.8%	86.1%	$ 74,903,341	$ 226,136,107	$ -	$ 230,210,631	$ 53,172,544	$ 679,087,408
AngioDynamics Inc	0.0%	0.00%	0.0%	100.0%	0.0%	100.0%	$ -	$ -	$ -	$ 122,571,429	$ -	$ 122,571,429
Animas Corp	23.6%	10.50%	15.2%	11.2%	1.9%	62.4%	$ 65,348,046	$ 29,074,343	$ 42,088,572	$ 31,012,632	$ 5,371,831	$ 276,898,500
Artes Medical Inc	11.4%	5.40%	0.0%	0.0%	4.9%	21.7%	$ 10,729,040	$ 5,082,177	$ -	$ -	$ 4,592,782	$ 94,114,386
AtriCure Inc	9.8%	61.70%	10.1%	2.4%	4.5%	88.5%	$ 13,995,199	$ 88,118,928	$ 14,381,809	$ 3,484,768	$ 6,383,981	$ 142,818,360
Baeta Corp	91.0%	0.00%	3.0%	2.3%	3.4%	99.9%	$ 20,763,200	$ -	$ 675,374	$ 522,502	$ 775,768	$ 22,816,703
BioForm Medical Inc	10.1%	63.30%	0.0%	9.6%	4.4%	87.4%	$ 36,033,754	$ 225,835,309	$ -	$ 34,249,905	$ 15,733,550	$ 356,769,840
BioMimetic Therapeutics Inc	13.3%	51.90%	0.0%	13.4%	2.8%	81.4%	$ 16,457,282	$ 64,220,520	$ -	$ 16,581,021	$ 3,452,317	$ 123,738,960
Bruker AXS Inc	87.0%	0.00%	0.0%	9.5%	0.0%	96.5%	$ 302,724,936	$ -	$ -	$ 33,056,171	$ -	$ 347,959,697
CABG Medical Inc	58.1%	0.00%	31.4%	0.0%	0.7%	90.2%	$ 53,977,507	$ -	$ 29,172,009	$ -	$ 678,203	$ 92,904,488
Cardica Inc	19.8%	16.60%	0.0%	35.5%	10.8%	82.7%	$ 18,709,687	$ 15,685,899	$ -	$ 33,545,146	$ 10,224,183	$ 94,493,370
Cedexis Inc	4.0%	22.70%	0.0%	52.6%	7.3%	86.6%	$ 17,668,075	$ 100,266,328	$ -	$ 232,335,191	$ 32,111,727	$ 441,701,884
Conor Medsystems Inc	7.6%	38.31%	0.0%	8.8%	17.5%	72.2%	$ 31,867,677	$ 160,638,252	$ -	$ 36,899,416	$ 73,421,451	$ 419,311,542
CryoCor Inc	4.9%	56.50%	0.0%	30.8%	7.1%	99.3%	$ 5,707,594	$ 65,812,058	$ -	$ 35,876,308	$ 8,305,132	$ 116,481,519
CTI Molecular Imaging Inc	55.1%	0.00%	9.5%	13.8%	4.7%	83.1%	$ 393,858,261	$ -	$ 67,857,335	$ 98,571,708	$ 33,357,238	$ 714,287,742
Cutera Inc	25.7%	62.30%	1.7%	0.0%	10.4%	100.0%	$ 36,297,034	$ 87,988,530	$ 2,443,341	$ -	$ 14,617,677	$ 141,233,596
Cynosure Inc	0.0%	0.00%	0.0%	78.3%	5.9%	84.2%	$ -	$ -	$ -	$ 120,302,590	$ 9,126,403	$ 153,643,155
Dexcom Inc	0.0%	43.70%	0.0%	19.9%	13.2%	76.8%	$ -	$ 132,079,375	$ -	$ 60,145,985	$ 39,744,709	$ 302,241,132
Digirad Corp	0.0%	60.02%	0.0%	12.0%	6.3%	78.3%	$ -	$ 129,660,551	$ -	$ 25,923,469	$ 13,631,424	$ 216,028,908
DJ Orthopedics Inc	3.0%	0.00%	0.0%	95.9%	1.1%	100.0%	$ 9,106,339	$ -	$ -	$ 291,099,292	$ 3,338,991	$ 303,544,622
Electromed Inc	17.9%	0.00%	22.3%	0.0%	8.6%	48.8%	$ 5,859,251	$ -	$ 7,300,318	$ -	$ 2,816,632	$ 32,751,540
Electro-Optical Sciences Inc	7.3%	2.46%	31.0%	0.0%	4.7%	45.5%	$ 3,837,305	$ 1,293,119	$ 16,295,404	$ -	$ 2,481,107	$ 52,565,820
EnteroMedics Inc	3.8%	89.60%	0.0%	0.0%	3.2%	96.6%	$ 3,098,731	$ 73,064,826	$ -	$ -	$ 2,617,613	$ 81,545,565
ev3 Inc	0.6%	7.50%	0.0%	91.1%	1.0%	100.0%	$ 2,515,495	$ 32,527,950	$ -	$ 394,976,054	$ 4,423,801	$ 433,706,000
FoxHollow Technologies Inc	33.2%	22.30%	0.0%	0.0%	12.8%	68.3%	$ 102,542,821	$ 68,959,738	$ -	$ -	$ 39,644,119	$ 309,236,494
Hansen Medical Inc	15.0%	71.13%	0.0%	0.0%	4.8%	90.9%	$ 36,898,419	$ 175,440,142	$ -	$ -	$ 11,814,400	$ 246,647,184
HemoSense Inc	0.0%	88.40%	0.0%	0.0%	7.5%	95.9%	$ -	$ 46,353,161	$ -	$ -	$ 3,932,678	$ 52,435,702
Insulet Corp	0.0%	67.80%	0.0%	17.7%	8.2%	93.7%	$ -	$ 250,520,020	$ -	$ 65,401,244	$ 30,335,831	$ 369,498,555
IntraLase Corp	5.0%	53.80%	0.0%	33.1%	8.2%	100.0%	$ 16,555,161	$ 178,133,536	$ -	$ 109,727,609	$ 27,117,354	$ 331,103,227
Ivivi Technologies Inc	5.0%	0.00%	0.0%	85.0%	10.0%	100.0%	$ 2,889,241	$ -	$ -	$ 48,938,685	$ 5,726,684	$ 57,554,610
Kinetic Concepts Inc	27.7%	0.00%	0.0%	62.5%	9.8%	100.0%	$ 580,175,626	$ -	$ -	$ 1,307,959,990	$ 205,605,364	$ 2,093,740,980
Kyphon Inc	4.4%	74.64%	0.0%	0.0%	5.4%	84.4%	$ 23,311,549	$ 399,076,606	$ -	$ -	$ 28,711,701	$ 534,668,550
LeMaitre Vascular Inc	57.1%	14.30%	0.0%	0.0%	8.8%	80.2%	$ 61,031,749	$ 15,287,336	$ -	$ -	$ 9,396,901	$ 106,904,448
Luna Innovations Inc	42.3%	0.00%	0.0%	35.7%	10.1%	88.1%	$ 24,705,717	$ -	$ -	$ 20,850,924	$ 5,869,798	$ 58,405,950
MAKO Surgical Corp	8.5%	35.87%	11.6%	30.9%	0.1%	86.9%	$ 15,672,541	$ 66,138,125	$ 21,369,971	$ 56,900,544	$ 221,259	$ 184,382,840
Masimo Corp	18.8%	7.60%	8.1%	22.9%	4.4%	61.8%	$ 168,802,454	$ 68,239,290	$ 72,728,717	$ 205,615,756	$ 39,058,015	$ 897,885,396
MedSource Technologies Inc	19.5%	0.00%	11.9%	38.2%	2.4%	72.0%	$ 59,352,752	$ -	$ 36,220,397	$ 116,118,333	$ 7,426,703	$ 304,373,088
Micrus Endovascular Corp	4.8%	0.00%	4.5%	49.4%	8.1%	66.8%	$ 7,228,859	$ -	$ 6,822,236	$ 74,397,008	$ 12,198,700	$ 150,601,231
Natus Medical Inc	20.5%	28.20%	0.0%	18.3%	6.3%	73.2%	$ 33,590,647	$ 46,252,746	$ -	$ 30,015,080	$ 10,267,454	$ 164,016,831
Nephros Inc	15.2%	0.00%	0.0%	54.5%	9.3%	79.0%	$ 11,055,330	$ -	$ -	$ 39,639,175	$ 6,785,936	$ 72,732,432
Northstar Neuroscience Inc	7.8%	49.90%	0.0%	20.8%	2.2%	80.7%	$ 28,337,546	$ 182,222,108	$ -	$ 75,956,310	$ 8,106,875	$ 365,174,565
NuVasive Inc	5.4%	45.10%	0.0%	36.4%	8.4%	95.3%	$ 13,840,055	$ 115,804,539	$ -	$ 93,568,013	$ 21,568,916	$ 256,772,813
NxStage Medical Inc	5.4%	63.20%	12.9%	8.3%	4.7%	94.5%	$ 10,903,421	$ 127,610,413	$ 26,047,062	$ 16,758,962	$ 9,389,057	$ 201,915,210
Obagi Medical Products Inc	25.1%	0.00%	0.0%	60.7%	10.5%	96.3%	$ 60,187,544	$ -	$ -	$ 145,553,145	$ 25,178,056	$ 239,791,013
Power Med Interventions Inc	22.3%	15.40%	0.4%	17.5%	0.1%	55.7%	$ 40,546,606	$ 28,000,795	$ 654,564	$ 31,819,085	$ 254,553	$ 181,823,345
Quinton Cardiology Systems Inc	0.0%	0.00%	0.0%	82.8%	17.3%	100.0%	$ -	$ -	$ -	$ 66,895,700	$ 13,945,025	$ 80,840,725
Restore Medical Inc	0.1%	65.90%	0.0%	23.3%	1.3%	90.6%	$ 97,608	$ 80,404,458	$ -	$ 28,428,283	$ 1,586,127	$ 122,009,800
SenoRx Inc	10.1%	65.40%	0.0%	5.2%	9.6%	90.3%	$ 12,104,302	$ 78,378,353	$ -	$ 6,231,918	$ 11,457,141	$ 119,844,576
Stereotaxis Inc	0.0%	42.53%	0.0%	14.3%	6.5%	63.3%	$ -	$ 89,023,309	$ -	$ 29,953,528	$ 13,563,862	$ 209,318,856
Symmetry Medical Inc	0.0%	0.00%	0.0%	98.1%	1.9%	100.0%	$ -	$ -	$ -	$ 484,368,964	$ 9,431,591	$ 493,800,555
Tengion Inc	6.4%	65.70%	0.0%	12.5%	1.3%	85.9%	$ 3,953,132	$ 40,581,366	$ -	$ 7,720,960	$ 802,980	$ 61,767,680
TheraSense Inc	9.8%	49.77%	3.0%	14.5%	7.5%	84.5%	$ 70,561,442	$ 360,189,020	$ 21,638,842	$ 104,792,787	$ 54,350,403	$ 723,707,099
Thermage Inc	5.5%	67.40%	0.0%	0.0%	11.7%	84.6%	$ 8,653,231	$ 106,041,409	$ -	$ -	$ 18,407,782	$ 157,331,468
Tomotherapy Inc	12.8%	55.68%	3.0%	9.8%	6.3%	87.5%	$ 117,116,579	$ 511,454,989	$ 27,648,698	$ 89,743,449	$ 57,685,656	$ 918,561,403
Trans1 Inc	15.5%	70.00%	0.0%	0.0%	6.1%	91.5%	$ 43,542,708	$ 197,153,271	$ -	$ -	$ 17,067,840	$ 281,647,530
VNUS Medical Technologies Inc	3.8%	81.30%	0.0%	12.0%	2.9%	100.0%	$ 8,213,263	$ 174,800,593	$ -	$ 25,779,325	$ 6,278,201	$ 215,006,880
Volcano Corp	5.0%	48.20%	0.0%	28.7%	10.2%	92.1%	$ 12,843,885	$ 123,076,591	$ -	$ 73,284,194	$ 25,917,581	$ 255,345,624
Wright Medical Group Inc	0.0%	4.91%	0.0%	88.9%	6.2%	100.0%	$ -	$ 17,172,543	$ -	$ 310,854,511	$ 21,754,220	$ 349,746,300
XTENT Inc	0.0%	74.70%	0.0%	0.0%	13.0%	87.7%	$ -	$ 272,461,473	$ -	$ -	$ 47,416,321	$ 364,740,928

Figure A-1: Comparison of VC Ownership Across Investor Profiles

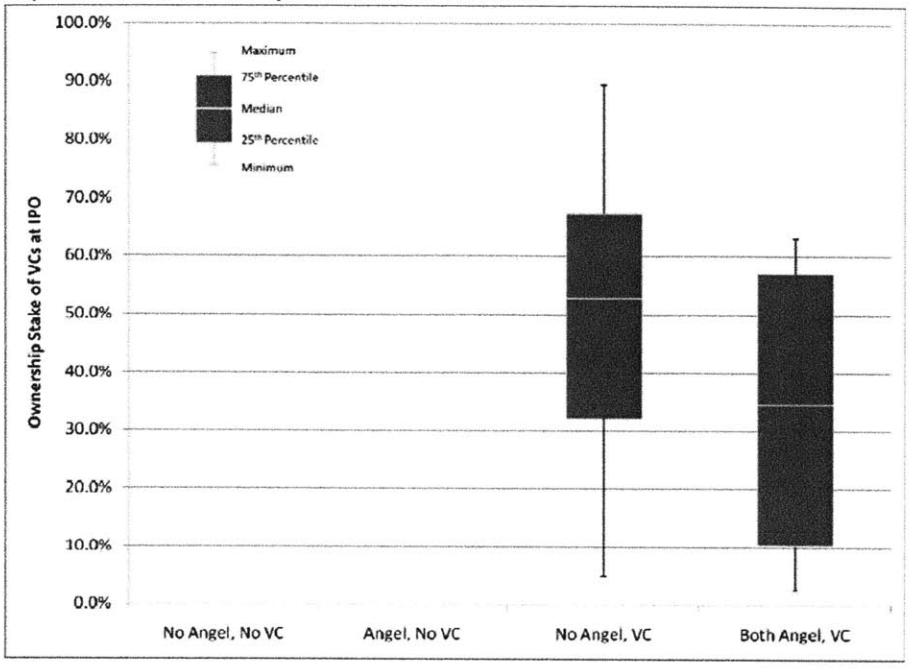


Figure A-2: Comparison of VC Valuation Across Investor Profiles

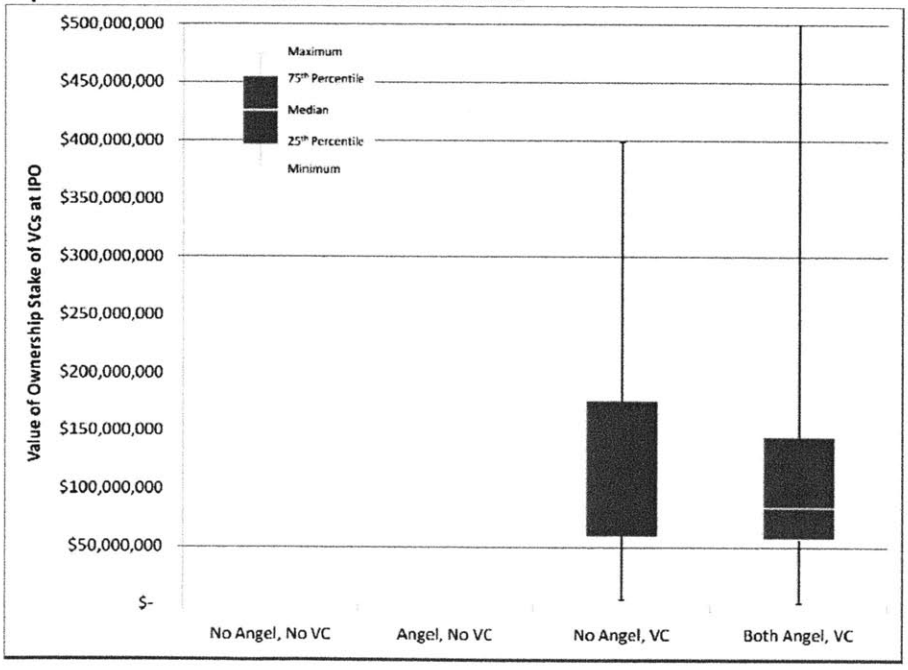


Figure A-3: Comparison of Angel Ownership Across Investor Profiles

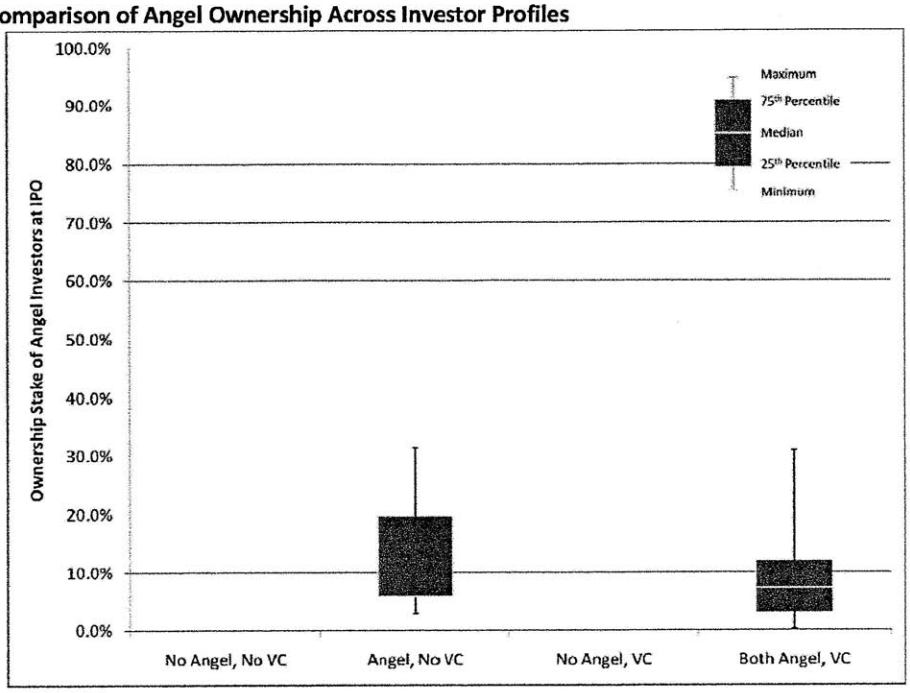


Figure A-4: Comparison of Angel Valuation Across Investor Profiles

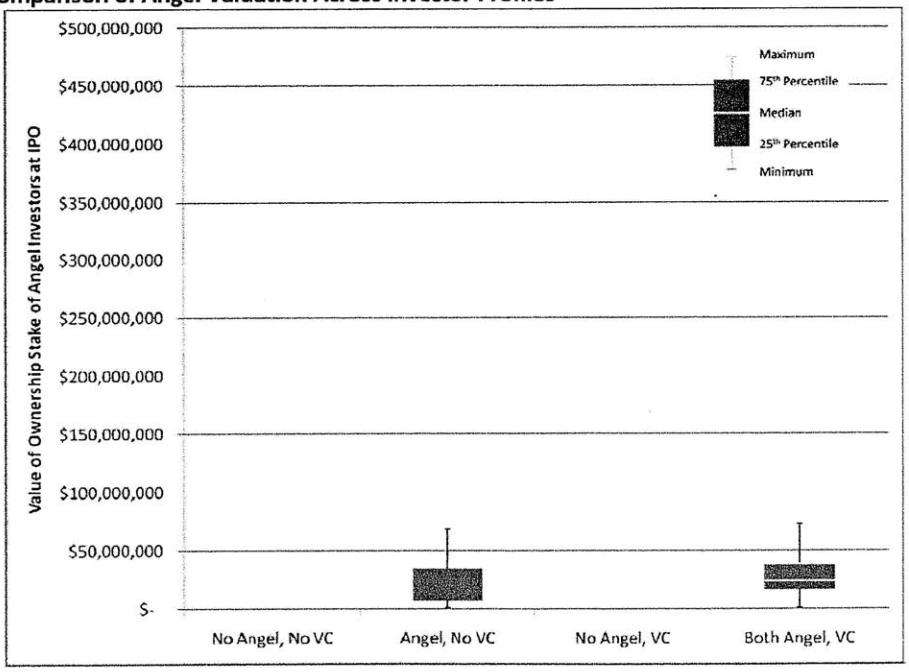


Figure A-5: Comparison of Other Shareholder Ownership Across Investor Profiles

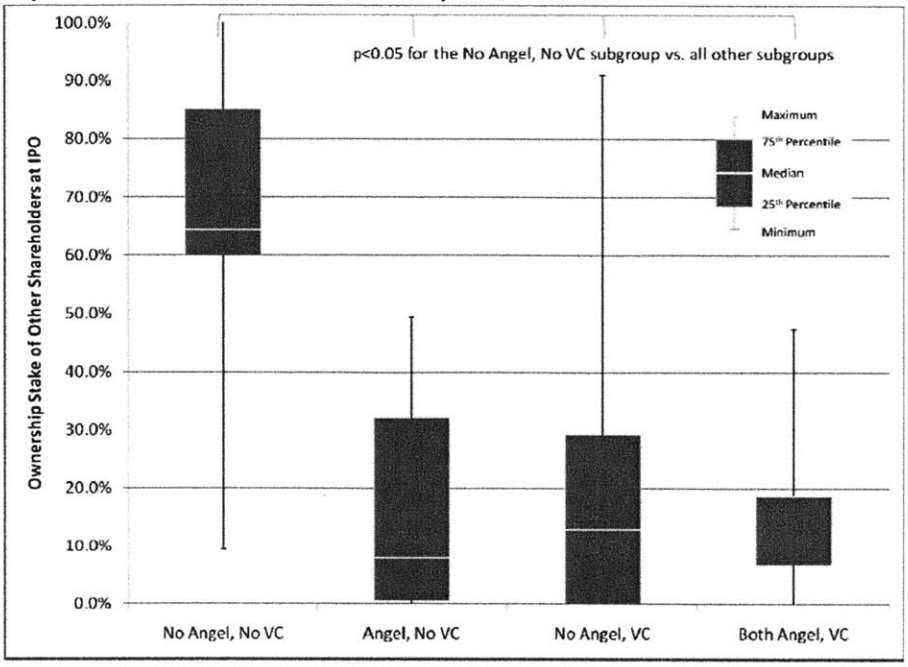


Figure A-6: Comparison of Other Shareholder Valuation Across Investor Profiles

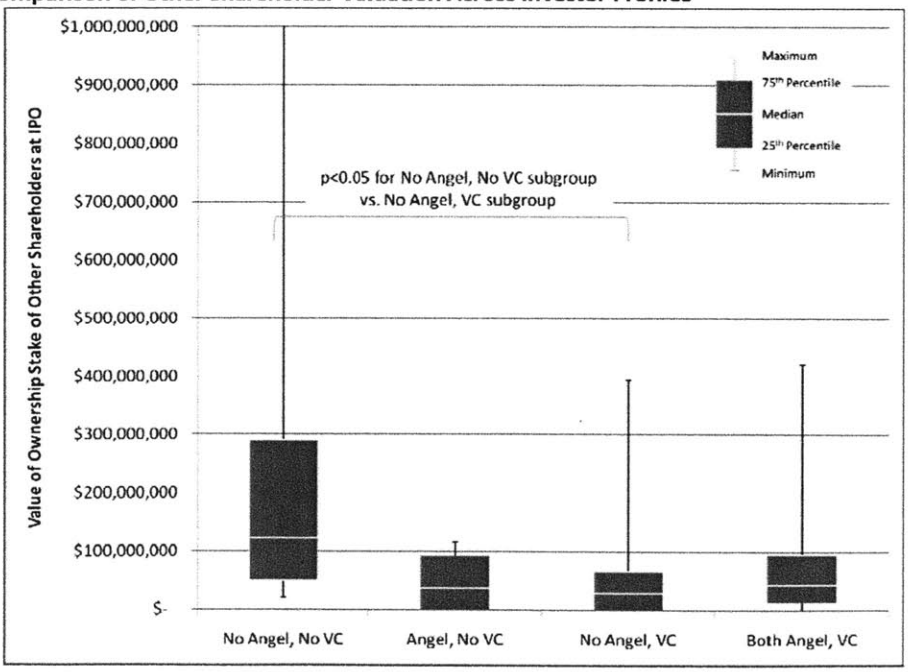


Figure A-7: Comparison of Non-Founder Insider Ownership Across Investor Profiles

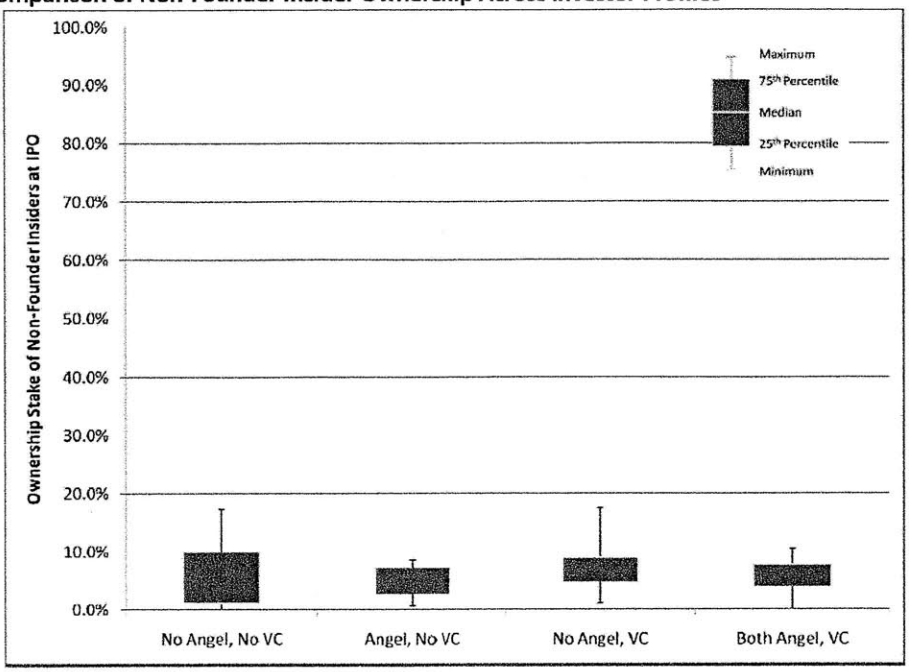


Figure A-8: Comparison of Non-Founder Insider Valuation Across Investor Profiles

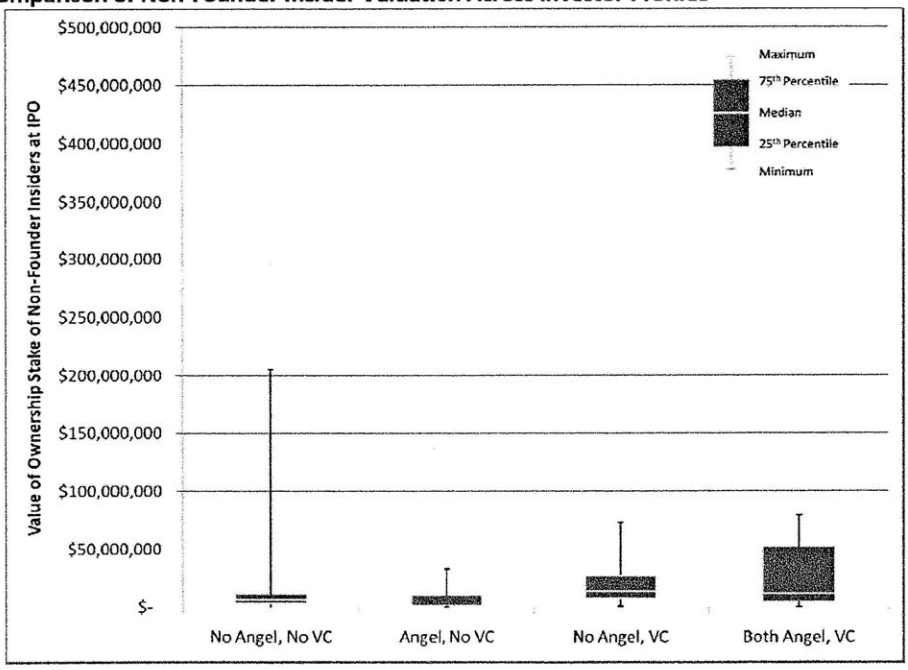
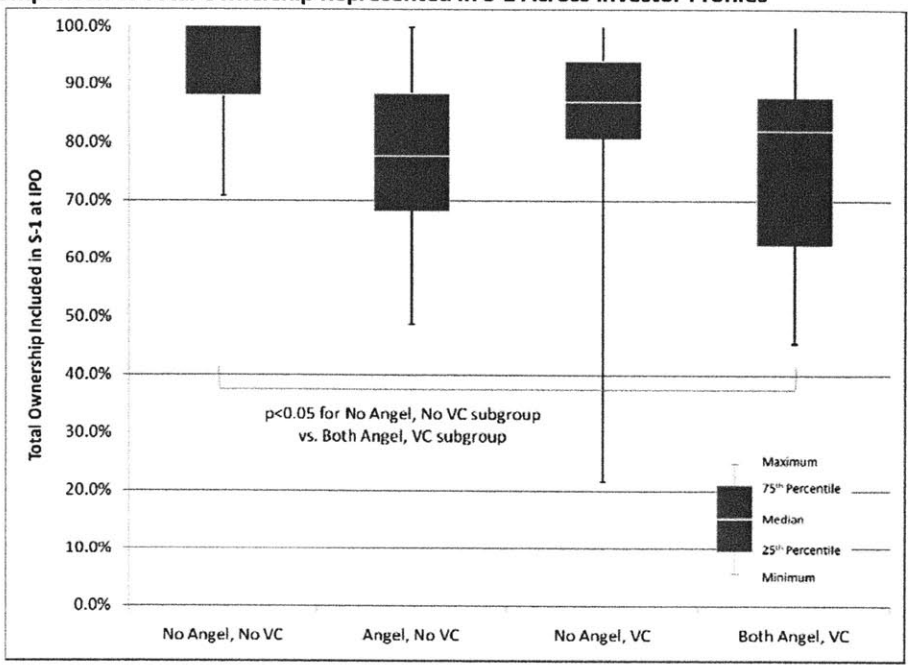


Figure A-9: Comparison of Total Ownership Represented in S-1 Across Investor Profiles



Angel Investor Performance Project (AIPP) Analysis Notes

Methods

- Data was downloaded from the publicly available website: http://sites.kauffman.org/aipp/
- The dataset was screened for all categories that were related to healthcare, and then filtered so that each company ID appeared only once (the most complete row was selected).
- The dataset was "cleaned", entailing assigning unique company IDs to blank entries (as long as the company description did not match another entry), renaming firm categories to be consistent, and reassigning firms that had specific descriptions into general categories.
- The dataset was filtered for all firms within the 'Medical devices and equipment' category.

Results

- 67 unique companies in healthcare related fields:
    - 21 Biotechnology
    - 23 Healthcare Services
    - 23 Medical devices and equipment (Medtech)
- 28 unique healthcare companies had a code for an exit (remainder were blank):
    - 9 (32%) were bought by another operating firm
    - 3 (11%) had IPOs
    - 16 (57%) ceased operating, were bought out by investors, or had other outcome
- 11 unique Medtech companies had a code for an exit (remainder were blank):
    - 4 (36%) were bought by another operating firm
    - 1 (9%) had an IPO
    - 6 (55%) ceased operating, were bought out by investors, or had other outcome