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The Consequences of Entrepreneurial Finance: Evidence from Angel Financings

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This article documents the fact that ventures funded by two successful angel groups experience superior outcomes to rejected ventures: They have improved survival, exits, employment, patenting, Web traffic, and financing. We use strong discontinuities in angel-funding behavior over small changes in their collective interest levels to implement a regression discontinuity approach. We confirm the positive effects for venture operations, with qualitative support for a higher likelihood of successful exits. On the other hand, there is no difference in access to additional financing around the discontinuity. This might suggest that financing is not a central input of angel groups. (*JEL* D81, G24, L26, M13, O31, O32)

One of the central and more enduring questions in the entrepreneurial finance literature asks to what extent early-stage financiers, such as angels or venture funds, have a real impact on the firms in which they invest. An extensive body of theoretical literature suggests that the combination of intensive monitoring, provision of value-added services, and powerful control

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rights in these types of deals should alleviate agency problems between entrepreneurs and institutional investors.[1] This bundle of inputs—it is argued—leads to improved governance and operations in portfolio f rms, lower capital constraints, and ultimately stronger f rm growth and performance.

The empirical documentation of this impact, however, has been challenging. Hellmann and Puri (2000) provide the f rst detailed comparison of the growth path of f rms that are backed by venture f nancing with those that are not.[2] This approach, however, faces the natural challenge that unobserved heterogeneity across entrepreneurs, such as ability or ambition, might drive the growth path of the f rms as well as the venture capitalists' decisions to invest. The question remains whether seed-stage investors have a causal impact on the performance of startups or whether their main role is to select f rms that have better inherent growth opportunities. These problems are particularly acute in evaluating early-stage investments that are, by their nature, opaque.

An alternative approach has been to f nd exogenous shocks to venture f nancing at the industry or regional levels. Examples of such shocks are public policy changes (Kortum and Lerner 2000), variations in endowment returns (Samila and Sorenson 2011), and differences in state pension funding levels (Mollica and Zingales 2007). These studies, however, can only examine the impact of entrepreneurial f nance at an aggregate level, which resembles a "needle in the haystack" challenge, given the very modest share of economic activity in which high-potential f rms are represented.

This article takes a fresh look at the question of whether entrepreneurial f nanciers affect the success and growth of new ventures. We focus on a neglected segment of entrepreneurial f nance: angel investments. Angel investors have received much less attention than venture capitalists, despite the fact that some estimates suggest that these investors are as important for high-potential startup investments as are venture capital f rms (Goldfarb et al. 2007; Shane 2008; Sudek et al. 2008). Angel investors are increasingly structured as semiformal networks of high-net-worth individuals, who are often former entrepreneurs themselves, that meet in regular intervals (often over a monthly breakfast or dinner) to hear aspiring entrepreneurs pitch their business plans. The angels then decide whether to conduct further due diligence and ultimately whether to invest in some of these deals as subgroups of members. Similar to venture capitalists, angel groups often adopt a very hands-on role in the deals in which they invest, providing entrepreneurs with advice and contacts.

In addition to their inherent interest as funders of early-stage companies, angel investment groups have an advantage for researchers over other venture

[1] Examples include Admati and Pf eiderer (1994), Berglöf (1994), Bergemann and Hege (1998), Hellmann (1998), and Cornelli and Yosha (2003).

[2] A similar approach is taken in Puri and Zarutskie (forthcoming) and Chemmanur et al. (2011), who employ comprehensive Census Bureau records of private f rms in order to form more detailed control groups based on observable characteristics.

funders in that they make their investment decisions through well-documented processes and, in some cases, formal votes.[3] This allows us to observe the level of support, or lack thereof, for the deals that come before the angel groups.[4]

Our analysis exploits very detailed data collected at the deal level of start-ups that pitched to two prominent angel investment groups (Tech Coast Angels and CommonAngels) during the 2001–2006 period. These organizations generously provided us access to confidential records with regard to the companies who approached them, the level of angel interest, the financing decisions made, and the subsequent venture outcomes. The dataset allows us to compare funded and unfunded ventures that approached the same investor. Furthermore, we use the interest levels expressed by the angels to form specialized treatment and control groups that have similar qualities.[5]

In addition, our data allow us to go further toward confirming a causal relationship by using a regression discontinuity approach (Lee and Lemieux 2010).[6] Within the quality ranges that we analyze, there exists a discrete jump in the probability of venture funding as interest accumulates around a deal. This discontinuity is due to how critical mass develops within angel groups around prospective deals.

From the data, we identify the threshold where a critical mass of angels emerges around a deal. Our approach compares firms that fall just above this threshold with the firms that fall just below. The underlying identification relies upon firms around the cutoff level having very similar ex ante characteristics. If true, we can confirm the causal effect of obtaining angel financing. After showing the ex ante comparability of the ventures in the border region, we examine differences in their long-run performance. In this way, we can

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3 By way of contrast, the venture firms that we talked to all employ a consensual process in which controversial proposals are withdrawn before coming up for a formal vote or disagreements are resolved in conversations before the actual voting takes place. In addition, venture firms also rarely document the detailed voting behind their decisions. Angel group members, in contrast, often express their interest for deals independently from one another and based upon personal assessment.

4 Our article is closest in spirit to work in the entrepreneurial finance literature on the investment selection process and returns of venture capitalists. Sorensen (2007) assesses the returns to being funded by different tiers of investors. Our work instead focuses on the margin of obtaining initial funding or not. Kaplan and Strömberg (2004) and Kaplan et al. (2009) examine characteristics and dimensions that venture capitalists rely on when making investment decisions. Goldfarb et al. (2007) and Conti et al. (2011) consider choices between angels and venture investors.

5 Thus, our work encompasses many of the matching traits used by prior work—such as industry, employment levels and growth rates, age, etc.—but also better captures the motivations of entrepreneurs (i.e., the control group also approached the investor at the same time as the treatment group) and the underlying qualities of the ventures (i.e., the angels rated the ventures comparably at the time of their pitch). To illustrate these gains more graphically, consider the case of Twitter (which is not part of our sample). Researchers can observe that Twitter is four years old, has approximately 300 employees (http://twitter.com/about, accessed December 20, 2010), is growing rapidly in terms of employment but not revenue, is located in Silicon Valley, and so on. But even with this information set, it is very hard to identify companies with which one should compare to Twitter. Our data allow us to compare funded ventures to others that the same sophisticated investors thought comparable at the time of the investment pitch.

6 While common in economics, this approach is underutilized in finance. Exceptions include Rauh (2006), Chernenko and Sunderam (2009), and Bakke and Whited (2010).

employ microdata on firm outcomes, while further minimizing the problem of unobserved heterogeneity between the funded and rejected transactions.

Several clear patterns emerge from our analysis: First—and not surprisingly—the interest levels expressed by angels in deals are a substantial factor in funding decisions. Second, when we compare, within a narrow quality range, firms that received funding to those that did not, the funded firms overall look more successful than those that pitched to the angel group but did not receive financing: They are 20%–25% more likely to survive for at least four years (or until December 2010, the last date of our data). They are also 9%–11% more likely to undergo a successful exit (IPO or acquisition) and 16%–19% more likely to have either reached a successful exit or grown to seventy-five employees by December 2010. Funded companies have 16–20 more employees as of 2010, are 16%–18% more likely to have a granted patent, and are growing faster as measured through Web traffic performance between 2008 and 2010. In addition, funded companies are better financed. Overall, they have a 70% higher likelihood of obtaining entrepreneurial finance and on average have a little less than two additional financing rounds. These subsequent deals are often syndicated by the angel group with other venture financiers.

These results are developed by using ventures that fall within a narrow quality range. We also demonstrate that the impact of angel funding on firm outcomes would be overstated if we look at the full distribution of ventures that approach the angel groups, since there is a clear correlation between initial venture quality and likelihood of funding. Using several techniques (e.g., matched samples and modeling angel interest as a covariate), we estimate that one would overstate the measured effects by about 25% if using the full distribution of deals that approached the investors. This emphasizes the importance and challenge of creating proper control groups in entrepreneurial finance studies.

Our third set of findings considers ventures just above and below the funding threshold by using the regression discontinuity methodology, which removes the endogeneity of funding and other omitted-variable biases if ventures just below and above the funding threshold are otherwise very similar. We confirm several of our prior findings: Ventures just above the threshold are more likely to survive, and they have superior operations in terms of employee counts, patenting, and Web traffic growth. We also find qualitative evidence to support the idea that funded ventures achieved a successful exit by December 2010, but these results are not statistically significant. This latter difference may suggest that the angel groups select ventures with quicker exit prospects, and that this desire for faster exits is not captured in our initial interest measures.

Interestingly, we do not find an impact of angel funding with regard to follow-on financing when using the regression discontinuity approach. This difference to the earlier estimate, which is based on a simple comparison between funded and unfunded firms, may suggest that access to additional

f nancing is not essential for the success of angel-funded f rms just above the threshold. But when looking at the full distribution of funded versus unfunded ventures, the positive selection bias of receiving angel funding translates into a higher likelihood of follow-on funding. This result might also underline that, in the time period we study, prior angel f nancing was not an essential prerequisite to accessing follow-on funding.

In a f nal step, we compare the returns of the venture capital industry to that of one of the angel groups. A natural concern is that these investments are by angels who are not professional investors; thus, their decisions and voting may be shaped by factors other than economic considerations (e.g., the joy of working with startup companies). While our project focuses on the consequences of f nancing for startup ventures, this additional analysis helps conf rm that the investments were warranted for the angel group as a whole. We f nd that the angel group performed as well as the venture capital industry overall during the period of study.

Thus, this article provides new evidence about an essential question in entrepreneurial f nance. We quantify the positive impact that these two angel groups had on the companies that they funded by simultaneously exploiting novel, rich microdata and addressing concerns about unobserved heterogeneity. We should note, however, that the angel groups that we worked with for this project are two of the largest and most established groups in the country. They are both professionally managed and, during the period we studied, at least one group performed as well as the venture industry as a whole. Given the substantial heterogeneity across angel investors, the magnitude of the impact that we estimate is likely to be at the upper end of the angel population. We hope that future research can further quantify the extent to which other angel investment groups and individual investors provide aid to startup ventures.

The plan of this article is as follows: Section 1 reviews the angel group investment process. Section 2 introduces our angel investment data and describes our methodology. Section 3 introduces our outcomes data. Section 4 presents the analysis. Section 5 evaluates the portfolio returns for one of the angel groups. The f nal section concludes the article.

1. The Angel Group Investment Process

Angel investors are high-net-worth individuals that make private investments in startup companies with their own money. While angel investors have a long history (e.g., Lamoreaux et al. 2004), angel groups are quite recent phenomena. Beginning in the mid-1990s, angels began forming groups in order to collectively evaluate and invest in entrepreneurial ventures. These groups are seen by the angels as having several advantages. First, angels can pool their capital to make larger investments than they otherwise could fund alone. Second, each angel can invest smaller amounts in individual ventures, allowing participation in more opportunities and the diversif cation of investment risks.

They can also undertake costly due diligence of prospective investments as a group, reducing the burdens for individual members. Fourth, these groups are generally more visible to entrepreneurs and thus receive a superior deal f ow. Finally, the groups frequently include some of the most sophisticated and active angel investors in a given region, which results in superior decision-making.

The Angel Capital Association (ACA) lists 300 U.S. groups in its database. In 2007, the average ACA angel group had forty-two member angels and invested a total of US$1.94 million in 7.3 deals. Between 10,000 and 15,000 angels are believed to belong to angel groups in the United States.[7]

Angel groups follow mostly similar templates. Entrepreneurs typically begin the process by submitting an application to the group that may also include a copy of their business plan or executive summary. After an initial screening by the staff, the f rms are then invited to give a short presentation to a small group of members, which is followed by a question-and-answer session. Promising companies are then invited to present at a monthly meeting (often a breakfast or dinner). The presenting companies that generate the greatest interest then enter a due diligence review process by a smaller group of angel members, although the extent to which due diligence and screening leads or follows the formal presentation varies across groups. If all goes well, this process results in an investment one to three months after the presentation. Figure 1 provides a detailed template for Tech Coast Angels (Sudek et al. 2008).

2. Angel Group Data and Empirical Methodology

This section jointly introduces our data and empirical methodology. The discussion is organized around the two groups from which we have obtained large datasets. The unique features of each investment group, their venture selection procedures, and their data records require that we employ conceptually similar, but operationally different, techniques for identifying group-specif c discontinuities. We commence with Tech Coast Angels, the larger of our two investment groups, and we devote extra time in this f rst data description to also conveying our empirical approach and the biases it is meant to address. We then describe our complementary approach with CommonAngels and how we ultimately join the two groups together to analyze their joint behavior.

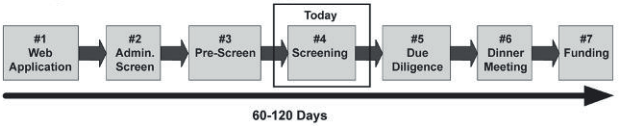
2.1 Tech Coast Angels

Tech Coast Angels is a large angel-investment group based in southern California. They have over 300 angels in f ve chapters and seek high-growth

[7] Statistics are based on http://www.angelcapitalassociation.org/ (accessed February 15, 2010).

TCA Orange County Screening Overview

Welcome to the #1 Angel network in the US. We are pleased you are attending an Orange County screening session. The screening process is an important part of the TCA process. Typically, we have over 300 companies per year apply over the web for TCA funding. Approximately one third of these companies make it to the screening process which you are about to participate in. Although each year varies, we typically fund between 10 and 20 companies per year. TCA consists of 4 chapters, each facilitating the first three steps of the deal flow process a little differently. The overall deal flow process for TCA consists of 7 steps as follows:



1. **Web Application** – Entrepreneurs apply to TCA on the Internet. This process includes filling out a 4 page overview of their startup venture.

2. **Admin Screen** – TCA staff perform a quick screen on the application to insure it is within the target area for a TCA venture. For instance, we typically fund between $250,000 and $1 million. If a company is seeking outside this range, typically they are not moved forward to pre-screen.

3. **Pre-Screen** – In Orange County entrepreneurs present a brief overview of their company to 3-7 TCA members. This includes 5 minutes of presentation and 25 minutes of informal questions and discussion with the TCA members. At the conclusion of this session, the prospective company is moved to screening, or given feedback why they may not be a good fit for TCA.

4. **Screening** – Typically 3 companies present at a screening. This consists of 15 minutes of PowerPoint and 15 minutes of Q&A. After the Q&A, we ask the entrepreneurs to leave the room and we discuss the company in private (typically it takes 10-15 minutes). The entrepreneurs are invited back into the room, and a designated member provides quick feedback. Typically, the companies present at all 5 chapters. Therefore, it is possible for a company to get little interest at one chapter, but enough interest at another chapter that will allow it to move forward to due diligence. In Orange County we utilize a moderator to facilitate the sessions. This is intended to help balance questions for our members such that a member will not dominate the Q&A time. If you are a prospective member you are welcome to ask questions during the Q&A portion of the presentation.

5. **Due Diligence** – A due diligence team is formed based on the number of interested members who signed up during the screening. A deal lead steps forward and helps coordinate the due diligence activities. Due diligence consists of verifying representations by the venture, customers, agreements, references, backgrounds, etc. The results of the due diligence process are posted on the TCA website (members only section), and if the results are positive, the venture moves forward to dinner meetings.

6. **Dinner Meeting** – Companies that pass due diligence present at monthly dinner meetings at each chapter. This allows them to get in front of members who might not have seen them at screening or were involved in the due diligence process. This is the opportunity for the entrepreneurs to garner enough interest by members to secure funding.

7. **Funding** – Funding occurs after there has been enough interest generated through dinner meetings and internal communication from the entrepreneur and deal lead. Members invest in deals individually, thus only a small percentage of members need to participate for the venture to secure funding. Typically, the minimum investment amount $25,000.

 V1.2

Figure 1

investments in a variety of high- and low-tech industries. The group typically looks for funding opportunities of US$1 million or less. (Additional details on this venture group are available at http://www.techcoastangels.com/.)[8]

[8] Tech Coast Angels grows from two to four chapters during our period of study, with on average 30–40 active angels per chapter. Table A1 (see Appendix) provides additional details.

Tech Coast Angels kindly provided us with access to their database regarding prospective ventures under explicit restrictions that the confidentiality of individual ventures and angels remain secure. For our study, this database was exceptional in that it allowed us to fully observe the deal flow of Tech Coast Angels. The database has detailed information about many of the companies that were and were not funded by Tech Coast Angels. Our analysis considers ventures that approached Tech Coast Angels between 2001 and 2006; as of early 2007, there were over 2,500 ventures in the database.

We first document in Table 1 the distribution of interest from the angel investors across the full set of potential deals. This description sets the stage for identifying a narrower group of firms around a funding discontinuity that offers a better approach for evaluating the consequences of angel financing. Table 2 then evaluates the ex ante comparability of deals around the border, which is essential for the identification strategy.

The central variable for the Tech Coast Angels analysis is the count of the number of angels expressing interest in a given deal. This indication of interest does not represent a financial commitment but instead expresses a belief that the venture should be pursued further by the group. The decision to invest ultimately depends upon three factors: one or more angels who are strong champions of the deal, the support of the professional manager, and a critical mass of angels who are willing to fund the venture as a group. While we do not observe the champions of the deals, we do have a unique window through which we can observe how funding relates to obtaining a critical mass of interested angels.

Table 1 documents the distribution of deals and angel interest levels. The first 3 columns of Table 1 show that 64% of ventures receive no interest at all. Moreover, 90% of all ventures receive interest from fewer than ten angels. This narrowing funnel continues until the highest bracket, where there are forty-four firms that receive interest from thirty-five or more angels. Fifteen

Table 1
Angel group selection funnel

Angel group interest level	Number of ventures	Cumulative share of ventures (%)	Share funded by angel group (%)
0	1640	64	0.0
1–4	537	84	0.7
5–9	135	90	3.7
10–14	75	93	12.0
15–19	52	95	17.3
20–24	42	96	38.1
25–29	33	97	30.3
30–34	21	98	28.6
35+	44	100	40.9

Table documents the selection funnel for Tech Coast Angels. The first column provides bins based upon the number of angels expressing interest in a deal. Column 2 describes the number of ventures that fell into each bin. Column 3 provides the cumulative fraction for each interest level. Column 4 reports the percentage of deals at each level that ultimately received funding from the angel group.

Table 2
Comparison of groups above and below border discontinuity

Traits of ventures above and below border discontinuity	Above border ventures	Below border ventures	Two-tailed t-test for equality of means
Basic characteristics			
Financing sought (US$ thousands)	1683	1306	0.277
Documents from company	3.0	2.5	0.600
Management team size	5.8	5.4	0.264
Employee count	13.4	11.2	0.609
Primary industry (%)			
Biopharma and healthcare	23.9	29.3	0.579
Computers, electronics, and measurement	15.2	17.1	0.817
Internet and e-commerce	39.1	39.0	0.992
Other industries	21.7	14.6	0.395
Company stage (%)			
Good idea	2.2	2.4	0.936
Initial marketing and product development	34.8	46.3	0.279
Revenue generating	63.0	51.2	0.272
Angel group decisions			
Documents by angel members	10.5	5.1	0.004
Discussion items by angel members	12.0	6.7	0.002
Share funded	63.0	39.0	0.025
Observations	46	41	

Table compares the ex ante traits of ventures above and below the border discontinuity. Columns 2 and 3 present the means of the above-border and below-border groups, respectively. The fourth column tests for the equality of the means, and the *t*-tests allow for unequal variance. The first panel compares venture traits documented at the time of the investment pitch. The first row tests equality for log value of financing sought. The second and third panels compare the distribution of ventures in terms of industries and stages of development, respectively. The shares in these panels sum to 100%. The final panel considers differences in the subsequent activities and funding of the angel investors for the groups.

ventures receive the interest of fifty angels or more. This funnel shares many of the anecdotal traits of venture funding—such as selecting a few worthy ventures out of thousands of business plans—but it is exceptionally rare to have the interest level consistently documented throughout the distribution and independent of actual funding outcomes.

The shape of this funnel has several potential interpretations. It may reflect heterogeneity in quality among companies that are being pitched to the angels. It could also reflect simple industry differences across ventures. For example, the average software venture may receive greater interest than would a medical devices company if there are more angels within the group involved in the software industry. There could also be an element of herding around "hot deals." Though, independent of what exactly drives this investment behavior of angels, we want to explore whether there are discontinuities in interest levels, where small changes in the number of angels expressing interest among otherwise comparable deals result in material shifts in the probability of funding.

The central idea behind this identification strategy is that angel interest in ventures does not map one-to-one onto quality differences across ventures, which we verify empirically. Instead, there is some randomness or noise

with regard to why some firms receive n votes and others receive $n + 1$. It is reasonable to believe that there are enough idiosyncrasies in angels' preferences and beliefs that the interest count does not present a perfect ranking of the quality of the underlying firms. Certainly, the 2% of ventures with thirty-five or more interested angels are not comparable to the 64% of ventures with zero interest. But, we will show that ventures with eighteen votes and twenty-two votes are much more comparable, except that the latter group is much more likely to be funded.

We thus need to demonstrate two patterns. First, we need to identify where in the distribution small changes in interest level lead to a critical mass of angels and thus a substantial increase in funding probability. As Tech Coast Angels does not have explicit funding rules that yield a mandated cutoff, we must identify by using observed behavior where de facto breaks exist. We then need to show that deals immediately above and below this threshold appear similar at the time that they approached Tech Coast Angels.

To investigate the first part, the last column of Table 1 documents the fraction of ventures in each interest group that are ultimately funded by Tech Coast Angels. None of the ventures with zero interest are funded, whereas over 40% of deals in the highest interest category are funded. The rise in funding probability with interest level is monotonic, excepting some small fluctuations at high interest levels. Ventures with high interest levels can remain unfunded by Tech Coast Angels for multiple reasons, e.g., the subsequent due diligence process uncovers poor information, the parties cannot agree upon deal terms, and the startup withdraws and chooses to take financing elsewhere.

There is a very stark jump in funding probability between interest levels of 15–19 angels and 20–24 angels, where the funded share increases from 17% to 38%. This represents a distinct and permanent shift in the relationship between funding and interest levels. We thus identify this point as our discontinuity for Tech Coast Angels. In most of what follows, we discard deals that are far away from this threshold and focus on the region around the border. This restriction prepares us for the border discontinuity exercise, but it is also warranted because the quality and funding prospects for ventures are most comparable in this region. Operationally, the narrower range of the quality distribution is also needed for many of our outcome variables, since collecting records for unfunded ventures is very challenging.

We specifically drop the 90% of deals with fewer than ten interested angels and the forty-four deals with very high interest levels. We designate our "above border" group as those ventures with interest levels of 20–34 angels; our "below border" group is defined as ventures with interest levels of 10–19 angels.[9]

[9] There is also a discrete step in funding probability around having ten or more interested angels, relative to having five to nine interested angels. This margin would be interesting to study as well, but it is operationally quite difficult, as the information collected for the typical unfunded venture declines at lower interest levels (e.g.,

Table A1 (see Appendix) provides further annual details on Tech Coast Angels' selection process. Our choice to use a raw angel count to designate the funding border, while the overall angel network is growing in size, ref ects two considerations. First, and most important, angels invest as subgroups of members once suff cient interest is achieved. Thus, comparisons to the overall size of the network are less important than the actual counts of angels who are interested in participating in a deal. Second, and more operationally, the growth in Tech Coast Angels is mainly through new chapters. While angels can be involved in deals in other chapters, statistics—such as the count of active angels per chapter, the average interest level in a funded deal, and the share of ventures funded by Tech Coast Angels—across years are quite stable despite the changes in the absolute size of the network. These factors suggest that the time-invariant bar is the most appropriate.

Having identif ed the border discontinuity from the data, we now verify the second requirement, i.e., that ventures above and below the border are comparable ex ante, except in the probability that they received funding from Tech Coast Angels. This step is necessary to assert that we have identif ed a quasi-exogenous component to angel investing that does not merely ref ect underlying quality differences among the f rms. Once established, a comparison of the outcomes of above- versus below-border ventures will provide strong conf rmation of the role of angel f nancing in venture success, as their initial qualities are very similar.

Before assessing this comparability, we make two sample adjustments. First, in order to allow us to later jointly analyze our two investment groups, we restrict the sample to ventures that approached Tech Coast Angels in the period 2001–2006. This restriction also allows us a minimum horizon of four years for measuring outcomes. Second, we remove cases in which the funding opportunity is withdrawn from consideration by the venture itself. These withdrawn deals are mainly due to ventures being funded by venture capital f rms, where the venture had simultaneously courted multiple f nanciers. As these deals do not f t well into our conceptual experiment of the benef ts and costs of receiving or being denied angel funding, it is best to omit them from the sample. Our f nal sample includes eighty-seven f rms from Tech Coast Angels, with forty-six ventures being above the border and forty-one below. Forty-f ve of the eighty-seven ventures are funded by Tech Coast Angels.

Table 2 shows that the characteristics of ventures above and below the funding threshold are very similar to one another ex ante. If our empirical approach is correct, the randomness in how localized interest develops will result in the observable characteristics of f rms immediately above and below the threshold not being statistically different. Table 2 documents this comparability across a number of venture characteristics. Columns 2 and 3 present the means of the

due diligence reviews are not undertaken). We set the lower bound for our study to be above this threshold of ten angels being interested.

above- and below-border groups, respectively. The fourth column tests for the equality of the means, with the t-tests allowing for unequal variance.

The two border groups are very comparable in terms of venture traits, industries, and venture stages. The first 4 rows show that basic characteristics, like the amount of funding requested, the documents provided by the venture to the angels, and the firm's number of managers and employees, are not materially different for the firms above and below the discontinuity. The same is true for industry composition and stage of the business (e.g., whether the firm is in the idea stage, in its initial marketing and product development stage, or already revenue generating). We report two-tailed tests for simplicity; differences in means for all traits are not significant at a 10% level in one-tailed tests in either direction as well. Pearson chi-square probabilities for the latter two distributions are 0.831 and 0.534, respectively. For all of these traits, the null hypothesis, which is that the two groups are similar, is not rejected.[10]

While there are no observable differences in the characteristics of the ventures in the first 3 panels, the fourth panel of Table 2 shows that there are significant differences in how angels engage with ventures above and below the cutoff. With even a small adjustment in interest levels, angels assemble many more documents with regard to the venture (evidence of due diligence), have more discussion points in their database about the opportunity, and are ultimately 60% more likely to fund the venture. All of these differences are statistically significant. This supports our identifying hypothesis that there is a nonlinear change in the provision of resources from the angel group around the cutoff. This will allow us to identify the effect of the bundle of inputs that the angels provide, holding constant the underlying quality of the firms around the cutoff.

2.2 CommonAngels

CommonAngels is a leading angel-investment group in Boston, Massachusetts. They have over seventy angels who seek high-growth investments in high-tech industries. The group typically looks for funding opportunities between US$500 thousand and US$5 million. (Additional details on this venture group are available at http://www.commonangels.com.)[11]

CommonAngels kindly provided us with access to their database, regarding prospective ventures, under explicit restrictions that the confidentiality of individual ventures and angels remain secure. The complete database for CommonAngels as of early 2007 contains over 2,000 ventures. However,

[10] Despite the power of these tests, we recognize that there are limits to what we can discern regarding the ventures. Most importantly, soft features (e.g., quality perceptions of management team) may systematically vary in ways not captured by our data.

[11] CommonAngels had about fifty members throughout our period of study, before expanding in recent years to seventy members.

unlike the Tech Coast Angels data, CommonAngels does not record interest for all deals. We thus cannot explicitly construct a distribution similar to Table 1. Nevertheless, the funnel process is again such that a small fraction of ventures receive funding (2%–3%). A little fewer than 30% of ventures that reach the pitch stage with CommonAngels receive funding.

CommonAngels does, however, conduct a paper-based poll of members, following the pitches at its monthly breakfast meetings. Most importantly, attending angels give the venture an overall score. Angels also provide comments about ventures and potential investments they might make in the company. Figure 2 provides a recent evaluation sheet. We focus on the overall score given by angels for the venture, as this metric is collected on a consistent basis throughout the sample period.

CommonAngels provided us with the original ballots for all pitches occurring between 2001 and 2006. After dropping two poor-quality records, our sample has a total of sixty-three pitches. One potential approach would be to order deals by the average interest levels of angels attending the pitch. We find, however, that the information content in this measure is limited. Instead, the data strongly suggest that the central funding discontinuity exists around the share of attending angels who award a venture an extremely high score. During the six years covered, CommonAngels used both a five- and ten-point scale. It is extremely rare that an angel awards a perfect score to a pitch. The breaking point for funding instead exists around the share of attending angels who award the pitch 90% or more of the maximum score (i.e., 4.5 out of five or nine out of ten). This is close in spirit to the dichotomous expression of interest in the Tech Coast Angels database.

Some simple statistics describe the nonlinear effect. Of the sixty-three pitches, fourteen ventures receive a 90% or higher score from at least one angel; no deal receives such a score from more than 40% of attending angels. Of these fourteen deals, seven deals are ultimately funded by CommonAngels. Of the forty-nine other deals, only eleven are funded. This stark discontinuity is not present when looking at lower cutoffs in interest levels. For example, all but twelve ventures receive at least one vote that is 80% of the maximum score (i.e., four out of five or eight out of ten). There is no further material difference in funding probability based upon receiving more or fewer 80% votes. The same applies to lower cutoffs for interest levels.

We restrict the sample to the forty-three deals that have at least 20% of the attending angels giving the presentation a score that is 80% of the maximum possible score or above. As a specific example, a venture is retained after presenting to a breakfast meeting of thirty angels if at least six of those angels score the venture as eight out of ten or higher. This step removes the weakest presentations and ventures. We then define our border groups based upon the share of attending angels that give the venture a score greater than or equal to 90% of the maximum possible score. To continue our example, a venture is considered above border if it garners six or more angels awarding the venture

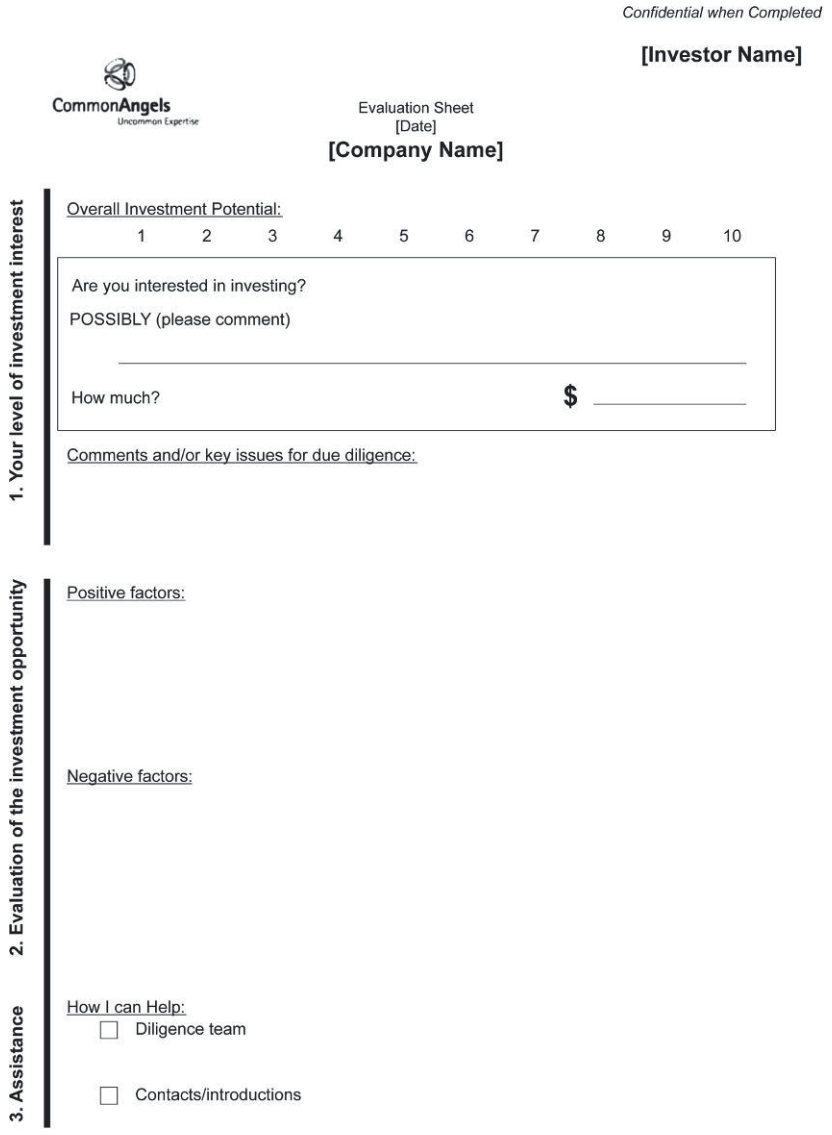


Figure 2

nine out of ten or better. A venture with only f ve angels at this extreme value is classif ed as below border.

While distinct, this procedure is conceptually very similar to the sample construction and culling undertaken with the Tech Coast Angels data. We only drop twenty CommonAngels pitches that receive low scores because the

selection into providing a formal pitch to the group itself accomplishes much of the pruning. With Tech Coast Angels, we drop 90% of the potential deals due to low interest levels. We implicitly do the same with CommonAngels by focusing only on sixty-three pitches out of the over 2,000 deals that are in the full database of submitted plans.

Our formal empirical analyses jointly consider the two groups. To facilitate this merger, we construct uniform industry classif cations and two simple indicator variables to signify whether a venture is funded or not and whether the venture is above or below the border discontinuity. This pooling produces a regression sample of 130 ventures.

3. Outcome Data

This section documents the data that we collect on venture outcomes. This is the most signif cant challenge for this type of project as we seek comparable data for both funded and unfunded ventures. In many cases, the prospective deals are small and recently formed, and may not even be incorporated. We develop three categories of outcomes: venture survival and success, venture operations and growth, and venture f nancing.

3.1 Venture survival and success

Our simplest measure is a binary indicator variable for f rm survival as of December 2010. This survival date is a minimum of four years after the potential funding event with the angel group. We develop this measure through several data sources. First, we directly contacted as many ventures as possible in order to learn their current status. Second, we looked for evidence of the ventures' operations in industry databases or newswires.[12] Finally, we examine every venture's website, if one exists. Existence of a website is not suff cient for being alive, as some ventures leave a website running after closing operations. Thus, we based our measurement on how recent various items, such as press releases, were.[13]

Our second measure is a binary indicator variable for whether the venture had undergone a successful exit by December 2010. A successful exit can either be an initial public offering (IPO) or a successful acquisition. We code acquisitions as successful or unsuccessful exits based upon the press releases, news articles, and blog posts that surround the event. We def ne an unsuccessful

[12] Industry databases include CorpTech, VentureXpert, Dun & Bradstreet, and Hoover's. Industry news sources (all sources are online with a ".com" suff x) include yahoo, linkedin, inc, businessweek, spoke, manta, venturebeat, wikipedia, crunchbase, glassdoor, insideview, healthcareitnews, socaltech, masshightech, xconomy, and boston.

[13] In cases of acquisitions, we code whether or not the venture is alive through making a judgment about the size of the acquisition. Ventures are counted as alive if the acquisition or merger was a successful exit that included major announcements or exit valuations greater than US$5 million (where known). If the event was termed an "asset sale" or similar phrase, we code the venture as not having survived. The results below are robust to simply dropping these cases.

exit as an "asset sale" or similar transaction. In total, three and eight of our 130 ventures, respectively, had a successful IPO or acquisition by December 2010.[14] Given the short time horizon, judging success through liquidity events may be restrictive—some successful entrepreneurs may have passed on exit opportunities to continue growing their businesses. Thus, our third measure augments the successful exit measure to also include if the venture has seventy-five or more employees in 2010, which we will also adjust below to thresholds of fifty and 100 employees. Twenty-two of our 130 ventures are successful, according to this combined measure. By contrast, forty-five of the 130 ventures have closed or had an unsuccessful exit.

3.2 Venture operations and growth

Our second set of metrics quantifies venture operations and growth after the potential financing event. While we would ideally consider a broad range of performance variables, such as sales and product introductions, obtaining data on private ventures is extremely challenging. This is especially true for unfunded ventures. We are able to employ three outcome variables: employment, patents, and website traffic. These three measures also allow for more differentiation between firms than do the binary indicators used for venture success.

We first consider the employment level of the venture in 2010. Employment measures are collected using the sources described above for venture survival. While we identified exact employment levels for many ventures, in other cases we had to transform reported employment ranges into point estimates. We applied a consistent rule in these cases to all ventures within the specified range. The chosen point estimates reflect the typical firm size distribution through the range (e.g., an employment level of twenty was assigned when the reported range was 10–50 employees). We further coded the employment levels of closed ventures with a zero value.

Finally, we faced the question of how to code employment levels for very successful ventures. These outliers with several hundred employees can have large effects on the outcomes. Other very successful cases have been acquired by large companies and thus are no longer reported separately. To address these issues, we cap the maximum employment level at 100 employees. We also code very successful exits as having 100 employees. The results are also robust to

[14] In five of our eight successful acquisition cases, acquisition values greater than US$40 million are reported in the media. In a sixth case, while the acquisition value was not disclosed, the acquired company disclosed substantial revenues (>US$12 million) and investor returns (>200%). Two cases are more difficult to assign. In the first, the venture (funded and above border) received major press attention at acquisition, with significant discussion of its integration and then joint release of the next product. This venture still operates as a private subsidiary of the acquiring company and the investor considers it a success while not disclosing the returns. In the second, the venture (unfunded and below border) was estimated to have had more than fifty employees and four funding rounds at acquisition and was described as "major" in the press. Recoding the last two cases as unsuccessful acquisitions marginally strengthens our empirical results below.

using caps of fifty or 250 employees. Using a maximum of 100 employees, our average venture had twenty-six employees in 2010 (thirty-six among operating businesses) versus twelve employees at the time of the pitch.

The second measure is an indicator variable for having been granted a patent by the United States Patent and Trademark Office (USPTO) by December 2010. About a quarter of the ventures received a patent. Of course, many ventures in our sample are not seeking patent protection. We partially control for this in the regressions with our industry controls, but we acknowledge that patenting is more generally an imperfect measure of innovation levels.

We also want to observe venture growth, but acquiring ongoing operational data is very challenging to do with unfunded ventures. However, we are able to use Web traffic records. To the best of our knowledge, this is the first time that this measure has been employed in an entrepreneurial finance study. We collected Web traffic data from Alexa (www.alexa.com), which is one of the largest providers of this type of information.[15]

We collected Web traffic data in the summer of 2008 and in January 2010. We identify ninety-one of our 130 ventures in one of the two periods and fifty-eight ventures in both periods. The absolute level of Web traffic and its rank are very dependent upon the specific traits and business models of ventures. This is true even within broad industry groups as degrees of customer interaction vary. Some venture groups may also wish to remain "under the radar" for a few years until they are ready for product launch or have obtained intellectual property protection for their work. Moreover, the collection method by Alexa may introduce biases for certain venture types. We thus consider the changes in Web performance for the venture between the two periods. These improvements or declines are more generally comparable across ventures.

One variable simply compares the log ratio of the Web rank in 2010 to that in 2008. This variable is attractive in that it measures the magnitudes of increase and decline in traffic. However, a limitation is that it is only defined for ventures whose websites are active in both periods. We thus also define a second outcome measure as a binary indicator for improved venture performance on the Web.[16] This technique allows us to consider all ninety-one ventures for

[15] Alexa collects its data primarily by tracking the browsing patterns of Web users who have installed the Alexa Toolbar, a piece of software that attaches itself to a user's Internet browser and records in detail the user's website. According to the company, there are currently millions of such users. The statistics are then extrapolated from this user subset to the Internet population as a whole. The two pieces of information collected by the toolbar are Web reach and page views. Web reach is a measure of what percentage of the total number of Internet users visit a website in question, and page views measures on average how many pages they visit on that website. Multiple page views by the same user in the same day only count as one entry in the data. The two usage variables are then combined to produce a variable known as site rank, with the most visited sites like Yahoo and Google having lower ranks.

[16] If we observe the Web ranks in both 2008 and 2010, the indicator variable takes a value of one if the rank in 2010 is better than that in 2008. If we only observe the firm on the Web in 2008, we deem its Web performance to have declined by 2010. Likewise, if we only observe the firm in 2010, we deem its Web performance to have improved.

which we observe Web traffic at some point, while sacrificing the granularity of the other measure.[17]

3.3 Venture financing

Our final measures describe whether the venture received venture financing. We define these measures through data collected from VentureXpert and CorpTech, and we directly cross-checked with as many ventures as possible. We consider both indicator variables for financing events and counts of financing rounds. As described below, we also use data on the investors in each round to identify the role of CommonAngels and Tech Coast Angels in subsequent financing events (either exclusively or in a syndicated deal).

4. Results for Entrepreneurial Firms

This section documents our empirical results with regard to the consequences of entrepreneurial finance for startups. We first compare the subsequent outcomes of funded ventures with those of unfunded ventures. We then more closely test the discontinuity between border investments and angel funding. We close by comparing the outcomes of ventures above and below the border.

4.1 Funding and firm outcomes

Tables 3a–3c quantify the relationship between angel group financing and outcomes. We focus on the 130 ventures that are used in our border analysis. This sample restriction removes both very low- and very high-quality ventures; it focuses on ventures that are similar in quality and for which funding prospects were quite uncertain at the time of the pitch. We later consider alternative estimation techniques and the full sample of ventures. Table A2 (see Appendix) provides descriptive statistics on outcomes for the funded and unfunded groups.

Table 3a considers our outcome variables for venture success. In the first column, we regress a dummy variable for whether the venture was alive in 2010 on the indicator for whether the firm received funding from the angel group. In Panel A, we include only a constant and the funding dummy variable; in Panel B, we control for angel group, industry, and year fixed effects (controlling for the year that the venture approached the angel group). The coefficients on the indicator variables are 0.20 and 0.25, both of which are statistically significant at the 1% level. Firms that received angel funding are 20%–25% more likely to survive for at least four years.

[17] Where possible, we also cross-checked the Alexa trends for ventures against Google Insights. Google Insights is based upon the search queries that are made by users. While Google Insights allows for historical monthly measurement, the quality of the search results varied much more across ventures than did the Web traffic measures. These differences are because relevant search terms can be much more ambiguous when ventures have common names or products than measures of the Web traffic that went to a specific URL.

Table 3a
Analysis of angel group financing and venture success

	(0,1) venture in operation or successful exit by December 2010	(0,1) venture underwent successful exit (IPO or acquired) by December 2010	(0,1) venture underwent successful exit or had 75+ empl. by December 2010	(0,1) venture underwent successful exit or had 50+ empl. by December 2010	(0,1)venture underwent successful exit or had 100+ empl. by December 2010
	(1)	(2)	(3)	(4)	(5)
			Panel A: Base regression		
(0,1) indicator variable for venture funding being received from angel group	0.199	0.093	0.187	0.209	0.153
	(0.081)	(0.051)	(0.067)	(0.072)	(0.065)
			Panel B: Panel A, including angel group, year, and industry fixed effects		
(0,1) indicator variable for venture funding being received from angel group	0.246	0.110	0.163	0.196	0.151
	(0.083)	(0.054)	(0.074)	(0.080)	(0.074)
Observations	130	130	130	130	130

Panel A includes linear regressions of firm outcomes on a dummy variable for whether the firm received venture funding. Regressions in Panel B include industry, year, and angel group fixed effects. The first column tests whether the venture is alive in December 2010. The second column tests whether the venture had a successful IPO or acquisition by December 2010. Columns 3–5 also consider ventures successful if they achieved indicated employment levels in December 2010. Robust standard errors are reported.

Table 3b
Analysis of angel group financing and venture operations and growth

	Employee count in 2010 with a maximum of 100 employees	Employee count in 2010 with a maximum of 100 employees	(0,1) indicator variable for granted patent by 2010 from USPTO	(0,1) indicator variable for improved Web rank from 2008 to 2010	Log ratio of 2010 Web rank to 2008 rank (negative values are improvements)
	(1)	(2)	(3)	(4)	(5)
			Panel A: Base regression		
(0,1) indicator variable for venture funding being received from angel group	19.799 (5.829)	16.121 (6.811)	0.156 (0.077)	0.116 (0.096)	−0.324 (0.191)
Employment level at the time that the venture approached the angel group		0.647 (0.143)			
			Panel B: Panel A, including angel group, year, and industry fixed effects		
(0,1) indicator variable for venture funding being received from angel group	19.264 (6.541)	17.959 (8.487)	0.175 (0.084)	0.162 (0.107)	−0.389 (0.212)
Employment level at the time that the venture approached the angel group		0.679 (0.152)			
Observations	130	83	130	91	58

Panel A includes linear regressions of firm outcomes on a dummy variable for whether the firm received venture funding. Regressions in Panel B include industry, year, and angel group fixed effects. The first column tests employment levels in 2010. Failed ventures are given zero employment, and a maximum of 100 employees is given for very successful ventures. Very successful acquisitions are also given this maximum value. The second column also controls for employment at the time the venture approached the angel group. Column 3 is an indicator variable for having been granted a patent by the USPTO. The last two columns test for improved venture performance through website traffic data from 2008 to 2010. Column 4 is an indicator variable for improved performance, while column 5 gives log ratios of Web traffic (a negative value indicates better performance). Robust standard errors are reported.

Table 3c
Analysis of angel group financing and venture financing

	Receives any venture financing	Receives any venture financing as reported in Venture Xpert	Receives later venture financing than the current angel investment	Receives later venture financing with investors other than original angel investors	Column 3, excluding deals that are syndicated with the original angel investors
	(1)	(2)	(3)	(4)	(5)
	Panel A: Base regression with (0,1) indicator variable for indicated financing activity				
(0,1) indicator variable for venture funding being received from angel group	0.704 (0.055)	0.382 (0.082)	0.213 (0.085)	0.230 (0.085)	0.077 (0.084)
	Panel B: Panel A, including angel group, year, and industry fixed effects				
(0,1) indicator variable for venture funding being received from angel group	0.706 (0.063)	0.405 (0.087)	0.270 (0.090)	0.253 (0.092)	0.124 (0.095)
	Panel C: Base regression with count of financing rounds for indicated financing activity				
(0,1) indicator variable for venture funding being received from angel group	1.624 (0.361)	1.302 (0.388)	0.777 (0.371)	0.963 (0.392)	0.404 (0.355)
	Panel D: Panel C, including angel group, year, and industry fixed effects				
(0,1) indicator variable for venture funding being received from angel group	2.065 (0.436)	1.765 (0.467)	1.239 (0.446)	1.385 (0.477)	0.762 (0.436)
Observations	130	130	130	130	130

Panels A and C include linear regressions of firm outcomes on a dummy variable for whether the firm received venture funding. Regressions in Panels B and D include industry, year, and angel group fixed effects. Column 1 tests whether the venture receives financing, including the current angel financing event. The second column uses only data of financings in Venture-Xpert, which we build upon in Table 4. The third column excludes the current angel financing round where applicable. The fourth column considers deals that have investors other than CommonAngels and Tech Coast Angels. The last column considers deals that do not involve CommonAngels and Tech Coast Angels at all. Across these outcomes, Panels A and B present binary indicator variables, while Panels C and D consider counts of financing rounds. Robust standard errors are reported.

Column 2 shows that funded ventures are also 9%–11% more likely to undergo a successful exit by December 2010. In unreported specif cations, we also disaggregated this result into a 4%–7% higher likelihood of successful acquisition and a 4%–5% higher likelihood of going public. Finally, column 3 f nds that the funded ventures are 16%–19% more likely to be successful, where success represents achieving seventy-f ve employees or a successful exit by December 2010. Columns 4 and 5 show that this venture success result does not substantially depend on the threshold used to measure employment success. These additional outcomes are all statistically signif cant and precisely measured. Moreover, ref ecting the use of indicator variables, they are very robust to modest changes in sample composition.

Table 3b considers our metrics of venture operations and growth using a similar specif cation to Table 3a. The f rst column f nds that funded ventures have 19–20 more employees in 2010 than do unfunded ventures. This estimate is again statistically signif cant. Column 2 shows that this higher employment level in 2010 is not due to funded ventures having greater employment at the time of the pitch. Median regressions f nd an employment growth of 13.0 (5.2) employees.[18]

Column 3 shows that funded ventures are 16%–18% more likely to have a granted patent. Columns 4 and 5 consider improvements and growth in Web traff c performance. Funded ventures are 12%–16% more likely to have improved Web performance, but these estimates are not precisely measured. On the other hand, our intensive measure of f rm performance, the log ratio of website ranks, f nds a more powerful effect. Funded ventures show on average 32%–39% greater improvements in Web rank than unfunded ventures in recent years.

Finally, Table 3c analyzes whether angel funding leads to other f nancing. Panels A and B consider indicator variables for types of f nancing activity, while Panels C and D consider counts of f nancing rounds. The f rst column begins with whether the venture ever receives professional venture capital f nancing. This starting point provides background on whether alternative f nancing to the angel group was easily available. We f nd that funded ventures are 70% more likely to receive some form of venture f nancing than are start-ups that are rejected by the angel groups. On average, they have 1.6–2.1 more f nancing rounds. These estimates suggest that rejected deals found it reasonably diff cult to obtain venture f nancing at all.

The estimates in column 1 use data on venture f nancing that we developed from multiple sources, including contacting the venture directly. Column 2 shows similar results but with somewhat lower elasticities, when we use

[18] Our data description highlighted the need to cap very high employment or successful exits at a certain employment level. The measured employment effect with controls is higher at 38.8 (16.5) employees if the cap is increased to 250 employees. On the other hand, the estimated effect is 12.2 (3.6) employees if the cap is lowered to f fty employees. Based upon the data we could collect for very successful ventures in our sample, a cap of 100 employees appears most appropriate and our preferred estimate is the 19–20 employee f gure.

only data that we obtain from searching VentureXpert. We will return to this estimation when discussing Table 4's expanded sample.

Column 3 returns to the financing data used in column 1 and removes the current angel financing event. Thus, we now compare the probability of a funded venture obtaining further financing to the probability of a rejected deal obtaining any financing. Even after excluding the current angel financing event, the ventures funded by the angel groups are 21%–27% more likely to obtain later financing and have on average 0.8–1.2 more financing rounds.

The last two columns quantify the role of the angel groups in these subsequent financing events. Column 4 counts deals that include investors other than the original angel groups. A comparison of columns 3 and 4 shows that most of the additional financing events include outside investors. Column 5 alternatively counts deals that only include outside investors. The effects here are a third to a half of their magnitude in column 3. Funding by these two angel groups aids access to follow-on financing, with a substantial portion of the subsequent deals syndicated by the angel groups with other venture financiers.

Of course, we cannot tell from this analysis whether angel-backed firms pursue different growth or investment strategies and thus have to rely on more external funding. Alternatively, the powerful relationships could reflect a supply effect where angel group investors and board members provide networks, connections, and introductions that help ventures access additional funding. We return to this issue after viewing our border discontinuity results.[19]

4.2 The role of sample construction

The results in Tables 3a–3c suggest that funding by these angel groups is associated with improved venture performance. In describing our data and empirical methodology, we noted several ways that our analysis differed from a standard analysis. We first consider only ventures that approach our angel investors, rather than attempting to draw similar firms from the full population of business activity to compare with funded ventures. This step helps ensure comparable treatment and control groups ex ante in that all the ventures are seeking high growth. Second, we substantially narrow even this distribution of prospective deals until we have a group of companies that are comparable ex ante. This removes heterogeneous quality in the ventures that approach the angel investors. Finally, we introduce the border discontinuity to bring exogenous variation in funding outcomes.

Before proceeding to the border discontinuity, it is useful to gauge how much the second step—narrowing the sample of ventures to remove

[19] We do not find that being financed by the angel groups materially influences the types of venture investors subsequently accessed, at least in terms of venture fund size or age (two common proxies for the prestige of venture funds). These results question one common rationale given for pitching to angel investors: that they provide an entry to prestigious venture capital firms later.

Table 4
Border samples versus full samples

Outcome variable is (0,1) indicator variable for receiving venture financing as reported in Venture Xpert (see column 2 of Table 3c)	Simple TCA univariate regression with border sample	Full TCA univariate regression with complete sample			Matched sample on interest levels and covariates
		Base estimation	Interest levels	Combined estimation	
	(1)	(2)	(3)	(4)	(5)
(0,1) indicator variable for venture funding being received from angel group	0.432 (0.095)	0.562 (0.054)		0.403 (0.071)	0.418 (0.070)
Number of angels expressing interest in the deal			0.011 (0.002)	0.007 (0.002)	
Observations	87	2385	2385	2385	167

Linear regressions quantify the role of sample construction in the relationship between funding and venture outcomes. Column 1 repeats a modified, univariate form of column 2 in Table 3c with just the Tech Coast Angels sample. Column 2 expands the sample to include all of the potential ventures in the Tech Coast Angels database, similar to Table 1. The difference in elasticities between the two columns quantifies the role of sample construction in assessing angel funding and venture performance. As a second technique, columns 3 and 4 analyze interest levels joint with funding. Column 5 considers a matched sample approach, where we pair funded ventures with unfunded ventures that are closest to them in terms of interest levels and covariates (year of pitch, city/chapter, industry, stage, initial employment). Robust standard errors are reported.

quality differences inherent in the selection funnel—inf uences our regression estimates. Table 4 presents this analysis for one outcome variable and the Tech Coast Angels data. We are restricted to only one outcome variable by the intense effort to build any outcomes data for unfunded ventures. The likelihood of receiving venture funding is the easiest variable to extend to the full sample.

The f rst column repeats a modif ed, univariate form of column 2 in Table 3b with only the Tech Coast Angels sample. The elasticities are very similar, and we use only the information that we would have collected from VentureXpert. The second column expands the sample to include 2,385 potential ventures in the Tech Coast Angels database. The elasticity increases by 25% to 0.56. The difference in elasticities between the two columns demonstrates the role of sample construction in assessing angel funding and venture performance. The narrower sample provides a more comparable control group. Our rough estimate of the bias due to not controlling for heterogeneous quality is thus about a quarter of the true association.

The third and fourth columns demonstrate this bias in a second way. In column 3, we regress a dummy variable for obtaining venture funding on the linear interest variable. By itself, collective interest is very predictive of future outcomes; the coeff cient on the angel funding dummy is 0.11 and signif cant at the 1% level. This positive association, moreover, holds when excluding companies that Tech Coast Angels ultimately funds. In unreported regressions, we f nd that the interest-level variable has a coeff cient of 0.006 (0.002), indicative of the power of the screening mechanism. The fourth column shows that controlling for the ex ante interest levels of the angels, and thereby the approximate quality of investment opportunities, reduces the measured elasticity in the full sample to a little less than that measured for our border group. In total, these results suggest that while there is a positive and signif cant relationship between the level of interest by the angels in a deal and the underlying quality of the f rms, there is a strong nonlinearity in outcomes for those deals that were supported by the angel group versus those that were not supported.

Finally, column 5 shows a similar pattern by using another econometric technique. We create a matched sample where we pair funded ventures with unfunded ventures that are as close as possible in terms of interest levels, date of pitch, city/chapter, industry, stage, and employment at time of pitch. We drop funded ventures for which a close match is not available. This technique again produces very similar outcomes.[20] The combined results of Table 4 emphasize the importance of identifying a comparable control group in terms of venture quality for measuring the outcomes of venture f nancing events.

[20] The matched sample in Table 4 includes ventures outside our primary interest region where an appropriate match could be identif ed. We have further conf rmed that our results across the other outcome variables hold when using a matched sample approach within our primary interest region.

4.3 Border discontinuities and angel funding

We next turn to our border discontinuity exercise. Table 5 formally tests that there is a signif cant discontinuity in funding around the thresholds for the ventures considered by Tech Coast Angels and CommonAngels. The dependent variable is an indicator variable that equals one if the f rm received funding and zero otherwise. The primary explanatory variable is an indicator variable for the venture being above or below the interest discontinuity. Table A3 (see Appendix) provides descriptive statistics on outcomes for above- and below-border groups.

Column 1 presents a regression with just a constant, while column 2 controls for angel group f xed effects, year f xed effects, and industry f xed effects. These regressions combine data from the two angel groups. Across these two groups, we have 130 deals that are evenly distributed above and below the discontinuity. We f nd that there is a statistically and economically signif cant relationship between funding likelihood and being above the border; i.e., in being above the border, the funding likelihood increases by about 32%. Clearly, the border line designation is not a perfect rule—and this fuzziness will limit how strongly below we interpret the regression discontinuity—but it does signify a very strong shift in funding probability among ventures that are comparable ex ante, as is shown in Table 2.

Column 3 shows similar results when we add year and angel group f xed effects. These f xed effects control for the secular trends of each angel group. The funding jump also holds for each angel group individually. Column 4 repeats the regression controlling for deal characteristics like f rm size and number of employees at the time of the pitch. The sample size shrinks to eighty-seven since we only have this information for Tech Coast Angel deals. Despite the smaller sample size, we still f nd a signif cant difference in funding probability. The magnitude of the effect is comparable to the full sample at 29%. Unreported regressions f nd a group-specif c elasticity

Table 5
Border discontinuity and venture funding by angel groups

	(0,1) indicator variable for being funded by angel group			
	(1)	(2)	(3)	(4)
(0,1) indicator variable for venture being above the funding border discontinuity	0.316 (0.085)	0.328 (0.089)	0.324 (0.094)	0.292 (0.110)
Angel group, year, and industry f xed effects		Yes	Yes	Yes
Year x angel group f xed effects			Yes	
Additional controls				Yes
Observations	130	130	130	87

Column 1 reports a linear regression of venture funding by the angel groups on a dummy variable for being above the border discontinuity. Column 2 includes industry, year, and angel group f xed effects. Column 3 includes year x angel group f xed effects. Column 4 includes additional controls of stage of company and employment-level f xed effects. Robust standard errors are reported.

for CommonAngels of 0.45 (0.21). These results suggest that the identified discontinuities provide a reasonable identification strategy.[21]

4.4 Border discontinuities and firm outcomes

Tables 6a–6c consider venture outcomes and the border discontinuity. Even after eliminating observable heterogeneity through sample selection, the results in Tables 3a–3c are still subject to the criticism that ventures are endogenously funded. Omitted variables may also be present. Looking above and below the funding discontinuity helps us evaluate whether the ventures that looked comparable ex ante, except in their probability of being funded, are now performing differently. This test provides a measure of exogeneity to the relationship between angel financing and venture outcomes.

Tables 6a and 6b have the same format as Tables 3a and 3b, and the only difference is that the explanatory variable is the indicator variable for being above the funding border. The coefficients are not directly comparable across the two estimation approaches, but we can compare the qualitative results.[22] In Table 6a, being above the border is associated with stronger chances for survival, but it is only qualitatively associated with venture success by December 2010, as measured by successful exits or having seventy-five or more employees. In Table 6b, above-border ventures are associated with generally better operating performance, as measured by employment levels, patenting, and website traffic growth. Median regressions find an employment growth of 15.0 (4.1) employees.

This comparability indicates that endogeneity in funding choices and omitted variable biases are not driving the general association earlier found between financing by these two groups and startup performance. The results in Table 6a, however, do suggest that some of the association between funding and venture success by December 2010 may be due in part to factors not captured by the angel interest levels (e.g., the speed with which the investment can reach a liquidity event).

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[21] We find similar results in a variety of robustness checks. To report one, concern could exist that angels have fixed voting patterns that skew the scores. For example, the most meaningful endorsement for a venture could come from an angel who very rarely expresses interest in any deal, and so his or her vote carries unequal weight in the decisions. These patterns could be obscured in our aggregated measures. To check this, we develop a second measure of the interest level in deals that normalizes each angel's total expressed interest to be the same. That is, we down-weight the votes of angels who express interest in every deal. We find very similar results to those reported below, which suggests that our identification strategy is not being contaminated by bandwagon effects and angel-specific heterogeneity in voting.

It is also worth noting that the professional managers of both angel groups found this funding discontinuity a reasonable description of their groups' behavior. One manager noted that because the angels need to jointly invest, the development of critical mass behind a deal is essential and nonlinear. He also noted that the group early on (before our sample) changed its meeting procedures so that angels scored their sheets before an open group discussion was held to allow collection of more independent views of the venture.

[22] The coefficients would be comparable if we used the border discontinuity in an instrumental variables framework. Given the substantial fuzziness of our funding discontinuity, we only use this empirical approach to confirm the overall qualitative direction of our findings.

Table 6a
Analysis of border discontinuity and venture success

	(0,1) venture in operation or successful exit by December 2010	(0,1) venture underwent successful exit (IPO or acquired) by December 2010	(0,1) venture underwent successful exit or had 75+ empl. by December 2010	(0,1) venture underwent successful exit or had 50+ empl. by December 2010	(0,1) venture underwent successful exit or had 100+ empl. by December 2010
	(1)	(2)	(3)	(4)	(5)
			Panel A: Base regression		
(0,1) indicator variable for venture being above the funding border discontinuity	0.222	0.074	0.116	0.081	0.112
	(0.081)	(0.052)	(0.069)	(0.074)	(0.067)
			Panel B: Panel A, including angel group, year, and industry f xed effects		
(0,1) indicator variable for venture being above the funding border discontinuity	0.247	0.075	0.088	0.057	0.095
	(0.095)	(0.058)	(0.086)	(0.089)	(0.082)
Observations	130	130	130	130	130

Panel A includes linear regressions of f rm outcomes on a dummy variable for whether the f rm was above the border discontinuity. Regressions in Panel B include industry, year, and angel group f xed effects. The f rst column tests whether the venture is alive in December 2010. The second column tests whether the venture had a successful IPO or acquisition by December 2010. Columns 3–5 also consider ventures successful if they achieved indicated employment levels in December 2010. Robust standard errors are reported.

Table 6b
Analysis of border discontinuity and venture operations and growth

	Employee count in 2010 with a maximum of 100 employees	Employee count in 2010 with a maximum of 100 employees	(0,1) indicator variable for granted patent by 2010 from USPTO	(0,1) indicator variable for improved Web rank from 2008 to 2010	Log ratio of 2010 Web rank to 2008 rank (negative values are improvements)
	(1)	(2)	(3)	(4)	(5)
			Panel A: Base regression		
(0,1) indicator variable for venture being above the funding border discontinuity	14.339	9.558	0.190	0.244	−0.356
	(5.974)	(6.925)	(0.079)	(0.097)	(0.194)
Employment level at the time that the venture approached the angel group		0.711			
		(0.131)			
			Panel B: Panel A, including angel group, year, and industry fixed effects		
(0,1) indicator variable for venture being above the funding border discontinuity	12.431	11.187	0.154	0.232	−0.382
	(7.421)	(8.006)	(0.089)	(0.120)	(0.249)
Employment level at the time that the venture approached the angel group		0.755			
		(0.150)			
Observations	130	83	130	91	58

Panel A includes linear regressions of firm outcomes on a dummy variable for whether the firm was above the border discontinuity. Regressions in Panel B include industry, year, and angel group fixed effects. The first column tests employment levels in 2010. Failed ventures are given zero employment, and a maximum of 100 employees is given for very successful ventures. Very successful acquisitions are also given this maximum value. The second column also controls for employment at the time the venture approached the angel group. Column 3 is an indicator variable for having been granted a patent by the USPTO. The last two columns test for improved venture performance through website traffic data from 2008 to 2010. Column 4 is an indicator variable for improved performance, while Column 5 gives log ratios of Web traffic (a negative value indicates better performance). Robust standard errors are reported.

Table 6c
Analysis of border discontinuity and venture f nancing

	Receives any venture f nancing	Receives later venture f nancing than the current angel investment
	(1)	(2)
	Panel A: Base regression with (0,1) indicator variable	
(0,1) indicator variable for venture being above the funding border discontinuity	0.162 (0.085)	0.069 (0.089)
	Panel B: Panel A, including controls	
(0,1) indicator variable for venture being above the funding border discontinuity	0.177 (0.094)	−0.033 (0.102)
	Panel C: Base regression with count of f nancing rounds	
(0,1) indicator variable for venture being above the funding border discontinuity	−0.224 (0.367)	−0.535 (0.352)
	Panel D: Panel C, including controls	
(0,1) indicator variable for venture being above the funding border discontinuity	−0.039 (0.459)	−0.369 (0.421)
Observations	130	130

Panels A and C include linear regressions of f rm outcomes on a dummy variable for whether the f rm was above the border discontinuity. Regressions in Panels B and D include industry, year, and angel group f xed effects. Column 1 tests whether the venture receives f nancing, including the current angel f nancing event. The second column excludes the current angel f nancing round where applicable. Across these outcomes, Panels A and B present binary indicator variables, while Panels C and D consider counts of f nancing rounds. Robust standard errors are reported.

Finally, Table 6c looks at border outcomes with respect to venture f nancing. The identif cation of the investors is not very meaningful in this context, so we simply focus on whether the venture receives any f nancing (at all or removing the current f nancing round). Table 6c shows that being above the border discontinuity does not lead to greater venture f nancing in later years. This null result may indicate that the least squares association between current and future f nancing ref ects the investment and growth strategies of the f nanciers but that this path is not necessary for venture growth or success as measured by our outcome variables in Tables 6a and 6b. This interpretation would also f t with the substantial syndication evident in Table 3c. We return to these questions in our conclusions.[23]

5. Performance of Angel Investors

One natural concern is whether these investments represent an economically driven activity, since angels are individuals who often derive utility from simply meeting with and investing in entrepreneurs. This raises questions

[23] We have conf rmed the border results in several ways. Perhaps most importantly, the results do not depend upon how the two angel groups are combined or changes in angel group size over the sample. Similar patterns emerge, e.g., when considering Tech Coast Angels in the period after 2001. We also f nd positive associations for each group individually, although some results are not statistically signif cant due to smaller sample sizes.

about whether our findings could apply to the venture investment process as a whole. One way to address this concern is to look at the angels' returns, relative to those of the typical professional venture capital fund. If these two measures are comparable, then this will dispel some of these hobbyist concerns.[24]

We undertake this analysis using venture capital data from VentureXpert, which has been previously, extensively used in earlier research (e.g., Kaplan and Schoar 2005). We compare on an annual basis the investment multiples of the industry with that of one of the angel groups. We compute two ratios (with data as of December 2009): 1) the amount returned to investors to the amount invested (distributed to paid-in capital); and 2) the sum of the distributed capital and the current remaining value of the investment portfolio to the amount invested (total value to paid-in capital). We compute a simple average across years and one weighted by the venture capital investment in each year.

There are two complications. First, professional venture funds charge investors a management fee (typically 2% of committed capital) and retain a share of the profits (usually 20%, which is termed carried interest). The returns reported by VentureXpert are net of these fees. Direct investments by angels do not incur these costs. Thus, we adjust the returns of the angel groups as if they had paid these fees, assuming that an extra amount equal to the management fees incurred from the time of the investment to December 31, 2009, was raised but not invested. Second, we reduce any distributions by 20% of the difference between the value of the distribution and the amount invested in the distributed shares in order to reflect the carried interest.

A second complication is that the angel data are computed by using investment dates, while VentureXpert's tabulations are arranged by the fund's vintage year (measured using the final closing date of the fund). The actual investment may be earlier—many groups will begin investing immediately after the first closing—or later, continuing for a number of years after the final closing. Data constraints require that we use the inexact time comparisons, so we compare the angel investments to the performance of venture funds raised two years later.

Table 7 presents the comparison, with the bottom lines providing the summary statistics. Using a simple average, the two groups are about equivalent when using the distributed capital measure, while the angel group outperforms using the total value measure. When weighted, the venture industry outperforms when using the distributed capital measure, while the angel group outperforms using the total value measure. Collectively, the evidence provides little support for the claim that angel investors are hobbyists who are not seriously pursuing the investment process.

[24] Of course, this analysis does not prove that the findings about the impact of angel investors carry over to other investors. For instance, even if the returns were equal, it might be that the angel groups invest more unobservable effort and their approach would not be sustainable if they priced their inputs at market rate. Again, it is important to note that both funds have professional managers and that CommonAngels further raises venture funds from limited partners that its professional managers invest alongside the angels (Applegate and Simpson 2011).

Table 7
Analysis of angel group portfolio investment returns

Cumulative U.S. VC vintage year performance					Angel group performance, by year of investment									
Fund year	Sample size	Total VC funds raised in vintage year (US$ billion)	Capital weighted average: D/PI	Capital weighted average: TV/PI	Year	$ Invested	Distributed capital ($s)	Total value ($s)	Estimated fees paid ($s)	Estimated carry paid ($s)	D/PI	TV/PI	Net of fee D/PI	Net of fee TV/PI
1995	49	9.5	3.84	4.16	1997	1,150,000	18,630,000	18,630,000	178,250	3,496,000	16.20	16.20	11.39	11.39
1996	36	12.0	4.22	4.78	1998	6,285,510	242,342	3,130,342	974,254	0	0.04	0.50	0.03	0.43
1997	64	19.8	2.11	2.37	1999	16,331,104	10,386,749	13,138,226	2,531,321	0	0.64	0.80	0.55	0.70
1998	78	30.0	1.28	1.72	2000	12,819,029	5,588,458	13,815,428	1,986,949	80,610	0.44	1.08	0.37	0.93
1999	107	55.7	0.45	0.74	2001	6,563,700	4,277,088	35,390,216	1,000,964	696,766	0.65	5.39	0.47	4.59
2000	122	104.5	0.48	1.03	2002	3,701,495	1,218,194	3,977,907	545,971	16,930	0.33	1.07	0.28	0.93
2001	59	38.9	0.56	1.16	2003	4,251,519	914,050	6,967,163	596,276	71,255	0.21	1.64	0.17	1.42
2002	20	9.4	0.21	0.97	2004	7,466,829	615,813	9,617,376	970,688	27,540	0.08	1.29	0.07	1.14
2003	17	11.6	0.34	1.11	2005	14,079,569	350,000	17,975,928	1,548,753	15,173	0.02	1.28	0.02	1.15
2004	23	19.8	0.24	1.04	2006	11,567,778	1,025,000	16,189,696	1,041,100	58,524	0.09	1.40	0.08	1.28
2005	21	29.0	0.11	1.02	2007	9,469,772	0	7,538,680	662,884	0	0.00	0.80	0.00	0.74
2006	38	22.0	0.11	0.96	2008	6,527,593	0	5,421,499	326,380	0	0.00	0.83	0.00	0.79
Wtd average, VC funds raised			1.16	1.76							1.56	2.69	1.12	2.12
Wtd average, TCA weights			0.78	1.33							0.72	2.15	0.54	1.80

Table compares performance of an angel group fund to the venture capital industry as a whole. We use a two-year lag (e.g., comparing 2005 venture funds to 2007 angel investments) under the assumption that funds invest with a lag. Weights used in the first weighted industry average returns are based on total VC dollars raised. Weights used in the second weighted industry average employ the same year distribution as the angel group's investments. Net of fee assumes 2% management fee for first seven years and 0.5% for next three years; analysis assumes additional funds raised to cover fees. Net of carry assumes 20% of difference between distributed and invested capital; deducted from distributed capital or total value. Performance is as of June 30, 2010. Industry data from Thomson Reuters.

6. Conclusions and Interpretations

This study analyzes two prominent angel groups and their effects on the start-ups in which they invest. We find that the angel investments enhance the outcomes and performance of the firms that are funded by these groups. Using a variety of econometric techniques, we find consistent evidence that financing by these angel groups is associated with improved likelihood of survival for four or more years, higher levels of employment, and more traffic on these firms' websites. We also find evidence that angel group financing helps in achieving successful exits and reaching high employment levels. These latter success results are strong in the base data, but they are only qualitatively supported in the border analysis.

Our evidence with regard to the role of angel funding for access to future venture financing is mixed. Being funded by one of the angel groups is associated with superior follow-on financing in the base data, but there is no evidence that this matters around the border discontinuity (where the other results are supported). We do not want to push this asymmetry too far, but one might speculate that access to capital per se is not the most important value added that angel groups provide. Our results suggest that some of the "softer" features, such as their mentoring or business contacts, may help new ventures the most.

Overall, we find that the interest levels of angels at the stages of the initial presentation and due diligence are predictive of investment success. These findings suggest that in addition to having a causal impact on the ventures they fund, angels engage in an efficient selection and screening process, which sorts proposals into relevant bins, i.e., complete losers, truly exceptional opportunities, potential winners, and so on (e.g., Kerr and Nanda 2009).

At the same time, this article leaves many questions unanswered. Our experiment does not allow us to identify the costs of angel funding (e.g., Hsu 2004), as we cannot observe equity positions in the unfunded ventures. We thus cannot evaluate whether taking the money was worth it from the entrepreneur's perspective after these costs are considered. In addition, we cannot test the impact of angel funding against specific alternative counterfactuals, such as whether the venture would have been better off with venture capital funding.

Moreover, we have looked at just a few of the many angel investment groups that are active in the United States. Our groups are professionally organized and managed, and it is important for future research to examine a broader distribution of investment groups and their impact for venture success. Likewise, future work needs to evaluate the performance of individual angel investors. It would be important to understand whether the dual motives of many angels—financial returns and nonpecuniary benefits from working with entrepreneurs—affect their approach and the type of support that these investors provide. Our article demonstrates that angel investments can have an important impact on the deals they support and can offer an empirical foothold for analyzing many important questions in entrepreneurial finance.

Table A1
Extended data on angel group selection funnel

Year	Total count of ventures examined by group	Angels expressing interest in 1+ deals	Angels expressing interest in 10+ deals	Angels in 10+ deals per active chapter	Average interest level, incl. zeros	Average interest level, excl. zeros	Mean interest in funded ventures	Median interest in funded ventures	Share of ventures that are funded (%)	Funded share adj. for external decisions (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2001	346	62	57	29	1.7	6.5	10.2	13.0	2.9	3.5
2002	313	77	72	36	1.9	7.8	27.0	25.5	2.6	2.9
2003	311	196	135	34	2.7	9.0	19.7	21.0	4.8	5.5
2004	343	169	135	34	2.5	7.8	30.8	34.5	2.9	3.2
2005	312	183	146	37	3.5	7.6	27.0	23.0	3.8	4.0
2006	406	214	158	40	3.9	8.5	26.4	21.0	4.2	4.3

Table documents the annual activity of Tech Coast Angels. The first column lists the count of ventures examined by the group. The next two columns show the number of angels expressing interest in deals, with our primary count being the angels who express interest in ten or more deals (over all the years that we observe). Tech Coast Angels expands from two to four chapters in 2003. One of the new chapters pre-existed as a separate angel group; the second pulled both new and existing members. On a per-chapter basis, the number of active angels remains mostly constant during this growth period, as shown in the fourth column. The fifth column shows that the average interest in a deal rises over the sample. This increase is primarily due to fewer deals receiving zero interest. The average nonzero interest is flatter in column 6. The seventh and eighth columns show that the mean and median interest levels for funded ventures is mostly flat during our sample, with the exception of the lower values in 2001. The mean interest statistic caps interest levels at fifty angels. The last two columns show the share of ventures funded by year, with the tenth column adjusting for external decisions (e.g., the venture withdrew to take funding elsewhere). These funding percentages have minor fluctuations around 3.5% during the sample period.

Table A2
Simple outcomes comparisons for funded and unfunded groups

Outcomes of ventures funded and unfunded	Funded ventures	Unfunded ventures	Two-tailed *t*-test for equality of means
Venture success by December 2010			
(0,1) venture in operation or successful exit	0.763	0.563	0.016
(0,1) venture underwent successful exit (IPO or acquisition)	0.136	0.042	0.070
(0,1) venture underwent successful exit or had 75 employees	0.271	0.085	0.007
Venture operations and growth by December 2010			
Employee count in 2010 with a maximum of 100 employees	36.8	17.0	0.001
(0,1) venture had a granted patent by 2010 from USPTO	0.339	0.183	0.047
(0,1) venture had an improved Web rank from 2008–2010	0.356	0.239	0.229
Log ratio of 2010 Web rank to 2008 Web rank (negative good)	−0.030	0.294	0.096
Venture f nancing by December 2010			
(0,1) venture receives any venture f nancing	1.000	0.296	0.000
Count of venture f nancing rounds	2.525	0.901	0.000
Observations	59	71	

See Tables 3a–3c.

Table A3
Simple outcomes comparisons for border discontinuity groups

Outcomes of ventures above and below border discontinuity	Above border ventures	Below border ventures	Two-tailed *t*-test for equality of means
Venture success by December 2010			
(0,1) venture in operation or successful exit	0.782	0.560	0.007
(0,1) venture underwent successful exit (IPO or acquisition)	0.127	0.053	0.161
(0,1) venture underwent successful exit or had 75 employees	0.236	0.120	0.095
Venture operations and growth by December 2010			
Employee count in 2010 with a maximum of 100 employees	34.3	19.9	0.018
(0,1) venture had a granted patent by 2010 from USPTO	0.364	0.173	0.018
(0,1) venture had an improved Web rank from 2008–2010	0.436	0.192	0.015
Log ratio of 2010 Web rank to 2008 Web rank (negative good)	−0.080	0.276	0.071
Venture f nancing by December 2010			
(0,1) venture receives any venture f nancing	0.709	0.547	0.057
Count of venture f nancing rounds	1.509	1.733	0.542
Observations	55	75	

See Tables 6a–6c.

References

Admati, A. R., and P. Pf eidere. 1994. Robust Financial Contracting and the Role of Venture Capitalists. *Journal of Finance* 49:371–402.

Applegate, L., and K. Simpson. 2011. CommonAngels A. Case 810-082, Harvard Business School.

Bakke, T.-E., and T. M. Whited. 2010. The Real Effects of Market Liquidity: Causal Evidence from Delisting. Unpublished Working Paper, University of Rochester.

Bergemann, D., and U. Hege. 1998. Venture Capital Financing, Moral Hazard, and Learning. *Journal of Banking & Finance* 22:703–35.

Berglöf, E. 1994. A Control Theory of Venture Capital Finance. *Journal of Law, Economics, and Organizations* 10:247–67.

Chemmanur, T. J., K. Krishnan, and D. K. Nandy. Forthcoming. How Does Venture Capital Financing Improve Eff ciency in Private Firms? A Look Beneath the Surface. *Review of Financial Studies*.

Chernenko, S., and A. Sunderam. 2009. The Real Consequences of Market Segmentation. Unpublished Working Paper, Harvard University.

Conti, A., M. C. Thursby, and F. Rothaermel. 2011. Show Me the Right Stuff: Signals for High-tech Startups. Working Paper Series No. 17050, National Bureau of Economic Research.

Cornelli, F., and O. Yosha. 2003. Stage Financing and the Role of Convertible Debt. *Review of Economic Studies* 70:1–32.

Goldfarb, B., G. Hoberg, D. Kirsch, and A. Triantis. 2007. Are Angels Preferred Series A Investors? Unpublished Working Paper, University of Maryland.

Hellmann, T. 1998. The Allocation of Control Rights in Venture Capital Contracts. *RAND Journal of Economics* 29:57–76.

Hellmann, T., and M. Puri. 2000. The Interaction Between Product Market and Financing Strategy: The Role of Venture Capital. *Review of Financial Studies* 13:959–84.

Hsu, D. H. 2004. What Do Entrepreneurs Pay for Venture Capital Aff liation? *Journal of Finance* 59:1805–44.

Kaplan, S. N., and A. Schoar. 2005. Private Equity Performance: Returns, Persistence and Capital Flows. *Journal of Finance* 60:1791–823.

Kaplan, S. N., and P. Strömberg. 2004. Characteristics, Contracts, and Actions: Evidence from Venture Capitalist Analyses. *Journal of Finance* 59:2177–210.

Kaplan, S. N., B. Sensoy, and P. Strömberg. 2009. Should Investors Bet on the Jockey or the Horse? Evidence from the Evolution of Firms from Early Business Plans to Public Companies. *Journal of Finance* 64:75–115.

Kerr, W., and R. Nanda. 2009. Democratizing Entry: Banking Deregulations, Financing Constraints, and Entrepreneurship. *Journal of Financial Economics* 94:124–49.

Kortum, S., and J. Lerner. 2000. Assessing the Contribution of Venture Capital to Innovation. *RAND Journal of Economics* 31:674–92.

Lamoreaux, N., M. Levenstein, and K. Sokoloff. 2004. Financing Invention During the Second Industrial Revolution: Cleveland, Ohio, 1870–1920. Working Paper Series No. 10923, National Bureau of Economic Research.

Lee, D. S., and T. Lemieux. 2010. Regression Discontinuity Designs in Economics. *Journal of Economic Literature* 48:281–355.

Mollica, M., and L. Zingales. 2007. The Impact of Venture Capital on Innovation and the Creation of New Businesses. Unpublished Working Paper, University of Chicago.

Puri, M., and R. Zarutskie. Forthcoming. On the Life-cycle Dynamics of Venture-capital- and Non-venture-capital-f nanced Firms. *Journal of Finance*.

Rauh, J. D. 2006. Investment and Financing Constraints: Evidence from the Funding of Corporate Pension Plans. *Journal of Finance* 61:31–71.

Samila, S., and O. Sorenson. 2011. Venture Capital, Entrepreneurship, and Economic Growth. *Review of Economics and Statistics* 93:338–49.

Shane, S. 2008. The Importance of Angel Investing in Financing the Growth of Entrepreneurial Ventures. Working Paper No. 331, U.S. Small Business Administration, Off ce of Advocacy.

Sorensen, M. 2007. How Smart Is the Smart Money? A Two-sided Matching Model of Venture Capital. *Journal of Finance* 62:2725–62.

Sudek, R., C. Mitteness, and M. Baucus. 2008. Betting on the Horse or the Jockey: The Impact of Expertise on Angel Investing. *Academy of Management Best Paper Proceedings*.