The Consequences of Entrepreneurial Finance:

A Regression Discontinuity Analysis

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Abstract: This paper documents the role of angel group funding for the success, operations, and venture financing of high-growth start-up firms. We first show that ventures funded by angel groups experience outcomes superior to ventures rejected by the angel group on many dimensions: survival, successful exits, employment levels, patenting, web traffic, and financing. These differences exist even when creating very rigorous control groups of non-funded ventures that receive similar interest levels from the same investor at the time of the investment pitch. We further show that angel groups display strong discontinuities in their funding behavior over small changes in the collective interest levels of angels. When implementing a regression discontinuity approach around these discontinuities, we find a positive effect of angel financing on most operations of the venture. On the other hand, the findings regarding the access to additional financing are not confirmed. Overall, the results suggest that the bundle of inputs (especially non-financial) that angel investors provide have a large, positive impact on start-up ventures.

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One of the central and most enduring questions in the entrepreneurial finance literature is the extent to which early stage financiers such as angels or venture funds have a real impact on the firms in which they invest. An extensive theoretical literature suggests the combination of intensive monitoring, staged investments, and powerful control rights in these types of deals should alleviate agency problems between entrepreneurs and institutional investors (examples include Admati and Pfleiderer, 1994; Berglöf, 1994; Bergmann and Hege, 1998; Cornelli and Yosha, 2003; and Hellmann, 1998). This bundle of inputs, the works suggest, can lead to improved governance and operations in the portfolio firms, lower capital constraints, and ultimately stronger firm growth and performance.

But the empirical documentation of this impact has been challenging. Hellmann and Puri (2000) provide a first detailed comparison of the growth path of venture backed versus non venture backed firms.[1] This approach, however, faces the natural challenge that unobserved heterogeneity across entrepreneurs, such as ability or ambition, might drive the growth path of the firms as well as the venture capitalists' decision to invest. The question remains whether seed stage investors provide value-added services (such as financial capital and soft inputs) that causally affect the performance of start-ups or whether their main role is to select firms that have better inherent growth opportunities. These problems are particularly acute for evaluating early-stage investments.

An alternative approach is to find exogenous shocks to the level of venture financing. Examples of such exogenous shocks are public policy changes (Kortum and Lerner, 2000), variations in endowment returns (Samila and Sorenson, 2010), and differences in state pension funding levels (Mollica and Zingales, 2007). These studies, however, can only examine the

[1] A similar approach is taken in Puri and Zarutskie (2008) and Chemmanur et al. (2009) who employ comprehensive Census Bureau records of private firms to form more detailed control groups based on observable characteristics.

impact of entrepreneurial finance activity at an aggregate level. Given the very modest share that high-potential growth firms represent of all entrepreneurial ventures and economic activity overall, these studies face a "needle in the haystack" type challenge to detect any results.

This paper takes a fresh look at the question of whether entrepreneurial financiers affect the success and growth of new ventures. We focus on a neglected segment of entrepreneurial finance: 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 start-up investments as venture capital firms (Shane, 2008; Goldfarb et al., 2007; Sudek et al., 2008). Angel investors are increasingly structured as semi-formal networks of high net worth individuals, often former entrepreneurs themselves, who meet in regular intervals (usually once a month for breakfast or dinner) to hear aspiring entrepreneurs pitch their business plans. The angels then decide to conduct further due diligence and ultimately whether to invest in some of these deals either individually or in subgroups of the members. Similarly to traditional venture capital investments, angel investment groups often adopt a very hands-on role in the deals they get involved in and provide entrepreneurs with advice and contacts to potential business partners.

In addition to their inherent interest as funders of early stage companies, angel investment groups are distinguished from the majority of traditional venture capital organizations by the fact that they make their investment decisions through well documented collections of interest and, in some cases, formal votes. 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

investors, in contrast, express their interest for deals independently from one another and based upon personal assessment. This allows us to observe the level of support or lack thereof for the different deals that come before the angel group.[2]

Our analysis exploits very detailed data of ventures 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 of the companies who approached them, how angel interest formed and the financing decisions made, and subsequent venture outcomes. As described below, we further collected as much information as possible about the funded and unfunded ventures through venture industry sources (e.g., VentureXpert, CorpTech), surveys of the entrepreneurs, web searches, and similar steps.

The resulting dataset allows us to make several unique contributions to measuring the consequences of entrepreneurial finance. Two contributions are very basic but also extremely important. First, our estimates are developed by comparing funded and unfunded ventures that approached the same investor. Second, we use the interest levels expressed by the angels themselves to form specialized treatment and control groups that have similar qualities. Thus, our work encompasses many of the matching traits used by prior work—industry, employment levels and growth rates, age, etc.—but goes well beyond in that we capture better 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).[3]

[2] Our paper 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 Stromberg (2004) and Kaplan et al. (2009) examine characteristics and dimensions that venture capitalists rely on when making investment decisions. Goldfarb et al. (2008) and Conti et al. (2008) consider choices between angels and venture investors.

[3] 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,

Second, our data allow us to go further towards confirming the causal relationship. Even with careful use of the interest measures to proxy for quality, one could still argue that the funding decisions are based upon traits of ventures that were observable to the angels at the time of the pitch but were not expressed in their interest votes and not recorded in our data. Within the quality ranges that we analyze, there exists a discrete jump in the probability of venture funding as interest accumulates around a deal. As we describe further below, this fuzzy discontinuity is due to how critical mass develops within the angel group around prospective deals. This discontinuity allows us to make use of the regression discontinuity design methodology. This econometric technique, while today widely used in program evaluations by economists (Lee and Lemieux, 2010), remains underutilized in financial economics (exceptions include Rauh, 2006; Chernenko and Sunderam, 2009; and Bakke and Whited, 2010).

We identify from the data 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 on firms around the cut-off level having very similar ex ante characteristics, in which case 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 employ micro-data 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. As a descriptive

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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 to which one should compare 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.

value, our analysis of the selection funnel of the ventures is unique, however, in that interest levels are measured for every venture. This allows us to estimate a variety of statistics for which we only have anecdotal accounts. Second, and more importantly, angel groups display break points or discontinuities where a small change in the collective interest levels of the angels leads to a discrete change in the probability of funding among otherwise comparable ventures. This provides a powerful empirical foothold for overcoming quality differences and selection bias between funded and unfunded ventures.

Second, we look at the impact of angel funding on venture success, venture operations, and access to venture financing. We begin by comparing firms that received funding to those that did not within a narrow quality range. We show that funded firms are 25% more like to survive for at least five years (or until December 2010). They are also 11% more like to undergo a successful exit (IPO or acquisition) and 16% more likely to be generally successful (as measured by a successful exit or reaching 75 employees by December 2010). Funded companies have 18-19 more employees in 2010, are 18% more likely to have a granted patent, and are growing faster as measured through web traffic performance between 2008 and 2010. Finally, funded companies are better financed. Overall, they have a 70% higher likelihood of obtaining entrepreneurial finance and have on average two additional financing rounds. Being funded by the angel groups aids access to follow-on financing in large part through deals subsequently syndicated by the angel groups with other venture financiers.

These results are developed 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, 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 need and difficulty in studies of entrepreneurial finance to create proper control groups for funded ventures that are similar in initial quality.

Our third set of findings considers ventures just above and below the funding threshold using the regression discontinuity methodology, which removes the endogeneity of funding and many omitted variable biases. We robustly confirm several of our outcomes: the ventures are more likely to be alive, and they have superior operations in terms of employee counts, patenting, and web traffic growth. We also find qualitative support for ventures having achieved a successful exit by December 2010, but these results are not statistically significant. This latter difference may suggest that the angel groups also select on ventures with quicker exit prospects than are expressed in our initial interest measures. Nevertheless, this first set of results with the border discontinuity confirm the importance of receiving angel investments for the survival and growth of the venture.

Interestingly, we do not see an impact of angel funding on accessing additional financing when using the regression discontinuity approach (qualitatively or quantitatively). This may suggest that access to additional financing is often a by-product of how angel funded firms grow but that this path may not be essential for venture operational improvements as we measure them. The important role of the syndication in the least squares results also points in this direction. This result might also underline that, in the time period we study, prior angel financing was not an essential prerequisite to accessing follow-on funding.

Our final analysis calculates the overall returns to the one of the angel group's portfolio and compares them to the venture financing industry as a whole. While our project focuses on

the consequences of financing for start-up ventures, this additional analysis helps confirm that the investments were warranted for the angel group as a whole. We find that the angel group outperformed the venture capital industry overall during the period of study.

Thus, this paper provides a fresh look and new evidence at an essential question in entrepreneurial finance. It quantifies the positive impact that angel investors make to the companies that they fund in a way that simultaneously exploits novel, rich micro-data and addresses 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. Given the observed heterogeneity across angel groups, the magnitude of the impact that we estimate are likely to be at the upper end of the angel population.

The plan of this paper 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 final section concludes the paper.

1. The Angel Group Investment Process

Angel investments—or equity investments by individuals into high-risk ventures—is an among the oldest of human commercial activities, dating back at least as far as the investment agreements recorded in the *Code of Hammurabi* circa 1790 B.C. For most of American economic history, angels represented the primary way in which entrepreneurs obtained high-risk capital for start-up businesses (e.g., Lamoreaux et al., 2004), whether directly through individuals or through the offices that managed the wealth of high net worth individuals beginning in the last decades of the nineteenth century. Wealthy families such as the Phippses,

Rockefellers, Vanderbilts, and Whitneys invested in and advised a variety of business enterprises, including the predecessor entities to AT&T, Eastern Airlines, McDonald-Douglas, and W.R. Grace.

The first formal venture capital firm, however, was not established until after World War II: American Research and Development (ARD) was formed by MIT President Karl Compton, Harvard Business School Professor Georges F. Doriot, and Boston business leaders in 1946. Over time, a number of the family offices transformed as well into stand-alone venture firms, including such groups as Bessemer, Venrock, and J.H. Whitney.

While angel investors have a long history, angel investment groups are a quite recent phenomenon. Beginning in the mid 1990s, angels began forming groups to collectively evaluate and invest in entrepreneurial ventures. These groups are seen as having several advantages by the angels. First, angels can pool their capital to make larger investments than they could otherwise. Second, each angel can invest smaller amounts in individual ventures, allowing participation in more opportunities and diversification 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 flow. Finally, the groups frequently include some of the most sophisticated and active angel investors in the region, which results in superior decision-making.

The Angel Capital Association (ACA) lists 300 U.S. groups in its database. The average ACA angel group had 42 member angels and invested a total of $1.94 million in 7.3 deals in 2007. Between 10,000 and 15,000 angels are believed to belong to angel groups in the U.S.[4]

Most groups follow a template that is more or less similar. Entrepreneurs typically begin the process by submitting to the group an application that may also include a copy of their

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

business plan or executive summary. The firms, after an initial screening by the staff, are then invited to give a short presentation to a small group of members, followed by a question-and-answer session. Promising companies are then invited to present at a monthly meeting (often a weekday breakfast or dinner). The presenting companies that generate the greatest interest then enter a detailed due diligence review process, although the extent to which due diligence and screening leads or follows the formal presentation varies across groups. A small group of angel members conduct this additional, intensive evaluation. 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-specific discontinuities. We commence with Tech Coast Angels, the larger of our two investment groups, and we devote extra time in this first data description to also convey 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 five chapters seeking high-growth investments in a variety of high-tech and low-tech industries. The group typically looks for funding opportunities of $1 million or less. Additional details on this venture group are available at http://www.techcoastangels.com/.

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. Our analysis considers ventures that approached Tech Coast Angels between 2001 and 2006. We thus mainly build upon data records that existed in early 2007. At this time, there were over 2500 ventures in the database. The database is also exceptional in that it has detailed information about many of the companies that are not funded by Tech Coast Angels.

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 Angel analysis is a 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 being out-spoken champions of the deal, the support of the professional manager, and a critical mass of

angels being willing to fund the venture as a group. While we do not observe the champions of the deals, we do have a unique window into how funding relates to obtaining a critical mass of interested angels.

Table 1 documents the distribution of deals and angel interest levels. The first three columns of Table 1 show 64% of ventures receive no interest at all. Moreover, 90% of all ventures receive interest by fewer than ten angels. This narrowing funnel continues until the highest bracket, where there are 44 firms that receive interest from 35 or more angels. 15 ventures receive the interest of 50 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 documented consistently 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 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". But independent of what exactly drives this investment behavior of angels, we want to explore whether there are discontinuities in interest levels such that small changes in angels expressing interest among otherwise comparable deals results in material shifts in funding probability.

The central idea behind this identification strategy is that angel interest in ventures does not map one-to-one into quality differences across ventures, which we verify empirically below. Instead, there is some randomness or noise in why some firms receive n votes and others receive n+1. It is reasonable to believe that there are enough idiosyncrasies in the preferences and beliefs

of angels so that the interest count does not present a perfect ranking of the quality of the underlying firms. Certainly, the 2% of ventures with 35 or more interested angels are not comparable to the 64% of ventures with zero interest. But we will show that ventures with 18 votes and 22 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 do 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 cut-off, we must identify from 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. The rise in funding probability with interest level is monotonic with interest, excepting some small fluctuations at high interest levels.

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, focusing on the region around the border. This restriction prepares us for the border discontinuity exercise, but it 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 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 we drop the 44 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.

Having identified from the data the border discontinuity, we now verify the second requirement that ventures above and below the border look ex ante comparable except that they received funding from Tech Coast Angels. This step is necessary to assert that we have identified a quasi exogenous component to angel investing that is not merely reflecting underlying quality differences among the firms. Once established, a comparison of the outcomes of above border versus below border ventures will provide a better estimate of the role of angel financing in venture success as the quality differences inherent in the Table 1's distribution will be removed.

Before assessing this comparability, we make two sample adjustments. First, to allow us to later jointly analyze our two investment groups, we restrict the sample to ventures that approached Tech Coast Angels in the 2001-2006 period. This restriction also allows us a minimum horizon of four years for measuring outcomes. Second, we remove cases where the funding opportunity is withdrawn from consideration by the venture itself. These withdrawn deals are mainly due to ventures being funded by venture capital firms (i.e., the venture courted multiple financiers simultaneously). As these deals do not fit well into our conceptual experiment of the benefits and costs of receiving or being denied angel funding, it is best to omit them from the sample. Our final sample includes 87 firms from Tech Coast Angels, with 46 ventures being above the border and 41 below. 45 of the 87 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 firms 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 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 two border groups are very comparable in terms of venture traits, industries, and venture stages. The first four 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., is the firm 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 Squared probabilities for the latter two distributions are 0.831 and 0.534, respectively. For all of these traits, the null hypothesis that the two groups are similar is not rejected.

While there are no observable differences in the characteristics of the ventures in the first three panels, the fourth panel of Table 2 shows that there are significant differences in how angels engage with ventures above and below the cut-off. With just a small adjustment in interest levels, angels assemble many more documents regarding the venture (evidence of due diligence), have more discussion points in their database about the opportunity, and ultimately are 60% more likely to fund the venture. All of these differences are statistically significant. This supports

our identifying hypothesis that there is a non-linear change in the provision of resources from the angel group around the cut-off. 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 cut-off.

2.2. CommonAngels

CommonAngels is the leading angel investment group in Boston, Massachusetts. They have over 70 angels seeking high-growth investments in high-tech industries. The group typically looks for funding opportunities between $500 thousand and $5 million. Additional details on this venture group are available at http://www.commonangels.com.

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 2000 ventures. Unlike the Tech Coast Angels data, however, 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 under 30% of ventures that reach the pitch stage with CommonAngels receive funding.

CommonAngels does, however, conduct a paper-based poll of members following 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 provided 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 between 2001 and 2006. After dropping two poor quality records, our sample has 63 pitches in total. 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 that 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 that award the pitch 90% or more of the maximum score (that is, 4.5 out of 5, 9 out of 10). This is close in spirit to the dichotomous expression of interest in the Tech Coast Angels database.

Some simple statistics describe the non-linear effect. Of the 63 pitches, 14 ventures receive a 90% or above score from at least one angel; no deal receives such a score from more than 40% of attending angels. Of these 14 deals, 7 deals are ultimately funded by CommonAngels. Of the 49 other deals, only 11 are funded. This stark discontinuity is not present when looking at lower cut-offs for interest levels. For example, all but 12 ventures receive at least one vote that is 80% of the maximum score (that is, 4 out of 5, 8 out of 10). There is further no material difference in funding probability based upon receiving more or fewer 80% votes. The same applies to lower cut-offs for interest levels.

We restrict the sample to the 43 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 30 angels if at least six of those angels score the venture as 8 out of 10 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 9 out of 10 or better. A venture with only five angels at this extreme value is classified 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 20 CommonAngels pitches that receive low scores, but that is 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 63 pitches out of over 2000 deals in the full database of submitted plans.

Our formal empirical analyses jointly consider the two groups. To facilitate this merger, we construct simple indicator variables for whether a venture is funded or not, whether the venture is above and below the border discontinuity, and uniform industry classifications. 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 significant 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 financing.

3.1. Venture Survival and Success

Our simplest measure is a binary indicator variable for firm 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. We first directly contacted as many ventures as possible to learn their current status. Second, we looked for evidence of the ventures' operations in industry databases or news wires.[5] Finally, we examined every venture's web site if one exists. Existence of a web site is not sufficient for being alive, as some ventures leave a web site running after closing operations. We thus based our measurement on how recent various items like press releases were.[6]

Our second measure is a binary indicator variable for whether the venture has undergone a successful exit by December 2010. A successful exit can either be initial public offering (IPO) or a successful acquisition. We code acquisitions as successful exits or not based upon the press releases, news articles, and blog posts surrounding the event. We define an unsuccessful exit as an "asset sale" or similar transaction. In total, 3 and 8 of our 130 ventures have a successful IPO or acquisition, respectively, by December 2010. 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 75 or more employees in 2010. 22 of our 130 ventures are successful according to this combined measure. By contrast, 45 of the 130 ventures have closed or had an unsuccessful exit.

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

[6] In cases of acquisition, we code whether the venture is alive or not through a judgment of 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 $5 million (where known). If the event was termed an "asset sale" or similar, we code the venture as not having survived. The results below are robust to simply dropping these cases.

3.2. Venture Operations and Growth

Our second set of metrics quantify venture operations and growth after the potential financing event. While we would ideally consider a range of performance variables like sales and product introductions, obtaining data on private ventures is extremely challenging. This is especially true for unfunded ventures. We are able to make traction with three outcome variables: employment, patents, and web traffic. These three measures also allow for more short-term differentiation than 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 with the specified range. The chosen point estimates reflect the typical firm size distribution through the range (e.g., an employment level of 20 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. In empirical exercises, we show that the results are robust to instead using caps of 50 employees or 250 employees. Using a maximum of 100 employees, our average venture had 26 employees in 2010 (36 among operating businesses) versus 12 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 have 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 an imperfect measure of innovation levels more generally.

We also want to observe venture growth, but developing time consistent data for this exercise is very challenging. We are able to make traction, however, through web traffic records. To our knowledge, this is the first time that this measure has been employed in an entrepreneurial finance study. We collected web traffic data from www.alexa.com, one of the largest providers of this type of information.[7]

We collected web traffic data in the summer of 2008 and January 2010. We identify 91 of our 130 ventures in one of the two periods, and 58 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.

[7] 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 onto a user's Internet browser and records the user's web use in detail. 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 'building block' 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 how many pages, on average, 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.

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 improvements and declines in traffic. A limitation, however, is that it is only defined for ventures whose web sites are active in both periods. We thus also define a second outcome measure as a binary indicator for improved venture performance on the web.[8] This technique allows us to consider all 91 ventures for which we observe web traffic at some point, while sacrificing the granularity of the other measure.[9]

3.3. Venture Financing

Our final measures describe whether the venture received venture financing. We define these measures through data collected from VentureXpert, CorpTech, and cross-checked with as many ventures directly 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 with syndication).

4. Results for Entrepreneurial Firms

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

[8] 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.

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

4.1. The Impact of Funding on Firm Outcomes

Tables 3a-3c quantify the relationship between angel group financing and venture outcomes. We focus mostly on the 130 ventures that are used in our border analysis. This sample restriction removes both very low quality and very high quality ventures, focusing 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 3a considers our indicator 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. We control for angel group, year, and industry fixed effects. Year fixed effects are for the year that the venture approached the angel group. The coefficient on indicator variable is 0.27 and is statistically significant at the 1% level. Firms that received angel funding are 27% more likely to survive for at least five years.

Columns 2 shows that funded ventures are also 11% more likely to undergo a successful exit by December 2010. Unreported specifications disaggregate this result into a 7% higher likelihood of successful acquisition and a 4% higher likelihood of going public. Finally, Column 3 finds that the funded ventures are 16% more likely to be successful, where success represents achieving 75 employees or a successful exit by December 2010. These additional outcomes are all statistically significant and precisely measured. Moreover, reflecting 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 specification to Table 3a. The first column finds that funded ventures have 19.3 more employees in 2010 than unfunded ventures. This estimate is again statistically significant. Column 2 shows

that this higher employment level in 2010 is not due to funded venture having greater employment at the time of the pitch.[10]

Column 3 shows that funded ventures are 18% more likely to have a granted patent. Columns 4 and 5 consider improvements and growth in web traffic performance. Funded ventures are 16% more likely to have improved performance, but this estimate is not precisely measured. On the other hand, our intensive measure of firm performance, the log ratio of web site ranks, finds a more powerful effect. Funded ventures show on average 39% greater improvements in web rank than unfunded ventures in recent years.

Finally, Table 3c estimates whether angel funding promotes stronger venture financing. Panel A considers indicator variables for types of financing activity, while Panel B considers counts of financing rounds. The first column begins with whether the venture ever receives professional financing. This starting point provides background on whether alternative financing to the angel group was easily available. We find that funded ventures are 70% more likely to receive some form venture financing than start-ups rejected by the angel groups. On average, they have 2.1 more financing rounds. These estimates suggest that rejected deals found it reasonably difficult to obtain venture financing at all.

The estimates in Column 1 use data on venture financing that we developed from multiple sources, including contacting the venture directly. Column 2 shows similar results, but somewhat lower elasticities, when we use only data that we would obtain from searching VentureXpert. We return to this estimation shortly when discussing Table 4's expanded sample.

[10] Our data description highlighted the need to cap very high employment or successful exits at a certain employment level. The measured employment effect 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 50 employees. Based upon the collected data for very successful ventures, a cap of 100 employees appears most appropriate, and our preferred estimate is the 19.3 employee figure.

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 obtains any financing. Even after excluding the current angel financing event, the ventures funded by the angel groups are 27% more likely to obtain later financing and have on average 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. Comparing 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 little under half of their magnitude in Column 3. Being funded by the 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 this issue below after viewing our border discontinuity results.[11]

4.2. The Role of Sample Construction

The results in Tables 3a-3c suggest an important association between angel funding and venture performance. In describing our data and empirical methodology, we noted several ways

[11] 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.

that our analysis differed from a standard regression. 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 to funded ventures. This step helps ensure ex ante comparable treatment and control groups in that all the ventures are seeking high growth. Second, we substantially narrow even this distribution of prospective deals (illustrated in Table 1) until we have a group of companies that are ex ante comparable (shown in Table 2). 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 quality differences inherent in the selection funnel—influences 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 first column repeats a modified, univariate form of Column 2 in Table 3b with just the Tech Coast Angels sample. The elasticities are very similar, and we only use the information that we would have collected from VentureXpert. The second column expands the sample to include 2385 potential ventures in the Tech Coast Angels database. The elasticity increases 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 coefficient on the angel funding dummy is 0.11 and significant at the 1% level. This positive association moreover holds when excluding companies that Tech Coast Angels ultimately funds. In unreported regressions, we find that it has a beta coefficient 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 qualities of investment opportunity, reduces the measured elasticity in the full sample to similar to our border group by about 10%. In total, these results suggest that while there is positive and significant relationship between the level of interest by the angels in a deal and the underlying quality of the firms, there is a strong non-linearity in outcomes for those deals that were supported by the angel group versus those that were not.

Finally, Column 5 shows a similar pattern with 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.[12] 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 financing events.

[12] The matched sample in Table 4 includes ventures outside of our primary interest region where an appropriate match could be identified. We have further confirmed 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 significant 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 firm received funding and zero otherwise. The primary explanatory variable is an indicator variable for the venture being above or below the interest discontinuity.

Column 1 controls for angel group fixed effects, year fixed effects, and industry fixed 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 find that there is a statistically and economically significant relationship between funding likelihood and being above the border: being above the border increases funding likelihood by about 33%. Clearly, the border line designation is not a perfect rule—and this fuzziness will limit below how strongly we interpret the regression discontinuity—but it does signify a very strong shift in funding probability among ventures that are ex ante comparable as shown in Table 2.

Column 2 shows similar results when we add year*angel group fixed effects. These fixed effects control for the secular trends of each angel group. The funding jump also holds for each angel group individually. Column 3 repeats the regression controlling for deal characteristics like firm size and number of employees at the time of the pitch. The sample size shrinks to 87 as we only have this information for Tech Coast Angel deals. But despite the smaller sample size, we still find a significant difference in funding probability. The magnitude of the effect is comparable to the full sample at 29%. Unreported regressions find a group-specific elasticity for

CommonAngels of 0.45 (0.21). These results suggest that the identified discontinuities provide a reasonable identification strategy.[13]

4.4. Border Discontinuities and Firm Outcomes

Tables 6a-6c consider venture outcomes and the border discontinuity. Even with eliminating observable heterogeneity through sample selection, the results in Table 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 to evaluate whether the ventures that looked ex ante comparable, 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 success.

Tables 6a and 6b have the same format as Tables 5a and 5b; 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.[14] 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

[13] 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 band-wagon 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 non-linear. 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.

[14] 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.

2010 as measured by successful exits or having 75 or more employees. In Table 6b, above border ventures are associated with generally better operating performance as measured by employment levels, patenting, and web site traffic growth.

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

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

5. Results for the Angel Investors

The focus of our paper is on the impact of angel group investments for start-up firms, but one natural question revolves around the extent to which these investments represent an economically driven activity. Angel investors are not professional investors managing other organizations' capital, but rather individuals who likely derive utility from simply meeting with

and investing in entrepreneurs. This raises questions about whether our findings apply well to the venture industry 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 funds. If these two measures are comparable, then this will dispel these hobbyist concerns.[15]

We undertake this analysis using data on the performance of venture funds from VentureXpert, which has been previously extensively used in venture capital research like Kaplan and Schoar (2005). We compare the track record of the industry to that of one of the angel groups as December 2009. Because of data limitations for the angel investments, we compare the investment multiples of the transactions executed in each year rather than rates of returns. We compute two ratios: 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).

There are several complications which make such a comparison complex. First, professional venture funds charge investors a management fee (typically 2% of committed capital) and retain a share of the profits. The returns reported by VentureXpert are net of these fees. Direct investments by angels do not incur these costs. We thus 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 that year.

A second complication is that the angel data are computed using investment dates, while VentureXpert's tabulations are arranged by the fund's vintage year (measured using the fund's

[15] It is also important to note that both funds have professional managers. CommonAngels further raises venture funds from limited partners that its professional managers invest alongside the angels (e.g., Applegate et al., 2010).

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 initial closing. But, data constraints require that we use the inexact time comparisons.

A third, subtle complication is the aggregation across years. We weight the industry data in two ways: by amount raised by the venture capital industry as a whole in each vintage year (the vintage year weighting scheme), and using the same weights as the angel group's investments (the angel weighting scheme). Whether the venture industry or the angel group made better timing decisions about their investments is hard to tell due to the uncertainty about ultimate performance of the yet-to be exited investments, but the industry as a whole invested a greater amount during the older "bubble" years. Such a pattern means that a comparison of distributed to paid-in capital will be tilted in favor of the venture industry using the vintage year weighting, since the investments tend to be more mature and thus have had more time to have been exited.

Table 7 presents the comparison, with the bottom lines providing the summary statistics. The performance in both cases is better using the vintage year weighting than the angel group weighting, which reflects the lack of maturity (and hence lower valuations) of the more recent years' portfolios' performance, as well as the superior performance of both groups in the 1997 investments. Using the venture capital activity weighting scheme, the angel group sharply outperforms the venture industry as a whole, even after adjusting for pseudo-fees and carry: the ratios of distributed capital and total value to paid-in capital are at least two times greater. Using the angel group weighting scheme, the differences narrow, but the angel group still has a marked advantage in the ratio of total value to paid-in capital. Collectively, the evidence provides little

support for claim that angel investors are hobbyists who are not pursuing the investment selection process seriously.

6. Conclusions and Interpretations

The results of this study, and our border analysis in particular, suggest that angel investments enhance entrepreneurial operations and performance. Using a variety of econometric techniques, we find consistent evidence that angel financing is associated with improved outcomes for firms like survival for four or more years, employment, and stronger web traffic performance. We also find suggestive evidence that angel group financing aids ultimate venture success in terms of achieving successful exits or reaching high employment levels. These success results are very strong in the base data, but they are only qualitatively supported in the border analysis. This difference may be due to our moderate time horizon, or it could reflect that the angel groups purposeful select ventures with rapid exit potential (but that this potential is somehow not reflected in our interest measures).

Our evidence regarding the role of angel funding for access to future venture financing is more mixed. Being funded by 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 bring. 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. However, additional screening and

evaluation do not substantially improve the selection and composition of the portfolio further. These findings suggest that the selection and screening process is efficient at sorting proposals into approximate bins: complete losers, potential winners, and so on. The process has natural limitations, however, in further differentiating among the potential winners (e.g., Kerr and Nanda, 2009).

At the same time, this paper has important limitations. Our experiment does not allow us to identify the costs to ventures of angel group support (e.g., Hsu, 2004), as equity positions in the counterfactual, unfunded ventures are not defined. We thus cannot evaluate whether taking the money was worth it from the entrepreneur's perspective after these costs are considered. On a similar note, we have looked at just a few of the many angel investment groups that are active in the US. 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. This project demonstrates that angel investments are important and also offer an empirical foothold for analyzing many important questions in entrepreneurial finance.

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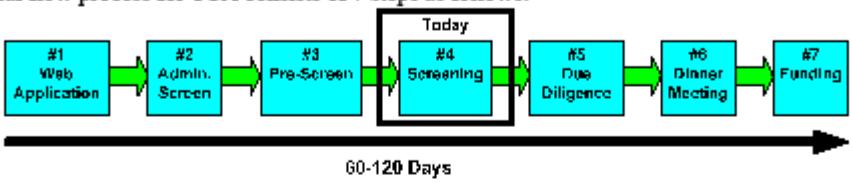
Figure 1: Tech Coast Angels Investment Process

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.

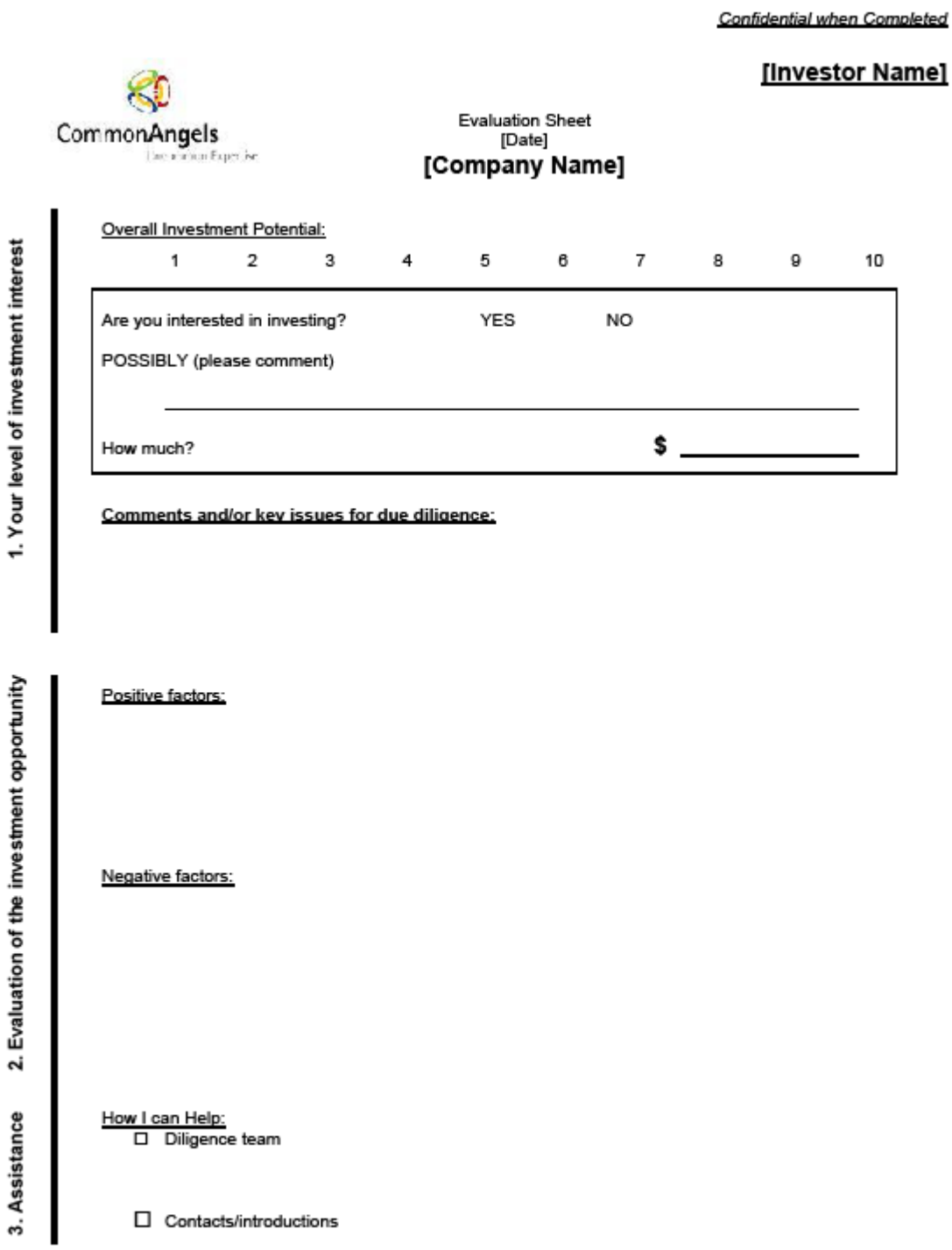
5. **Due Diligence** – A due diligence team is formed based on the number of interested members who signed up during the screening. A deal lead steps forward and helps coordinate the due diligence activities. Due diligence consists of verifying representations by the venture, customers, agreements, references, 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 2: CommonAngels Pitch Evaluation Sheet



Confidential when Completed

[Investor Name]

CommonAngels

Evaluation Sheet
[Date]
[Company Name]

1. Your level of investment interest

Overall Investment Potential:

1 2 3 4 5 6 7 8 9 10

Are you interested in investing? YES NO

POSSIBLY (please comment)

_____

How much? $ _____

Comments and/or key issues for due diligence:

2. Evaluation of the investment opportunity

Positive factors:

Negative factors:

3. Assistance

How I can Help:

☐ Diligence team

☐ Contacts/introductions

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%	0.000
1-4	537	84%	0.007
5-9	135	90%	0.037
10-14	75	93%	0.120
15-19	52	95%	0.173
20-24	42	96%	0.381
25-29	33	97%	0.303
30-34	21	98%	0.286
35+	44	100%	0.409

Notes: Table documents the selection funnel for Tech Coast Angels. The vast majority of ventures proposed to Tech Coast Angels receive very little interest, with 90% of plans obtaining the interest of fewer than ten angels. A small fraction of ventures obtain extremely high interest levels with 50 angels or more expressing interest in 15 ventures. We identify an interest level of 20 angels as our border discontinuity. Our "below border" group consists of ventures receiving 10-19 interested angels. Our "above border" group consists of ventures receiving 20-34 interested angels.

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 ($ 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

Notes: Table demonstrates the ex ante comparability 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 three panels show that the two groups are very comparable in terms of venture traits, industries, and venture stage. The first row tests equality for log value of financing sought. For none of these ex ante traits are the groups statistically different from each other. The two groups differ remarkably, however, in the likelihood of receiving funding. This is shown in the fourth panel. Comparisons of the subsequent performance of these two groups thus offers a better estimate of the role of angel financing in venture success as the quality heterogeneity of ventures inherent in the full distribution of Table 1 is removed.

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 acq.) by December 2010	(0,1) venture underwent successful exit or had 75+ empl. by December 2010
	(1)	(2)	(3)
(0,1) indicator variable for venture funding being received from angel group	0.246 (0.083)	0.110 (0.054)	0.163 (0.074)
Angel group, year, and industry fixed effects	Yes	Yes	Yes
Observations	130	130	130

Notes: Linear regressions quantify the relationship between funding and venture success. Both Tech Coast Angels and CommonAngels data for 2001-2006 are employed in all regressions. 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. The third column further also considers venture successful if it has 75 employees or more in December 2010. Robust standard errors are reported. Funding by the angel group is associated with stronger subsequent venture success.

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)
(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)			
Angel group, year, and industry fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	130	83	130	91	58

Notes: See Table 3a. Linear regressions quantify the relationship between funding and venture operations. 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 web site 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). Across these outcomes, funding by an angel group is associated with stronger subsequent venture operations.

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)
			A. (0,1) indicator variable for indicated financing activity		
(0,1) indicator variable for venture	0.706	0.405	0.270	0.253	0.124
funding being received from angel group	(0.063)	(0.087)	(0.090)	(0.092)	(0.095)
			B. Count of financing rounds for indicated financing activity		
(0,1) indicator variable for venture	2.065	1.765	1.239	1.385	0.762
funding being received from angel group	(0.436)	(0.467)	(0.446)	(0.477)	(0.436)
Angel group, year, and industry fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	130	130	130	130	130

Notes: See Table 3a. 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 CommonAngels and Tech Coast Angels. The last column considers deals that do not involve CommonAngels and Tech Coast Angels at all. Across these outcomes, Panel A presents a binary indicator variables, while Panel B considers counts of financing rounds. Being funded by the angel groups aids access to follow-on financing, with a little under half of the subsequent deals syndicated by the angel groups with other venture financiers.

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

Notes: 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 demonstrates the role of sample construction in assessing angel funding and venture performance. The narrower sample provides a more comparable control group. Columns 3 and 4 illustrate this relationship in a second way through jointly analyzing interest levels with funded. 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.

Table 5: Border discontinuity and venture funding by angel groups

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

Notes: Regressions employ linear probability models to quantify the funding discontinuity in the border region. Both Tech Coast Angels and CommonAngels data are employed excepting Column 3. Additional controls in Column 3 include stage of company and employment levels fixed effects. A strong, robust increase in funding probability of about 30% exists for ventures just above the border discontinuity compared to those below. Robust standard errors are reported.

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 acq.) by December 2010	(0,1) venture underwent successful exit or had 75+ empl. by December 2010
	(1)	(2)	(3)
(0,1) indicator variable for venture being above the funding border discontinuity	0.247 (0.095)	0.075 (0.058)	0.088 (0.086)
Angel group, year, and industry fixed effects	Yes	Yes	Yes
Observations	130	130	130

Notes: See Table 3a. Linear regressions quantify the relationship between the border discontinuity and venture success. Ventures above the border are more likely to be alive in December 2010. Ventures above the border may have greater venture success in terms of IPOs/acquisitions or higher employment levels, but these results are not statistically significant.

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)
(0,1) indicator variable for venture being above the funding border discontinuity	12.431 (7.421)	11.187 (8.006)	0.154 (0.089)	0.232 (0.120)	-0.382 (0.249)
Employment level at the time that the venture approached the angel group		0.755 (0.150)			
Angel group, year, and industry fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	130	83	130	91	58

Notes: See Tables 3b. Linear regressions quantify the relationship between the border discontinuity and venture operations. Ventures above the border have improved operations relative to companies below the border across these metrics.

Table 6c: Analysis of border discontinuity and venture financing

	Receiving any venture financing	Receives later venture financing than the current angel investment
	(1)	(2)
	A. (0,1) indicator variable	
(0,1) indicator variable for venture being above the funding border discontinuity	0.177 (0.094)	-0.033 (0.102)
	B. Count of financing rounds	
(0,1) indicator variable for venture being above the funding border discontinuity	-0.039 (0.459)	-0.369 (0.421)
Angel group, year, and industry fixed effects	Yes	Yes
Observations	130	130

Notes: See Table 3c. The border discontinuity is not associated with increased subsequent financing events.

Table 7: Analysis of angel group portfolio investment returns

Fund year	Cumulative US VC vintage year performance				Angel group performance, by year of investment								
	Sample size	Total VC funds raised in vintage year ($B)	Capital weighted average: D/PI	Capital weighted average: TV/PI	$ 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
1997	64	19.8	2.11	2.37	$1,150,000	$18,630,000	$18,630,000	$178,250	$3,496,000	16.20	16.20	11.39	11.39
1998	78	30.0	1.28	1.72	$6,285,510	$242,342	$3,130,342	$974,254	$0	0.04	0.50	0.03	0.43
1999	107	55.7	0.45	0.74	$16,331,104	$10,386,749	$13,138,226	$2,531,321	$0	0.64	0.80	0.55	0.70
2000	122	104.5	0.48	1.03	$12,819,029	$5,588,458	$13,815,428	$1,986,949	$0	0.44	1.08	0.38	0.93
2001	59	38.9	0.56	1.16	$6,563,700	$4,277,088	$35,390,216	$1,000,964	$0	0.65	5.39	0.57	4.68
2002	20	9.4	0.21	0.97	$3,701,495	$1,218,194	$3,977,907	$545,971	$0	0.33	1.07	0.29	0.94
2003	17	11.6	0.34	1.11	$4,251,519	$914,050	$6,967,163	$596,276	$0	0.21	1.64	0.19	1.44
2004	23	19.8	0.24	1.04	$7,466,829	$615,813	$9,617,376	$970,688	$0	0.08	1.29	0.07	1.14
2005	21	29.0	0.11	1.02	$14,079,569	$350,000	$17,975,928	$1,548,753	$0	0.02	1.28	0.02	1.15
2006	38	22.0	0.11	0.96	$11,567,778	$1,025,000	$16,189,696	$1,041,100	$0	0.09	1.40	0.08	1.28
2007	20	36.1	0.03	0.94	$9,469,772	$0	$7,538,680	$662,884	$0	0.00	0.80	0.00	0.74
2008	12	28.5	0.00	0.85	$6,527,593	$0	$5,421,499	$326,380	$0	0.00	0.83	0.00	0.79
Wtd average, VC funds raised			**0.67**	**1.22**						**2.52**	**3.54**	**1.82**	**2.71**
Wtd average, TCA weights			**0.35**	**1.02**						**0.43**	**1.51**	**0.34**	**1.31**

Notes: Table compares performance of an angel group fund to the venture capital industry as a whole. Weights used in the first weighted industry average returns are based on cumulative 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. Industry data from Thomson Reuters.